CONSERVING THE ROOTS OF TRADE:
LOCAL ECOLOGICAL KNOWLEDGE OF ETHNOMEDICINES FROM
TANGA, TANZANIA MARKETS

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AT THE TIME OF MICROFILMING/SCANNING
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ABSTRACT

This dissertation is based on research with healers, vendors, harvesters, and consumers of medicinal plants in a botanically rich, economically poor area where conservation, livelihoods, and health are key concerns. It examines biological and social factors related to the knowledge, procurement, and use of medicinal flora, and considers whether focusing on locally important plants and places can promote larger conservation goals. Methods include: 79 semi-structured interviews on medicinal plant acquisition; 28 market inventories of >250 ethnospecies; 74 local ecological knowledge (LEK) surveys on nine medicinal species; 112 semi-structured household interviews and inventories of home gardens; and 13 focus groups to validate, expand, and return findings. Twenty key species were identified on the basis of their 25% prevalence rate among vendors’ stocks and vendors nominating them as important. These are primarily bark and roots of non-cultivated, locally harvested, native trees. Seventeen are widely distributed and found in areas that range from highly anthropogenic to relatively undisturbed, and three are comparatively vulnerable. They are Warburgia stuhlmannii (proposed as endangered due to its limited distribution in Coastal Forests) and Ocotea usambarensis and Morella salicifolia, two montane species which are primarily harvested in forest reserves.

While quantitative LEK survey analyses show no significant differences in knowledge among social groups (based on role, gender, experience, age), qualitative analyses indicate that healers have a greater understanding of and adhere more to harvesting pre- and proscriptions. Culturally based and ecologically based knowledge are significantly correlated, but knowledge and behavior are not necessarily consistent with each other.
The marketplace is a central locus for knowledge transmission and this transmission is influenced by market demands and motivated by opportunities to supplement livelihoods.

The dissertation concludes that phytomedicine harvest is not presently a threat to conservation in Tanga, but the availability of these plants may be limited in the future. This is indicated by local observations of shrinking medicinal plant habitats and populations, and a growing demand for commercial species that are wild harvested but not cultivated. The findings underscore the value of plant medicines to local people's health, livelihoods, and culture and, therefore, their potential to sponsor biodiversity conservation.
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<td>ARV</td>
<td>Antiretroviral Therapies</td>
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<td>CHAWATIATA</td>
<td><em>Chama cha Waganga na Wakunga Asilia Tanzania</em> ‘National Union of Traditional Healers and Midwives of Tanzania’</td>
</tr>
<tr>
<td>CITES</td>
<td>The Convention on International Trade in Endangered Species of Wild Fauna and Flora</td>
</tr>
<tr>
<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
</tr>
<tr>
<td>AIDS</td>
<td>Acquired Immunodeficiency Syndrome</td>
</tr>
<tr>
<td>JFM</td>
<td>Joint Forest Management</td>
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<tr>
<td>LEK</td>
<td>Local Ecological Knowledge</td>
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<tr>
<td>LRM</td>
<td>Local Resource Management</td>
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<tr>
<td>MO</td>
<td>Missouri Botanical Garden</td>
</tr>
<tr>
<td>NHT</td>
<td>National Herbarium of Tanzania</td>
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<tr>
<td>NTFP</td>
<td>Non-timber Forest Product</td>
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<tr>
<td>PLWA</td>
<td>Person Living with HIV/AIDS</td>
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<tr>
<td>SES</td>
<td>Socio-ecological Systems</td>
</tr>
<tr>
<td>TAWG</td>
<td>Tanga AIDS Working Group</td>
</tr>
<tr>
<td>TSh</td>
<td>Tanzanian Shilling</td>
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<tr>
<td>USD</td>
<td>United States Dollar</td>
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CLARIFICATION

Throughout this dissertation, I use the term “ethnospecies” to refer to local names of botanical species. (These appear in italics but English common names are not italicized.) Obviously these are not always 1:1 matches. In some cases there are multiple local names for the same species and in other cases the local name refers to several species. In each chapter, the first mention of each botanical species is by its genus, species, subspecies (if applicable), authority, and family. In subsequent references to that species, only the abbreviated genus and species is given. For the sake of uniformity, exceptions are in tables when the full name is used, even if it has been mentioned previously.

Foreign words are in italics. Translations of those words appear directly afterward in single quotes. Swahili is a national language of Tanzania and is the foreign language most used in this dissertation. Its pronunciation is phonetic. In Swahili there are seven noun classes and these determine the beginning of the word. Animate objects begin with ‘m’ in the singular and ‘wa’ in the plural (with some exceptions) and this appears, for example, in mganga ‘doctor’ and waganga ‘doctors.’ Maasai and Sambaa languages are used in a few cases, primarily to refer to ethnospecies.

Throughout this dissertation “management” broadly refers to the entire process from selection, cultivation (if applicable), harvest, preparation, sale, distribution, administration, and use of natural resources.
No novel or proprietary uses for medicinal uses plants are mentioned in this dissertation. In the few cases when uses are mentioned, they are common knowledge locally and they have already been published elsewhere.
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CHAPTER 1. RESEARCH PROBLEM AND OVERVIEW OF DISSERTATION

1.1 The Research Problem

1.1.1 Introduction

This dissertation focuses on medicinal plant knowledge, management, and use; their social and ecological underpinnings; and how they relate to conservation in Tanga, Tanzania, east Africa. Around the world, medicinal plants are used and harvested at growing rates but not much is known about their future availability. It is known they are important to health, livelihoods, culture and ecosystems. Medicinal plant use is based in traditions but it continues to evolve and adapt. The social and ecological contexts in which these plants and the people that use them exist need to be understood in order to effectively be included in resource management. This research shows that although medicinal plant management is not presently a threat to resource management in Tanga, it has a potential role to play in conservation.

If medicinal plants achieve their highest relative values in societies that live in areas richest in plant diversity, then conservation projects in these biodiverse places would benefit from a focus on medicinal plants (Hamilton 2004:1509). Worldwide, phytomedicines are more than salient features of ethnomedical systems; they are integral to the primary health care of 80% of people in developing countries (World Health Organization 2002) where they are relied upon by 75% of people living with HIV/AIDS (World Health Organization 2002), and serve as the first line treatment for 60% of children with high fevers associated with malaria (World Health Organization 2003). The collection and sale of medicinal plants are also the basis of a hidden yet vital economy that generates income for marginalized groups with little formal education or
regular employment opportunities. In the broader context, medicinal plants are involved in complex relationships with other organisms and processes, and thus are important from an ecological perspective. In other words, medicinal plant existence, use, and procurement are woven into the biological and social fabric of life. Accordingly, people interested in medicinal plants range among international conservation organizations, urban healers, rural harvesters and vendors, village mothers seeking to treat their children's convulsions, and people living with HIV/AIDS.

Although little is known about the specific circumstances of harvesting medicinal plants, there is well-founded concern that it threatens biodiversity conservation (Anyinam 1999; Cunningham 1993a; Hamilton 2004; Schippman, et al. 2002) as well as sustainable primary health care (Barany, et al. 2001; Grifo and Rosenthal 1997; Shanley and Luz 2003). Local stocks of *Warburgia salutaris* (Bertol.) Chiov. Canellaceae in Zimbabwe (Botha, et al. 2004a; Maroyi 2000) and *Prunus africana* (Hook. F.) Kalkman Roseaceae in Cameroon (Cunningham, et al. 2002) have become exhausted due to their demand locally and internationally. Processes such as these not only affect local health care and economies, they also affect forest structure and canopy cover, which can lead to an influx of invasive exotic species and affect ecological processes.

While there is no strong evidence that points to the danger of complete continental extinction of any one medicinal plant, "the seriousness of local, national or regional extinction, or, indeed, of commercial extinction should not be under-estimated. There can be serious consequences for human livelihoods and economies, botanical genetic conservation" (Hamilton 2004:1484), and ecological and human health. To address these issues, this dissertation will examine an East African case in Tanga,
Tanzania to explore the context of medicinal plant procurement, local ecological knowledge about medicinal plants, and the relationship of local natural resource management to larger conservation goals.

1.1.2 Conservation as a cultural construction

The preservation, maintenance, and restoration of habitats and their natural biological diversity are standard conservation goals. The labels "endangered," "threatened," "native," and "endemic" distinguish species that are priorities for conservation. Experts in medicinal and aromatic plant research assert that species most susceptible to over-harvest are habitat specific, slow growing and destructively harvested for their bark, roots or the whole plant (Schippman, et al. 2002:8). The International Union for the Conservation of Nature's Medicinal Plant Specialist Group has developed guidelines that focus on these and other criteria to identify conservation priorities for species in the trade. Yet, species' value and desirability as perceived by local users and outsiders commonly are highly variable, based on abstract qualities, and often incongruent.

Valuations of natural resources are cultural constructions that are not strongly supported by bioscience, yet they undoubtedly affect conservation planning. For example, megafauna such as whales, mountain gorillas, and pandas generate considerable attention from the public and motivate the flow of substantial resources toward their preservation. These creatures are situated prominently at the top of the conservation pyramid even though their value is questionable to the human communities that live in proximity, and the importance of their roles in ecosystem functioning is uncertain.
An example from coastal East Africa exemplifies the disconnect between outside and inside conservation priorities. Seven species of African violets, *Saintpaulia* of the Gesneriaceae family, are endemic to coastal and Eastern Arc forests in Tanzania and Kenya. Significant human and financial resources have been dedicated to the preservation of this species’ habitat and genetic stock, and a multimillion dollar industry based outside Africa has flourished because they are valued as attractive houseplants in Europe and North America. Local East African populations who live in areas where the plant is endemic do not widely value *Saintpaulia* for spiritual purposes or as a medicine, food, or textile; and they do not benefit from the horticultural celebrity of the plant. It is no wonder that local interest and participation in conserving habitat for this funny purple flower is less than enthusiastic. Paradoxically, *Artemisia africana* Jacq. Ex Willd. Asteraceae, a native species that is commonly used in Tanzania to treat malaria is reportedly becoming scarce (according to locals involved in the trade). The medicinal value of this species and genera are recognized widely. Co-Artum, a Swiss-manufactured pharmaceutical made from Artemisinin derived from *Artemisia annua* L. (a Chinese species), has been adopted by the World Health Organization as the first line of treatment for malaria. In recent years, foreign supplies fell short of the demand for the drug in malaria endemic nations (McNeil 2004). The result is that dispensary shelves go unstocked at the same time that the locally grown species becomes less available. Resources are not being directed toward the preservation of this locally valued species and minimal resources are available to locals to support its propagation (Edwin Shunda, personal communication August 10, 2006). Local interest in conservation would likely be improved if programs address local needs on local terms.
1.1.3 Need for an interdisciplinary approach

Clearly, the issues and influences on medicinal plants cross political, ecological, and cultural boundaries. The results of use and harvest have a ripple effect both in ecological and public health ponds. "...the significance of medicinal plants to people can be sufficiently great that arrangements made for the conservation and sustainable use of medicinal plants can lay important foundations for conservation of natural habitats and ecological services more generally" (Hamilton 2004:1478). Medicinal plants are not only important to people who live where the plants are found, they are also alluring to outsiders. To illustrate this point, 156 PhD dissertations were written on the subject of medicinal plants between 2000-2007, the majority of which came from universities in North America on non-North American locations. Medicinal plants have their own appeal, beyond that of whales, pandas, and gorillas. This common interest "offers fertile ground for bringing conservation debates into the public arena" (Hamilton 2004:1483) and for amplifying local voices on resource management and needs. There could be a great untapped potential in adopting medicinal plants (especially those with multiple uses, e.g., food, cosmetic, textile) as key species in conservation programs. The following quotes illustrate this point:

This [potential for conservation] stems from the special meanings that medicinal plants have to people, related to the major contributions that they make to many people’s lives in terms of health support, financial income, cultural identity and livelihood security. (Hamilton 2004:1477).

We see a number of benefits to identifying and focusing on culturally prominent species in research on environmental.

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1 This number was derived from a June 29, 2007 search of ProQuest database with the key words "medicinal plant" OR "ethnomedic" OR "ethnopharmacology" OR "medical botany" OR "traditional medicine" and limiting the search to doctoral dissertations published between 2000-2007 in any discipline.
economic, and cultural change and restructuring, as well as in ecological restoration and biodiversity conservation efforts. (Garibaldi and Turner 2004)

By addressing the conservation needs of locally important species and places, the larger conservation goals of an area also will be promoted.

1.1.4 Research focus

This research examines the circumstances of medicinal plant management (i.e., procurement, market system, cultivation, and use) in Tanga, Tanzania—a biologically diverse and unique area that has received much attention from conservationists and ecologists, a number of whom have pointed to local human populations and their use (or overuse) of natural resources and habitat modification as the major threats to forest health. This research explores the central question: What mediates medicinal plant management and how does it relate to larger conservation concerns in Tanga, Tanzania?

1.1.5 Origins of the dissertation

The origins of this dissertation can be traced to my earlier research in Tanga, Tanzania that examined the interaction between healers and hospital health workers who treat people living with HIV/AIDS with plant medicines. In 2000, I learned that 200 people living with HIV/AIDS (clients of a non-governmental organization called the Tanga Aids Working Group, TAWG) each receive 4 lbs. of plant medicines (4 species) monthly from a single healer. In 2006, the number of TAWG clients receiving the plant medicines annually increased to 2,100. The extreme importance but uncertain future availability of these plants was startling. Encouragement from local stakeholders who
expressed concern about their plants sparked me to investigate the sociocultural and ecological circumstances of medicinal plants, a topic that has not been researched in the area. Conservationists do not have easy access to the medicinal plant information (species and sources), which is guarded for cultural and economic reasons, and health workers who may be in contact with healers and procurers of plant medicines are already overexerted by caring for patients. Neither group has the access, time, or resources needed to explore the origins and status of the plants. These local and outside interests are the seeds from which this dissertation grew.

1.2 Overview of Theoretical Perspectives in Resource Management Strategies and Conservation

My research is informed by interdisciplinary analytical frameworks that integrate social and natural science theories and methodologies including biocultural, ethnobiological, and socio-ecological approaches. This confluence of theoretical understanding is confused in the literature by a number of prefixed and hyphenated brands of intellectual inquiry. Ultimately, they are all interested in the relationships among people (often, but not always indigenous people) and other organisms (often but not limited to botanical organisms) and their environments.

1.2.1 Biocultural and ethnobiological approaches

Of particular relevance here are studies that integrate ecological, biological, political-economic, and behavioral approaches. These elevate our understanding of the relationships among humans, culture, and health in theoretical terms and in terms of specific communities. Examples include the work of Etkin (e.g., Etkin and Ross 1997;

Their work highlights co-evolutionary relationships among people, plants, and disease. Common threads weaving through their work include: contextualizing medical systems within their larger cultural and ecological frameworks; identifying cultural and behavioral (compared to physiological) traits of humans as the most important in an evolutionary sense; and emphasizing how illness, health, medicines, and expectations of the events that surround them are socially and culturally constructed.

“Ethnobiology is the scientific study of dynamic relationships among peoples, biota, and environments... In the past, Ethnobiology concentrated on cataloging long lists of plants and animals with their associated preparations and uses. Recently our research objectives have become more process-oriented. For example, we now study the processes of cultivation and domestication, the management of useful plant and animal populations, the process of traditional knowledge acquisition and organization, and so forth” (Ethnobiology Working Group 2003).

Ethnobiology research also focuses on medicinal plants. In recognition of the links between biological and cultural diversity, more attention is being paid to research that focuses on local knowledge, health, and the use and management of biodiversity as it relates to ecological processes. Examples are Cocks and Dold’s research on the importance of medicinal plants in South Africa’s Eastern Cape both for cultural purposes and for biodiversity conservation (2006); Etkin’s research on Hausa local environmental knowledge, subsistence modes, and biodiversity (2002); Johns’ examination of the
origins of botanical foods and medicines for humans (1996); Stepp's investigation of the relationships among the ecology of Chiapas and Tzeltal Maya knowledge, use, and procurement of botanical medicines (2002); and Voeks' work which underscores the correlation between anthropogenic landscapes and medicinal plants in the humid tropics (2004). My research also considers biological and social factors in its examination of the knowledge, procurement, and use of medicinal plants within their ecological contexts.

1.2.2 Socio-ecological systems approach

Broadening the scale from examining the influences between humans and specific species or habitats, the socio-ecological systems (SES) approach focuses on the ways ecosystem processes are innately linked to human behavior and institutions. Berkes, Holling, and Folke began writing about this approach more than a decade ago as a way to understand the dynamic interactions that occur on different scales (temporal, spatial, and social) and domains (social institutions, ecological functions, technologies) (1998). This approach understands the normal state of a system as one of disequilibrium, which emphasizes the idea that systems are constantly interacting and adapting on a vast range of scales from microbes to landscapes. This is both a heuristic tool, in its insistence on the inseparability of social and ecological systems as one unit of study, and a way to direct applied research in its focus on adaptive capacity or adaptive management. Yet, the approach can be criticized for its shortcomings in not clearly articulating how to apply it. This is where anthropological (particularly ethnographic) methods are valuable.

While these three approaches (biocultural, ethnobiological, and socio-ecological) are close cousins, they differ. Biocultural approaches tend to be anthropocentric, and
ethnobiological approaches have historically been more biocentric, yet their tendency to meet on common ground is increasing. At the same time, ecologists draw on research from anthropology and ethnobiology and now speak the language of ‘socio-ecological systems’ to explore the processes involved in human-environment interactions. They recognize sociocultural and political systems are important influences on ecosystem adaptation and dynamics. This is a core concept in anthropology, which long ago conceived of humans as not only shaped by, but also active shapers of their environments. The difference is one of scope and scale as the ecologists’ unit of analysis is often on the level of ecosystems or watersheds and biocultural and ethnoecological approaches more often consider smaller systems or human communities.

1.3 Methods

My research utilizes ethnographic (Bernard 1995) and ethnobotanical methods (Alexiades and Sheldon 1996; Cunningham 2001; Martin 1995) to comprehend the context of medicinal plant management in Tanga, Tanzania. As natural complements to ethnographic and ethnobotanical methods, I use participatory research approaches. There is a growing awareness that conservation and successful management of forests cannot be achieved without the cooperation and support of local people. Involving them in research planning, data collection, interpretation, and dissemination is key to feeding back into local and official management.
1.3.1 Ethnographic

Ethnographic data were collected over the course of sixteen consecutive months in the field, which was preceded by almost two cumulative years in the research location. During this time, ethnographic studies of the daily lives of stakeholders in the medicinal plant market chain were conducted through careful observation of plant collection and related behaviors. Ethnomedical and ethnoecological data were gathered from consumers (lay people), specialist healers, commercial harvesters, and vendors of medicinal flora. Data collection began with unstructured interviews in the context of observation and participation in plant collection and related behaviors. Next, semi-structured interviews including cognitive methods (e.g., free listing) were used to determine, for example, the criteria for ranking and ordering plants (e.g., by popularity, scarcity, availability, origin). Collectors with a long history of experience shared their life histories for the purposes of adding a historical dimension to an understanding of plant collection and management. Finally, a structured local ecological knowledge survey was conducted. A knowledge score is calculated for each subject to assess how widespread that expert knowledge is and how it relates to demographic factors (e.g., by age, gender, years of experience collecting). “By being about to predict who understands TEK [traditional ecological knowledge] and TRM [traditional resource management], it should be easier to identify individuals who can work with scientists, bureaucrats, and the local-community to develop effective conservation measures” (Joyal 1996).

Data on plant collection, management, and use were confirmed on an ongoing basis through focus groups (Bernard 1995), approximately one every two months, with a minimum of six people per discussion.
1.3.2 Ethnobotanical

Following guidelines suggested by Martin (1995:191-200) and Cunningham (2001:60-95), economic and commercial data were derived from market surveys in Tanga town and Usambara villages. Medicinal plants which invariably appear in market-settings and enjoy a high volume trade, are the ones that deserve special consideration through ethnobotanical research. Focusing research on the most “popular” (not necessarily most biochemically efficacious) medicinal plants provides an important entry point for exploring which plants and habitats may be at risk from overharvest, and how knowledge and practices related to those plants may affect their ecological status.

The most popular medicinal plants are those that appeared with the highest frequency at local markets and with roadside vendors, and were named most frequently by vendors. The most popular medicines, both voucher specimens and the part used medicinally (root or bark), were used in the local ecological knowledge survey to elicit knowledge related to plant procurement and use.

Voucher specimens were prepared according to standard botanical collection procedures (Alexiades and Sheldon 1996) and deposited at local (National Herbarium of Tanzania, NHT) and US (Missouri Botanical Garden, MO) herbaria for taxonomic identification.

1.3.3 Participatory research approaches

Concerns of local healers and health care practitioners about the availability of plant medicines and concerns of conservation workers and forestry officers about the protection of species and habitats were important motivations for this research.
Accordingly, participatory methods (Maguire 1987) were key to designing and conducting research, evaluating findings, and disseminating results. These were used to finalize and pre-test semi-structured interviews and surveys; establish a ranking system for assessing local ecological knowledge; gather data through market surveys; and verify and disseminate results.

1.3.4 Selection of research locations

Tanga Region in Tanzania is a pertinent research location for ecological, cultural, and public health reasons. 1) Tanzania is botanically the richest area in East Africa with more than 10,000 plant species, 11.2% of which are endemic (Davis, et al. 1994), at least 10% of which have medicinal applications (Mshiu and Mahunnah 1984). The Tanga Region, in particular is also botanically rich with over 1,920 species, including many endemic ones (Davis, et al. 1994). Tanga's ecological and biological diversity results from a range in altitude and climates stretching from the arid lowland coastal forest remnants to the moist forest in the Eastern Arc Mountains, two biodiversity hotspots (Conservation International 2003). Research focused on communities in Tanga Town, home to the region's largest population and commercial district, and smaller communities in the Muheza and Lushoto Districts in the Usambara Mountains. The market survey was conducted in all locations, but participating vendors were primarily from Tanga town and participating harvesters were primarily from rural areas of Muheza and Lushoto Districts. Participating healers were from all areas. 2) The healers of Tanga Region are nationally renowned and this means it is a center for medicinal plant collection and trade. 3) The
demand for plant medicines is increasing in Tanga due to HIV/AIDS (Barany, et al. 2001).

1.4 Research Questions, Findings, and Significance

My primary objective is to understand what drives medicinal plant selection and management in Tanga, which may be valuable in predicting if and when certain plants or ecosystems are stressed, as well as informing the design of culturally appropriate resource management and sustained access to plants necessary for health and well-being.

1.4.1 Research questions

More specifically, this research seeks to address the following questions:

1) What is the context (sociocultural, ethnomedical, economic, and environmental) in which medicinal plants are procured, distributed, used, and managed?

2) What are the key roles, species, and places involved in the medicinal plant trade?

3) What are local ecological knowledge and behaviors related to the management of botanical medicines?

4) What are actual and potential consequences of these management practices?

5) How can an understanding of local knowledge and practices impact resource management and conservation?

1.4.2 Findings

The medicinal plants in Tanga markets meet a range of needs (physiological, social, economic) for all sectors of the population and are a reflection of their diverse
sociocultural and environmental origins. The selection, collection, distribution and use of these plants is rooted in local cultural and ethnomedical systems and influenced by the dynamic ecological, political, and economic contexts in which they are found.

Preferences for medicinal plant part, life form, species, and source habitats differ by social group. Although leafy material from fast-growing herbaceous species is commonly used and sometimes cultivated by consumers and healers, commercial plant medicines diverge from this trend. Overwhelmingly, they consist of wild harvested bark and roots from native trees that grow in a range of habitats from coastal to montane, in areas that are both highly anthropogenic and less influenced by human activity. Understanding these trends has implications for conservation.

Also essential for conservation planning is an understanding of local ecological knowledge (LEK) and local resource management (LRM). The assumption that the stakeholders involved in the medicinal plant market chain occupy fixed and distinct roles and have distinct levels of knowledge as consumers, harvesters, vendors, healers comes into question as the findings reveal that LEK is heterogeneous within social groups not just among them. Further, LEK related to commercial medicinal plants does not follow trends noted elsewhere in studies that focus on the knowledge of plants used at home or by specialists. This study demonstrates that medicinal plant knowledge is influenced not just by the cultural and environmental context in which it occurs, but also by the commercial settings to which it applies. The market is more than a starting point to identify locally important or scarce species to consider for conservation planning, it is also a site of medicinal plant knowledge transmission and innovation.
1.4.3 Significance

The research contributes to medical and environmental anthropologies by documenting previously unrecorded local ecological knowledge and adding to our understanding of the relationships between human health and the biophysical environment. This research builds on the recognition that conservation programs cannot be successful unless they understand and include the local populations and their concerns. It is based on the idea that learning about the pathways medicinal plants travel from their sources to their point of consumption can contribute to the design of culturally appropriate resource management, which is vital both to the health of people and the environment in Tanzania and has applications for other places in the world where people rely on plants for healthcare.

1.5 Organization of the Dissertation

Chapter Two deals with Theoretical perspectives in ethnomedicine, local knowledge, natural resource management strategies and conservation. Chapter Three describes the general biogeography of the larger research location, Tanga, Tanzania, as well as the details of the specific research sites. It also describes the populations of people who participated in the research. Chapter Four details the research design, methodology, and techniques. Chapters Five through Ten present the findings and analyses. In conclusion, Chapter Eleven summarizes the findings, casts them against the literature, and suggests future research directions.
CHAPTER 2: THEORETICAL PERSPECTIVES IN ETHNOMEDICINE, LOCAL KNOWLEDGE, NATURAL RESOURCE MANAGEMENT STRATEGIES, AND CONSERVATION

2.1 Introduction

This chapter establishes a theoretical framework for the dissertation. It begins by describing biocultural perspectives that integrate social and biological science approaches to understand dynamics between people and their natural world. It then reviews treatments of medicinal plants in contexts chemical, cultural, material, and ecological. Local ecological knowledge and resource management bridge the movement of plants from environmental to social contexts, and they are discussed in terms of their relevance to biodiversity conservation and resource management. The chapter concludes with examples of the role that medicinal plants can play in biodiversity conservation more broadly.

2.2 Biocultural Perspective

A biocultural perspective provides the overarching framework for this research. With roots in anthropology, biocultural research integrates bioscientific material (e.g., on disease, evolution, ecology) with interpretive and descriptive contributions from ethnography to examine people and plants on a range of scopes and scales: from the species level and particular ethnographic field sites to whole ecosystems and the human populations that are a part of them. One such approach used in this dissertation is ethnobiology, the “study of dynamic relationships among peoples, biota, and environments” (Ethnobiology Working Group 2003) in past and present societies. These modes of intellectual inquiry span a continuum from a cultural terminus to one that more
clearly resonates with biological approaches; however, the trend has been for these approaches to gravitate towards the middle where a variety of disciplines find a more balanced common ground. Research investigates, for example, the coevolution of biological and cultural diversity, local ecological knowledge acquisition and organization, the influence of human-environment interactions on human health, and how these issues relate to resource management.

2.2.2 Coevolution: understanding past dynamics between people and plants

A coevolutionary approach examines the interactions among people, other animal and plant species, phytochemicals, and pathogens to explain the development of food and medicine use. Etkin and Ross (2003) articulated a model of disease adaptation that integrates features of disease ecology and plant pharmacology to understand how certain foods and medicines affect malaria infection in a rural Hausa population in northern Nigeria. Johns (1996) merges ethnobotany and chemical ecology to look at the biocultural evolution of human dietary behavior and the origins of medicine. He hypothesizes, "human ingestion of plant chemicals is part of an integrated, adaptive response that has both biological and cultural components" and describes how the cultural evolution of the Aymara people and the evolution of the potato in the Andes are intimately related and have coevolved through the process of human selection for increased flavor and decreased toxicity in *Solanum* species. Etkin's treatment of the overlapping context of foods and medicines throughout human biological and social evolution deals with a range of plants and cuisines to advance our understanding of the cultural constructions and biochemical potential of ingested biological material (2006).
Etkin and Johns teach us that the food-medicine dichotomy is a cultural construct that misrepresents what is actually a fluid continuum. Based on concentrations and circumstances of ingestion—the same plant can be a cosmetic, beverage, spice, preservative, medicine, food, or poison. Through the processes of domestication and cultivation, the influence of cultural practices on plant evolution, landscape formation, and biodiversity is evident.

2.2.3 **Socio-Ecological Systems: guiding future interactions between people and plants**

Building on the work of anthropologists and botanists who frame their discussions in terms of specific species and particular eco-cultural settings, Berkes and coauthors work at the scale of landscapes and ecosystems. Their socio-ecological systems paradigm is premised on the contention that, “the delineation between social and natural systems is artificial and arbitrary” (1998:4). Using concepts from ecology (e.g., adaptive capacity, resilience) they focus on ecosystems, people and technology, local knowledge, and property rights institutions with particular attention to the interactions among these entities. This is a heuristic tool, in its insistence on the inseparability of social and ecological systems as one unit of study. It is also a way to direct applied research, with its focus on how local practices rooted in culture and influenced by political-economic realities affect communities, landscapes, and ecosystems that are important to local people and to the global population.
2.3 Medicinal Plant Management: Biological, Cultural, Socioeconomic, and Ecological Factors

Understanding a particular ethnomedical system and its concepts of health, understandings of disease etiology, appropriate modes of treatment, and expected outcomes of treatment is a prerequisite for comprehending how plant medicines are conceived of, procured, and used. Although much research on medicinal plants has been a-contextual, it is important to recognize plant medicines exist in the context of ethnomedical systems that give them meaning. As pharmacologic agents, cultural artifacts, trade goods, and components of complex ecosystems, medicinal plants are (to borrow language from Levi-Strauss) good to think with in exploring human-nature relations.

2.3.2 Medicinal plants are pharmacologic agents

A significant amount of research on medicinal plants exists as atomized contributions to the biological circumstances of their in vitro or in vivo effects. Driven by the quest to improve healthcare in developing nations (Akerele 1987; Ross 2003), and to develop new pharmaceuticals for developed nations (Schuster 2001), such research is dedicated to judging the efficacy of medicinal plants from biomedical pharmaceutical perspectives (Farnsworth, et al. 1985). The journals Ethnopharmacology, Pharmaceutical Biology, and at times, the Journal of Economic Botany exemplify this approach as they feature chemical analyses of medicines used in non-biomedical (often indigenous) medical systems. Research of this sort contributes little to our understandings of the specific circumstances of plant management. Because my research concerns the cultural
and ecological context in which medicines are harvested and used, their biochemical activity is not evaluated here.

2.3.3 Medicines are cultural artifacts with symbolic potency

Clearly the meaning of medicine is significant, and in order to be effective it has to convey the right message, regardless of its chemical contents. There is potency in name brand, form, taste, and appearance of medicine, who administers the medicine, and their expectations of its efficacy. These culturally constructed, culturally specific terms signal a medicine’s appropriateness and potential to heal. (See van der Geest, et al. 1996 for an insightful discussion of the metonymic and social aspects of medicines.)

For example, participants in a U.S. study were all given the same inert pill; however some were pink, some blue. Pink pill takers reported a stimulant effect; while blue pill takers reported a sedative effect. Interestingly, blue sleeping pills were not effective for men in Italy, where blue is the color of their football team, an icon that embodies the antithesis of relaxation (Moerman 2002). Other examples from Sub-Saharan Africa demonstrate the specificity with which local (i.e., plant and animal derived) medicines are used. Because of their associations with spirits, red and black are meaningful colors for East African healers, and the red and black seeds of Abrus precatorius L. Fabaceae and Afzelia quanzensis Welw. Fabaceae are widely featured in their materia medica (Cunningham 1993). Research in South Africa concludes that the symbolic meanings of medicines are highly species specific (Botha, et al. 2004b:45; Cunningham 1993a), and substitutes are rarely accepted, even for hard to get species,
which demonstrates the codified and shared meanings that plants have as medicines. (For examples from West Africa see van der Geest, et al. 1996: 166.)

Drawing on examples from rural northern Nigeria, Etkin (e.g., Etkin 1990; Etkin 1992; Etkin, et al. 1999) connects emic interpretations of medicines to local explanatory models of disease. Hausa consider bitter medicines such as cassia and horseradish tree to be dangerous for pregnant women who are discouraged from using them because of gastro and utero tropic effects. For the same reasons, they are also used as abortafacients for undesired pregnancies. Likewise, as bitter pharmaceuticals, chloroquine and chloramphenicol fit the local model and their use is discouraged by pregnant women as well as used to end unwanted pregnancies (Etkin 1992). In another example from Tema, Ghana, fathers give Milk of Magnesia as a gift to mothers. It is seen as an enhancer of their children’s health because it promotes frequent defecation, a local indicator of effective disease prevention (van der Geest and Whyte 1989:315).

These pharmaceuticals are integrated into local medical systems on local terms, even if they are different from their manufacturers’ ideas. Color and taste are but two ways people anticipate the power and utility of medicines. The method in which they are ingested also conveys curative powers. In northern Darfur, Sudan, a Berti man was cured of a disease by eating the prescriptions written by his doctor—a “fortunate mistake” that parallels the therapeutic Islamic practice of drinking the water used to dissolve select sacred passages from the Qur’an (El-Tom cited by van der Geest, et al. 1996:161). These examples demonstrate that a prescription is not just a piece of paper, a pill is not just a capsule of synthetic chemicals, nor is a plant just the producer of phytochemicals. Clearly medicines are used and given meaning within their ethnomedical (i.e. cultural)
contexts and these meanings are culturally constructed, multivalent, and can be specific to particular ethnomedical systems.

2.3.4 Medicinal plants are trade goods that are key to local livelihoods

From a global perspective, medicinal plants contribute to the livelihoods of rural poor people and they are an important source of raw materials to formal and informal herbal and pharmaceutical industries (Dold and Cocks 2002; Shanley and Luz 2003; Sheldon, et al. 1997). Medicines are well-suited as trade goods because they are urgently needed, the demand for them is unlimited (in theory), health is never certain, and their small size makes them easy to transport (van der Geest and Whyte 1989:350). Medicines contribute to people's livelihoods on most continents in rural, urban, and even corporate culture. Pharmaceuticals aside (many of which are also derived from plants), the world market for botanical medicines alone in 1999 was calculated to be worth $19.4 billion (Laird and Pierce 2002). This underscores the magnitude of the medicinal plant trade and the vast numbers and variety of people who are involved in it from the point of harvest to the point of sale.

That said, rural poor people typically are most dependent on medicinal plants – for their curative properties, cultural significance, and their ability to generate income. Medicinal plants are part of a hidden economy and a social security all at once. Harvesters and vendors are typically economically and socially marginalized sections of the population. This includes unemployed, landless people with little formal education, especially women and children (Cunningham 1991; Hamilton 2004; Mander 1998). For many farmers and herders, the sale of medicinal plants provides a supplemental,
intermittent, or fall-back source of income. In central Nepal, 15–30% of the total income of poorer households comes from the collection and sale of medicinal plants (Olsen 1997). Another study in Southwest India revealed that 70% households collect medicinal fruits (*Phyllanthus emblica* L. Euphorbiaceae) for income (Shankar, et al. 1996). Research on Maasai plant medicine vendors from Northeastern Tanzania identifies poverty as the reason for their involvement in the trade. Selling medicines is not a traditional livelihood for Maasai, but they do it to cope with the loss of their cattle herds (Ibrahim and Ibrahim 1998).

In Africa, medicinal plants are considered to be one of the most important non-timber forest products (Walter 2001). Research highlights their economic importance especially to women, the primary vendors (Brockington 2001; Dold and Cocks 2002:596). For example, in northern Tanzania (Tanga Region), Maasai pastoralists were evicted from grazing lands for the development of a game reserve. Subsequently, their herds (which are essentially the basis for their subsistence, livelihood, and cultural identity) dwindled. Many women became itinerant vendors of plant medicines to different ethnic groups in neighboring villages and to distant urban residents in major cities of Kenya, Tanzania (Brockington 2001), and Zanzibar. Almost all of the Maasai medicine plant vendors I met in Tanga are women who lost their cattle and goats after being moved out of what is now Mkomazi Game Reserve.

2.3.5 Medicinal plants are components of complex ecosystems

Although the effects of timber harvesting and clear-cutting forests for plantations and cattle ranching are much more dramatic, the removal and manipulation of forest
products (such as fruits, seeds, vines, bark for foods, textiles, and medicinal plants) also have ecological consequences. Researchers have quantified and evaluated the impacts of non-timber forest product harvesting at the levels of plant populations (e.g., Hall and Bawa 1993; Hegde, et al. 1996) up to the level of ecosystems and have found that it can affect nutrient cycling (Witkowski 1996) and seed dispersal (Ganeshaiah, et al. 1998), facilitate the spread of invasive species (Cunningham 1993a), decrease species richness, decrease the size classes of trees, and increase tree mortality (Ganeshaiah, et al. 1998; Hegde, et al. 1996; Murali, et al. 1996; Shaanker, et al. 1998; Shankar, et al. 1996; Shankar, et al. 1998). As with any forest product, the harvest of medicinal plants affects the general production of ecosystem goods (e.g., food, fuel) and services (e.g., nutrient cycling, water regulation) (Costanza, et al. 1997), and therefore it affects the functioning of the larger biotic community.

The threat posed to habitats by the unsustainable harvest of non-timber forest products catalyzed research on sustainable harvesting. In Mexico, Ticktin and Johns (2002b) compared the ecological impacts of three different harvest and management plans, two of which were based on local practices and one that was designed by the researchers. By quantifying and monitoring population dynamics, the researchers learned that harvesters who remove the entire plant (versus selected leaves) practice the most sustainable harvesting because they also manipulate light and density through managing overstory and understory plants. Research findings like these highlight the great complexity and variability of harvest, as well as, the need to conduct research with the plant harvesters to truly understand the mechanisms that underlie the impacts of harvest. We cannot assume that local practices are always most sustainable, nor can we intuit the
most sustainable method based on assumptions of ecological processes. We must consider the constellation of factors, including the socio-cultural and economic factors (Cunningham 2001; Hall and Bawa 1993:246; Hedge, et al. 1996) that drive these activities. My research recognizes that promoting the sustainable harvest of plant medicines requires understanding which species and plant parts are popularly harvested, their source locations, local management practices, and the socio-economic and cultural underpinnings of those practices. Local ecological knowledge emerges from and coheres around these practices.

2.4 Local Ecological Knowledge: a Paradigm for Examining Biodiversity Conservation

2.4.2 Defining Local Ecological Knowledge

Claude Lévi-Strauss referred to the science du concret or the “native knowledge of the natural milieu firmly rooted in the reality of an accumulation of concrete, personal experiences” (1966). Today, the more specifically defined concepts of indigenous knowledge (Ellen, et al. 2000) and traditional ecological knowledge (Berkes 1999) describe orally transmitted or demonstrated, localized, dynamic, shared systems of knowledge, practice, and beliefs about the relationships among humans, other living beings, and their environment. These knowledge systems are further described as holistic and constantly evolving through experimentation and innovation (Posey 2000:36). Throughout the dissertation I will use the term “local ecological knowledge” which overlaps with the above concepts of culturally guided and empirically based knowledge.
of ecological processes and species interactions as well as the behaviors associated with
the knowledge.

2.4.3 Applications for local ecological knowledge

Research shows how anthropogenic modification of ecosystems can encourage
plant population growth and biodiversity. Examples include the Ka’apor in Amazonia
who manage and manipulate forest resources to maximize useful species through
protecting, planting, transplanting, semi-domesticating, domesticating, and using them
(Balée and Gély 1989). These behaviors call into question the notion of “primary forests”
as untouched. Instead, Balée and Gély propose such forests are the product of long term
human manipulation.

Burning vegetation as a way of managing landscapes and resources has been
portrayed as wasteful and destructive by researchers who did not understand it. Instead,
Posey demonstrated that the Kayapó management of scrub savanna in Brazil is much
more sophisticated than simply burning and results in the creation of apétê, islands of
woody vegetation rich with useful species (1988). In California, Native Americans
enhanced redbud populations by burning, pruning, and weeding which extended their
2000) manipulated resources including the edible Avalanche Lily bulbs by selectively
harvesting large individuals and enhancing productivity through burning.

In many places including Mexico (Alcorn 1995) and Nigeria (Etkin 2002)
farmers work with rather than attempt to overcome natural diversity by managing
“weeds” as part of agricultural practices for soil enrichment and erosion control.
Research also demonstrates how the richness of local knowledge about plants and landscapes can deepen the bioscientific understanding of ecological systems (Gadgil, et al. 1993). Local ecological knowledge has applications to: develop resource management strategies and policies; identify indicators to monitor the sustainable use of resources; and expand into sustainable social and economic development programs, among other things.

Beginning in the 1980s, research in applied ethnobotany, applied environmental anthropology, and ethnoecology has done much to validate local ecological knowledge in the eyes of other researchers, program developers, and policy makers. An emphasis on the applications of local ecological knowledge to science, conservation, economic development, and health underlines the need for community participation in and ownership of research and official resource management policies and programs. Integrating conservation with development, or establishing community based conservation programs brings local people's interests (which are of different scope and time scale than those of outsiders) to the foreground. Integrating local and outside interests through such programs means that political and economic considerations must be embedded into research and management; the local community must be involved in the research process; and results and benefits must be returned in locally meaningful ways. To address these concerns, research and programs focus on livelihoods and health, topics that will be discussed soon.

2.5 Local Ecological Knowledge and Local Resource Management: a Framework to Examine the Links Between Plant Medicines and Conservation

Local resource management systems informed by culture and guided by local place-based knowledge. Examples are socio-political and religious entities that institute
resource management practices that take the form of taboos, and pre- and proscriptions for the utilization of natural resources. Colding and Folke (2001) identify six types of taboos that guide human contact with the natural environment: 1) segment taboos; 2) temporal taboos; 3) method taboos; 4) life history taboos; 5) specific-species taboos and 6) habitat taboos.

Institutions that function to conserve resources exist in Africa; however, they are deteriorating under socio-economic pressures. Sacred groves in Kenya (Wilson 1993) and Nigeria (Warren and Pinkston 1998) and buffer areas in the Sahel rangelands that were protected from grazing by herders are no longer taboo (Niamir-Fuller 1998). In Northern Tanzania, Iraqw’ar elders’ consensus has become less powerful in guiding people’s movements and resource utilization (Tengö and Hammer 2003:149). Similarly, in Morogoro Region (which borders Tanga Region, the study area), certain species (e.g. Scleroarya birrea (A. Rich.) Hochst. Anacardiaceae, Sterculia africana (Forssk.) Sterculiaceae, and Sterculia appendiculata K. Schum. Sterculiaceae) that previously were not harvested because of their association with ancestral sacrifices or with ritual beliefs are harvested now because of their increasing commercial value (Luoga, et al. 2000).

Traditionally, plants were primarily harvested on a relatively small scale and used locally. Relatively recently this has shifted to an economic context where plants are harvested much more intensively for use by distant populations. This shift has ecological consequences that further stress plant populations and ecosystems. Changes in knowledge and collecting strategies intensify concerns related to the management of medicinal plants. Attrition of elders and specialists as well as the accelerating shift from traditional to contemporary lifestyles means that the transmission and practice of local ecological
knowledge may be declining. Research conducted by Atran and coauthors (2004) suggests that the decline of intergenerational knowledge of local ecology is related to a decline in stewardship behavior. This highlights the importance of assessing the existing knowledge, its distribution, diversity, and development (or devolution).

2.5.2 Local resource management and medicinal flora

Three of the changes that have potential effects on the harvest intensity of medicinal plants are 1) a shift from specialist collectors (healers and their trainees) to commercial harvesters; 2) a shift away from traditional management practices through the removal or relaxing of taboos that increase the potential number of harvesters, collection times, and expediency of harvest (Cunningham 1993a); and 3) a growing demand for medicinal plants (e.g., Barany, et al. 2001; Letšela, et al. 2003:628; Shanley and Luz 2003; Williams, et al. 2000). The demand for medicinal plants is increasing because populations with little access to biomedicines and a strong reliance on medicinal plants are growing, and the incidence of chronic disease (e.g. HIV, diabetes, high blood pressure) is also on the rise.

Worldwide about 10-18% of existing native plant species are used medicinally (Schippman et al. 2002). In Tanzania, about 10% (or 1000 species) of the country’s flora are believed to be used in traditional medicinal practice (Shechambo, et al. 2001), but it is likely the number is much higher. Out of all the plants that can potentially be used medicinally, people make deliberate choices in harvesting and managing specific ones for medicines. Understanding who makes these decisions, and what influences their knowledge and practices has implications for conservation and resource management.
This is especially pertinent in source areas for medicinal plants that are high in biodiversity, like the mountain and coastal forests in Tanga.

### 2.5.3 Significance of location and habit of plant medicines in an ecocultural landscape

Local ecological knowledge can institutionalize an understanding of the healing potential of plants based on ecological characteristics and location where the plant grows, plant form, and plant part. Beyond a plant’s location in a specific ecological setting, its location and function in a particular cultural landscape is also important to its healing potential. For example, plants located where two paths cross, at the site where ancestors are worshipped, or on a termite mound can be more desirable than the same species growing in proximity, especially if it is growing in a graveyard. The habit of a plant that mimics the desired action of the medicine is another important characteristic signaling potency.

Local ecological knowledge of medicinal plant collectors also includes information about the differential utility of plant parts. Medicinal plant practitioners know that roots and young leaves of the same individual can have different chemical characteristics. Apparence theory predicts that herbaceous plants are more susceptible to herbivory and therefore have developed toxic, bioactive chemical defenses in their leaves. Some have used this theory to help explain the high frequency of herbaceous plants in pharmacopoeias worldwide (e.g., Hanazaki, et al. 2006:904; Shepard 2002; Stepp 2004). In any case, ecologically based and culturally based knowledge about medicinal flora and the practices associated with their management are embedded in local people’s daily lives, livelihood strategies, and systems of natural resource management.
They need to be understood and considered for conservation planning and for the sustainable management of medicinal plants.

2.6 Community Centered Natural Resource Management

The concepts of wilderness, protection, enhancement, resource management, and property rights are cultural constructs with various interpretations and objectives. A standard goal for researchers, conservationists, and by extension, government agencies, is to protect biodiversity in order to maintain a system's ecological processes and ecosystem goods and services. If it is not done in collaboration with local people whose priorities, expectations, and desired outcomes for managing resources are different, it will likely be done at their expense. Local people often sacrifice more in terms of livelihoods, health, and culture and benefit less from protected area reserves. The result can be that the same reserves meant to be protected are threatened. Consider the program to protect mountain gorillas in Uganda's Bwindi Impenetrable Forest. It banned local people from the collection of all forest products including Nyakibazi, a medicinal plant considered essential, and they retaliated by intentionally burning the forest and making threats against mountain gorillas (Wild and Mutebi 1996; Hamilton 2004:1489). The problem of how to protect the environment without excluding the humans who are a part of and rely on it has been written about for decades, but we are still learning how to go about addressing it. Unsuccessful community-based conservation programs are not evidence that the concept is worthless. A researcher in Tanga's Usambara forests said, "There is no viable alternative to CWD [conservation with development] projects if biological diversity is to be protected and if the relationships between local people and sites of
conservation importance are to be mutually supportive" (Stocking and Perkin 1992:348).

One way to reconcile the needs of local people and the needs of environmental preservation may be through non-timber forest product collection, processing, and sale. However, its merits as a way to promote local economic development while also preventing destructive income generating activities (e.g., logging, clearing for farming, cattle ranching) have been actively debated for years. Obviously, it needs to be considered on a case by case basis and cannot be endorsed wholesale. There is a need to better understand local communities and how conservation programs and policies can best work with them to benefit local conditions (Chapin 2004). Many think anthropology has a role to play in this (Brush 1993; Orlove and Brush 1996; Posey, et al. 1984; Sillitoe 1998; Sillitoe 2006). Some think a focus on medicinal plants can help meet conservation goals while also addressing local needs and that will be discussed later.

### 2.6.2 Non-timber forest products for conservation, development, and health

While the links between the health of ecosystems and the health of people may be more obvious in cases where water-borne bacteria or malaria mosquitoes threaten human health, the epidemic of HIV/AIDS has brought a specific set of concerns to the foreground. The links between human and ecosystem health are writ large in the context of HIV.

### 2.6.3 HIV and forest resources

In her poignant article “After the Forest” about the AIDS crisis in Thailand, Usher (1992) parallels the ecological degradation of forests with the collapse of human
immunity. She connects the fragmentation of forest ecosystems and the concurrent fragmentation and break down of local communities that relied on functioning, productive ecosystems for food, clothing, construction materials, medicine, and tools, as well as spiritual sustenance. The destruction of Thailand’s forests, due primarily to logging, the development of rubber plantations, salt mining, and dam construction, meant that villagers could no longer rely on them for the goods and services it provided for daily needs. To pay for the things they could no longer get from the forests, men worked in factories and plantations and women worked in the sex trade. Both came into contact with HIV. Usher connects the dots clearly and directly. Compromised forest health leads to compromised human health.

Drawing heavily from a political-economic perspective, Farmer’s treatment of AIDS in Haiti (1992) also makes a clear connection between ecosystem health and human health. He recounts the introduction of AIDS from a historical perspective informed by ethnography, epidemiology, and ecological data. He describes how the development of a dam and the relocation of villagers around the dam, lead to the destruction of local livelihoods and ecosystems and the subsequent spread of AIDS throughout a rural, poor, forest-dependent community.

In Sub-Saharan Africa, we also see how ecological collapse, the search for livelihoods, and AIDS are linked. More specifically, recent research focuses on non-timber forest products as important sources of income and medicines. Poor families affected by AIDS rely on them more to reduce spending for daily subsistence and to increase income (Barany, et al. 2005). Middle class and wealthy families also use phytomedicines even when they have the means to use pharmaceuticals. Plant medicines
are desirable because they are often more affordable than pharmaceuticals; in some cases they are free. They can be obtained discretely, which is important in a place where the stigma attached to HIV/AIDS remains pronounced. They are seen as safe because they are familiar, enmeshed in local and cultural practices, and they are perceived to have fewer side effects than pharmaceuticals. In Sub-Saharan Africa, the demand for phytomedicines is increasing due to an increased acceptance to seek HIV testing and treatment; the unavailability or unacceptability of anti-retroviral-therapies for some people living with HIV/AIDS; and an increased experience with chronic diseases that are not easily treated by pharmaceuticals. This includes AIDS, as well as diabetes, high blood pressure, and cancer.

There is a real concern that the AIDS pandemic is likely to increase pressures on existing stocks of plant medicines which could result in scarcity in the future. Dold and Cocks (2002), report from South Africa's Eastern Cape Province that the use of medicinal plants has increased and is predicted to further increase, primarily because of AIDS. Similarly, healers in Malawi and Mozambique perceive a decrease in available medicinal plant resources, including those used to address HIV/AIDS, and an increase in the number of people using them (Kayambazinthu, et al. 2005). “In the long-term, this expanded use may have negative feedbacks on the forest resource possibly undermining one of the few coping strategies available to rural households impacted by HIV/AIDS” (CIFOR 2006:2).
2.7 Botanical Prescriptions for Ecological Health

A focus on medicinal plants has been suggested as a potentially effective way to integrate local community interests into natural resource management and conservation. In order to consider the strengths and weaknesses of this argument, we must first consider where medicinal plants grow. If the source areas do not overlap with areas of interest to conservationists and environmentalists, the motivation for local people to conserve forests for their medicinal plant value is implausible.

2.7.1 To the source of conservation

In the 1980s and 1990s, environmentalists compelled us to conserve rainforests and equated them with storehouses of wonder drugs, a veritable nature’s pharmacy, home to plant medicines used by local people and the raw materials necessary for not-yet-developed pharmaceuticals. This argument came into question with research that showed medicinal plants are most often harvested from areas other than primary or old growth forests and that they are common weeds from anthropogenic vegetation, not the endemic or alluring plants of tropical rainforests. In Mexico, the Maya (Berlin, et al. 1999; Stepp 2002), Zapotec and Mixe (Frei, et al. 2000) reportedly harvest most of their medicinal plants from disturbed and successional growth areas not from old-growth forests. Stepp attributes this to apparency theory and resource availability theory which predict there is a higher concentration of metabolites in plants that are r-selected, fast growing, pioneer species that are relatively short lived (like herbaceous weeds) compared with old growth forest trees (2002). As a chemical defense strategy to discourage herbivory, metabolites such as alkaloids, cardiac glycosides, and terpinoids are produced by these plants. The
same metabolites are also active in humans and are therefore used in pharmaceuticals. Frei and colleagues attribute the preference for harvesting medicinal plants primarily from disturbed and successional areas with a social explanation, influenced by the proximity of medicinal plants to culturally based settlement patterns (2000). These findings are supported by the work of (Cassagrande 2001:261) with Tzeltal Maya. Mixe who live relatively close together prefer areas like home garden, community, and roadsides for medicinal plant harvesting; and Zapotecs whose residencies are more spaced apart prefer zones such as agricultural and forested areas.

In addition to habitat, researchers have also focused on the life form and abundance of medicinal flora. They report the importance of “weedy” species to local medical practice (e.g., Berlin 2003; Kohn 1993; Stepp 2004; Stepp and Moerman 2001; Voeks 2004). “Weeds are those plants that are successful in disturbed environments, short-lived, fast-growing and oftentimes, herbaceous” (Stepp 2004). This infers that medicinal plants are ubiquitous or even invasive and therefore less relevant to biodiversity and habitat conservation. Although it is not their primary objective, these studies question the rationale of conserving mature forests on the theme that they are nature’s pharmacies. Stepp concluded that “primary forest in the highlands of Chiapas is not going to be protected for its medicinal value” (2002: 161). By extension, bioprospectors who rely on the ethnopharmacological knowledge of indigenous and local people as leads for developing novel pharmaceuticals would also then, look less to primary and old growth forests.

Although the archetypal old growth forest may not be an important source of medicines worldwide, there is compelling evidence to show their importance to local
ethnomedical practices. While the researchers just mentioned agree with each other, their findings do not apply to all places. Their work has been conducted in North, Central, and South America and their claims have yet to be established anywhere in Africa.

Whereas herbaceous non-woody plants are the most utilized life form for medicines with 63% of uses for the Maya in Highland Chiapas (Stepp 2002), 70% in India (Balasingh, et al. 2000), and 50% in Nicaragua (Coe and Anderson 1996), I argue that these trends are much less common in Sub-Saharan Africa where dried bark and roots from woody perennials and trees are the most common sources of medicines. For example, Earthskine (2004) found that in KwaZulu-Natal, South Africa “almost 50% of the plant material traded for medicinal purposes comes from the forest biome.” This is supported by other authors who refer to other areas in Africa as well (e.g., Lopez in Press). Ecological and cultural systems in the New World are different to East Africa, its inhabitants, their ethnomedical systems, and their knowledge about their environment. This calls for a re-examination of the relevance of medicinal plants to conservation planning and natural resource management, particularly in areas like Tanga’s Eastern Arc Mountains and Coastal Forests, where biodiversity is high, and endemism is up to 25% for plants (Rodgers and Homewood 1982).

2.7.2 Medicinal plants: threats to and promise for conservation

Obviously, if the desired species are rare, collecting them can be problematic. In Cameroon, *Prunus africana* (Hook. F.) Kalkman Rosaceae is used locally as a medicine, but the European drug market’s strong demand for its bark (to treat benign prostatic hypertrophy), resulted in local extinction. *P. africana* is now listed under
Appendix Two of CITES the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Even for species that are not presently scarce, destructive methods of harvest are also problematic, and that appears to be the modus operandi for many commercial harvesters. A regional study on medicinal plant trade from South Africa found “present harvesting is indiscriminate, destructive, and unsustainable for many species, particularly those harvested from Afromontane Forest” (Dold and Cocks 2002:596). The authors conclude that 93% of the species traded are harvested unsustainably, basing this on an understanding that the parts sold (whole plant, bulb, tuber, roots, and bark which is obtained from ring barking) mean the plant must have died as a result of harvest (Cocks 2002:594)

The impacts of unsustainable management of forest resources, triggered or at least compounded by the HIV/AIDS epidemic, are becoming obvious. In Zimbabwe, the demand for *Warburgia salutaris* (Bertol.f.) Chiov. Canellaceae, a highly effective treatment for Candida (an opportunistic fungal infection of HIV/AIDS) resulted in the exhaustion of local stocks, and supplies are now imported from Mozambique and South Africa in order to meet the local demand (Maroyi 2000; Veeman, et al. 2001). In Malawi, HIV/AIDS is contributing to the erosion of medicinal plants, as herbalists in Malawi and Mozambique report medicinal plants used to treat AIDS-related illnesses are becoming less available (Barany et al. 2005). HIV/AIDS is also contributing to the erosion of forest resources in general, due to the strong demand for timber which results from the needs of a “growing coffin industry” (Mauambeta 2003). Other studies that have investigated the trade of medicinal plants within the context of the demand for the treatment of AIDS
symptoms also come to the conclusion that harvesting methods and quantities are not sustainable (e.g., Bodeker 2002; Earthskine 2004:251; Swallow 2004).

While there is no strong evidence that points to the danger of complete continental extinction of any one medicinal plant, "the seriousness of local, national or regional extinction, or, indeed, of commercial extinction should not be under-estimated. There can be serious consequences for human livelihoods and economies, botanical genetic conservation" (Hamilton 2004:1484), and ecological and human health. In areas where they are widely harvested or widely relied upon for local health and livelihoods, a focus on medicinal plants could strengthen conservation and natural resource management programs. All this leads to the conclusion that the sustainable harvest and use of medicinal plants must be promoted — for meeting immediate human health needs, mid-range livelihood needs, and long term needs of forest and ecosystem health. If sustainable harvests of non-timber forest products are essential for conservation, people's livelihoods, and health, promoting it requires at least knowing if the rates of harvest are exceeding the capacity of populations to replace the individuals that are extracted (Ticktin 2004). As important is an investigation of the people, practices, and influences that promote sustainable harvest and put it at risk.

2.7.3 Medicinal plants as cultural keystone species

Ecologists define keystone species as those that perform unique roles that are central to the functioning of an ecosystem, such that their removal can trigger the loss of other species. Applying this to human cultures, Garabaldi and Turner (2004) note that there are many examples where plants and animals "form the contextual underpinnings of
a culture, as reflected in their fundamental roles in diet, as materials, or in medicine…
and feature prominently in the language, ceremonies, and narratives of native peoples.’"
These cultural keystone species may be at the heart preserving and protecting biological
and cultural diversity. The authors suggest, ‘One of the key advantages in the
identification of cultural keystone species is that it provides an effective starting point for
conservation and restoration of what Berkes refers to as 'social-ecological systems'
(Berkes 2002:335 cited in Garibaldi and Turner 2004). Identifying a medicinal plant or
plants as a cultural keystone species has potential for conservation planning.

2.7.4 Medicinal plants as flagship species

The conservation of habitats usually requires support from local people living in
these areas as well as external support from governments, foundations, and researchers.
Promoting the conservation of flagship species is one strategy for winning support. For
example, Hamilton describes whales as “the super-animal flagship species of the sea
[that] motivate amazing human and financial resources to be directed toward their
preservation” (2004:1489). Medicinal plants are not only important to people who live in
areas where the plants are found, they are also alluring to outsiders which broadens their
potential to play a role in conservation. Although he finds fault with its argument, Voeks
(2004) has no problem with the outcome of the "rainforest medicine narrative" which has
helped to "publicize the regional and global consequences of destructive forest
exploitation and the accompanying rural poverty and injustices faced by tropical
peoples." He concedes that "environmental concern for rainforest medicinal plants and
folk healers thus may translate somehow to more informed policies with regard to forest
management and human rights for equitable development and cultural justice.

Recognizing the natural and cultural roles of disturbance pharmacopoeias will be an important foundation of these more informed policies" (Voeks 2004:882). Indeed, there could be a great untapped potential in adopting medicinal plants (especially those with multiple uses, e.g., food, cosmetic, textile) as flagship species in conservation programs, regardless of whether or not they come from old growth forests.

2.7.5 Medicinal plants as a microcosm of conservation

Whether or not medicinal plants can be specifically slotted as cultural keystone species or flagship species, their potential to positively influence conservation is still notable. Locals, outsiders, everyday people and specialists say they are important, interesting, and worthy of attention. Hamilton asserts, “Probably the single most important role for medicinal plants in biological conservation is the ‘use’ to achieve conservation of natural habitats more generally. This stems from the special meanings that medicinal plants have to people, related to the major contributions that they make to many people’s lives in terms of health support, financial income, cultural identity and livelihood security” (2004:1477). “Because so many species of plants are medicinal, medicinal plant conservation is, in some ways, a microcosm of plant conservation as a whole” (Hamilton 2004:1478). By addressing the conservation needs of locally important species and places, the larger conservation goals of an area will also be promoted. The threats to medicinal plant species are the same as the threats to plant diversity in general. In many cases, the most serious proximate threats are habitat loss (usually due to
agriculture and urbanization), habitat degradation and over-harvesting (Hamilton 2004; Maumbeta 2003; Shanley and Luz 2003; Usher 1992).

In Tanga, medicinal plants and healers have been recognized by local and outside people as important elements to include in resource management planning. A Tanzanian university professor writes, “Traditional healing is an institution that plays an important role in sustainable utilization and management of the forests” (Kajembe, et al. 2003:105). These factors signal the relevance that medicinal flora have to conservation efforts.

There are examples where medicinal plants are linking local interests with outside conservation priorities. In South Africa, Botha et al (2004b) examined community-based conservation with healers involved in medicinal plant trade who had identified the problem of acquiring plants. The healers developed a program with relevant stakeholders to cultivate medicinal plants; access medicinal plants on sites earmarked for development; obtain training on primary health care, HIV/AIDS, business management, and horticulture/permaculture; and to improve cooperation with local hospitals and clinics. In this dissertation, I will describe an emerging example of a medicinal plant-conservation project in Tanzania.

2.8 Conclusion

Medicinal plants have social, biological, chemical, and economic lives. Their value to human culture, livelihoods, and well-being gives them meaning beyond the ecological systems of which they are a part. The attributes of these plants that are locally appreciated may differ from those that are appreciated by outsiders, yet it is this
confluence of interests that makes medicinal plants attractive to consider for achieving local and international priorities for human and ecological health.
CHAPTER 3. PEOPLE AND PLACES

3.1 Introduction

Considering its size (945,087 km$^2$) Tanzania contains remarkable topographical and biological diversity which is matched by the cultural and linguistic variety of more than 120 ethnic groups. The official national languages are Swahili and English (although English is used much less). Nationally there are relatively equal proportions of Christians and Muslims (accounting for about 80% of the population) with the remaining 20% follow indigenous religions, although Tanga Region is overwhelmingly Muslim.

Botanically speaking, Tanzania is the richest area in East Africa with more than 10,000 plant species, 11.2% of which are endemic (Davis, et al. 1994) and at least 10% of which are said to have medicinal applications (Mahunnah 1991; Mshiu and Mahunnah 1984; World Health Organization 2003).

The selection of places and people I chose to work with are more apparent in the context of the findings. In this chapter I describe the cultural and socioeconomic characteristics of the research participants and characterize research locations in terms of their demography, ecology, and land use.

Figure 1 below depicts a map of the United Republic of Tanzania (Department of Peacekeeping Operations 2005).
3.1.1 Biogeography of the Tanga Region

The Tanga Region is botanically rich with over 1,920 species, including many endemic ones (Davis, et al. 1994). Located in northeastern Tanzania between 4-6°S latitude and 37-39°10'E longitude on the coast of the Indian Ocean, Tanga occupies 27,348 km² and ranks among the more densely populated of Tanzania's 26 regions. It has a tropical climate, bimodal rainfall pattern (from March to May, and October to December), and features mangrove coastline, plains, mountains, and dry coastal, lowland, and moist tropical forests. The ecological diversity in the region results from a range in altitude and climates stretching from mangroves at the shore, across the arid lowland coast to plains which are met by mountains that rise into moist tropical forest. The hot (23-33° C) and humid coastal area is dominated by bush land, palm gardens, village
cultivations, and plantations (mainly sisal). The upland plateaus are covered with bush land and shrub thickets interrupted by swampy lowlands and river swamps as well as village cultivations, plantations, and palm gardens. The Umba Plains and the Maasai Steppe are characterized by open savannah grassland with scattered trees and scrub thickets. Tanga's montane areas (Usambara and Nguu Mountains) have a temperate climate but its forests are tropical and they have remnants of old growth forests (Planning Commission in Dar es Salaam and the Regional Commissioner's Office in Tanga 1997). Tanga's geographic and climactic diversity is reflected in local knowledge exhibited by the use of a range of plants valued as medicines, foods, cosmetics, textiles, construction materials, and fuelwood.

3.1.2 Subsistence

Regionally, as nationally, Tanga livelihoods are characterized by subsistence farming of maize (*Zea mays* L. Gramineae), beans (*Phaseolus vulgaris* L. Papilionaceae), coconuts (*Cocos nucifera* L. Palmae), bananas (*Musa sapentium* L. Musaceae), cassava (*Manihot esculenta* Crantz Euphorbiaceae), rice (*Oryza sativa* L. Gramineae), potatoes (*Solanum tuberosum* L. Solanaceae). Throughout the region, farming is supplemented by small-scale livestock such as cows (*Bos taurus* L. Bovidae), goats (*Capra hircus* L. Bovidae), chickens (*Gallus gallus* Phasianidae) and dairy farming. Along the coast fishing remains an important cultural tradition and livelihood (probably more so than farming), and seaweed (*Eucheuma denticulatum* (N.L. Burman) F.S. Collins & Hervey Areschougiaceae) farming which is done mostly by women has recently become more popular as a means to supplement household incomes. Cash crops vary by district and
include oranges (*Citrus sinensis* (L.) Osbeck Rutaceae), cashews (*Anacardium occidentale* L. Anacardiaceae), sisal (*Agave sisalana* Perrine Agavaceae), tea (*Camellia sinensis* (L.) Kuntze Theaceae), coffee (*Coffea arabica* L. Rubiaceae), black pepper (*Piper nigrum* L. Piperaceae), and cardamom (*Elettaria cardamomum* (L.) Maton Zingiberaceae). Plantation farms (also called estate farms) are primarily sisal and tea. While the tea plantations remain active, the availability of synthetic fibers for rope in the 1970s was devastating to the sisal plantations, which fell out of favor in the global economy. The economic boost that sisal had provided to the region crashed and the plantations offer viable sources of income for relatively few Tanga residents today. In fact, Tanga’s economy as a whole has declined since the 1970s and 1980s when it flourished under sisal. The port in Tanga Town is still operational but much less active since the 1970s.

Compared to the rest of the Region, residents of Tanga District have considerably more options for income generation including professional institutions, service industries, retail shops, as well as a number of industrial manufacturing and processing operations such as seafood, dairy, textile, cement, plastic bags, grain, and timber. Still unemployment remains high in Tanga Region. A government report from 1997 cites about 30% unemployment (Planning Commission and the Regional Commissioner's Office 1997). While this figure is dated (recent data is unavailable), residents insist that in terms of employment and income generation, life is much more difficult now than in past years. Tanga Town, compared to other large cities such as Dar es Salaam or Arusha, has a reputation for its *maskani* “jobless corners” where unemployed men meet and spend the day together socializing. This phenomenon is much less apparent in other large cities.
3.1.3 Natural resources

Although Tanzania is arguably among the richest nations in the world in terms of natural and cultural resources, it is among the poorest in the world in terms of income. In 2005 the country’s per capita income was estimated to be at about US$350 (World Bank 2007). Poverty and growing human populations are usually identified as the greatest drivers of forest degradation because local people are dependent upon “free” forest resources such as fuel wood and nutrient rich space for farming. About 95% of Tanzanians rely on firewood or charcoal for cooking. While the collection of firewood by local people for their own use negatively impacts forests and woodlands, the commercial harvest of trees for charcoal, firewood, and timber is much more dramatic and detrimental. Tanga Region is a known source area that supplies charcoal to a wide range of urban centers from Mombassa, Kenya in the north to Dar es Salaam in the south.

Commercial mining also contributes to forest degradation. In coastal regions gas, gemstones (e.g., rubies), iron, titanium, limestone, and kaolin are mined. In the Eastern Arc Mountains, long term artisanal mining for gold, rubies, and garnets (Mittermeier, et al. 2005) as well as a recent gold rush in riparian areas of the Usambaras have significantly degraded the health and productivity of human and plant populations in those areas.

In Tanzania, the harvest of medicinal plants is very rarely cited as a contributing factor, and never as a driving factor of forest degradation. This means that with careful planning, Tanzania can avoid what other nations face in terms of the widespread deleterious effects of medicinal plant harvest.
3.1.4 Cultural Groups

3.1.4.1 Bantu ethnolinguistic group

There are multiple ethnic groups who call Tanga Region home. In terms of numbers, the main groups are Sambaa, Zigua, Bondei, and Digo, but the most populous group varies from district to district. The districts that concern this dissertation are Tanga, where the Digo (coastal dwellers) are marginally the largest group; Lushoto, where the Sambaa (Usambara Mountain dwellers) are overwhelmingly the largest group; and Muheza, which is mostly populated by the Bondei (lowland and valley dwellers).

Although each group has their own language, they all belong to the Bantu language group. When Sambaa, Bondei, and Zigua people speak wanasilizana “they hear each other.” It is not surprising that in addition to their languages being mutually intelligible, these groups share an ancient common ancestry. The Digo language, although Bantu, is less similar to the other languages just mentioned. The difference between Digo life on the coast, *pwani*, and Sambaa, Bondei, and Zigua life inland, *bara*, is marked by lifestyle, language, and subsistence. To summarize, even though they are diverse, Bantu-speaking people’s cultural traditions and lifestyles (e.g., initiation ceremonies, healing rituals, and religions systems) are relatively homogeneous (Beidelman 1967), especially when compared to Maasai.

3.1.4.2 Swahili culture

Historically, coastal Tanga is situated among the Swahili societies that stretched along the Indian Ocean in coastal towns and villages from Somalia, through Kenya and Tanzania, and into Mozambique. *Swahili*, is derived from the Arabic word for coasts,
Swahili. Swahili language (a Bantu language) and culture developed through interactions and relationships that evolved from trade routes that brought people from Africa and the Arabian Peninsula into contact with each other along the Indian Ocean.

Based on archaeological evidence, by the eighth century (if not earlier), Swahili societies developed along the East African coast (Spear 2000) as different groups of people adapted to the coastal environment. The indigenous groups interacted with and incorporated neighbors as well as overseas visitors. In the process, “they become progressively more economically differentiated (e.g., working with iron, fish, raising new crops, and building in stone), socially stratified, and Muslim with the expansion of international trade, increasing wealth, and immigration from Arabia and India” (Spear 2000). “Coastal peoples were thus immersed in dense webs of production and exchange, ethnicity, kinship and descent, and residence. They were also joined by Islamic (dini) and customary (mila) religious practices that linked them with the wider Muslim community (umma), on the one hand, and with local African communities, on the other” (Spear 2000). Swahili identity became grounded in these relationships between East African, Arabic, and West Asian people. The outcome was the creation of a new cultural identity based on distinctive architectural forms and an urban way of life, which may have been unique for the continent, but was rooted in indigenous local African social and urban traditions.

The culture resulting from these complex interwoven relationships among diverse people along a chain of locations on the East African coast is and has been difficult to characterize. Although scholars have debated it for decades, it has yet to be resolved in the literature or even on the street. “While earlier debates over Swahili identity and
history usually turned on racialized interpretations of culture, contemporary ones often focus on constructivist views of the ‘invention of tradition’ or ‘creation of tribalism’” (Spear 2000).

Describing contemporary Swahili people and culture has only become more difficult as East African, Asian, Arabic, European, and other people have increasingly interacted along the Swahili coast and local cultures have continued to evolve. Today, the population of Tanzania is comprised of about 1% of people of Indian and Arab descent (infoplease encyclopedia 2007), who are concentrated in urban coastal Swahili areas, including Tanga Town and the islands of Zanzibar. They have been residents of Tanzania for generations, speak Swahili, and are part of local culture. They are often of higher socio-economic status than Bantus. Some who claim mixed Arabic ancestry are known to identify as Swahili, but those with Indian ancestry do not.

Although Swahili people have been defined by some outsiders (i.e., scholars and visitors) as those who speak no language other than Swahili, this is problematic. For example, on Unguja and Pemba (islands of Zanzibar, Tanzania) Swahili language is a mother tongue. But in Tanga many people, especially younger generations, speak Swahili as their only language because their mother tongues of Sambaa, Ziguia, or Digo are less spoken at home, not taught in school, and do not serve as a common language in multi-ethnic Tanga. Tanzania’s first President, Julius K. Nyerere (in office 1961-1985), made Swahili a national language as a means to unite a culturally and linguistically diverse country. Although Tanzanian Swahili speakers do have a strong sense of national identity, speaking Swahili and being Swahili are not synonymous.
In Tanga, none of the people who participated in the research self-identified as Swahili when asked about their *kabila* 'ethnic group,' even if they were from Tanga Town which is considered a Swahili town. People typically identified themselves first as their ethnic group (Digo, Sambaa, Zigua, Maasai, Swahili, etc.), perhaps secondly as a person from *pwani* ‘coast,’ *milimani* ‘mountains,’ or *bara* ‘inland,’ and thirdly as a Tanzanian. My findings are in line with Spear’s assertion that “people labeled ‘Swahili’ by scholars rarely identify themselves as such, choosing identities based on their own town, putative origins, status, or descent group instead” (2000). Regardless of whether or not Swahili culture can or should be reified or characterized, a depiction of Tanga must reference its Swahili connections, especially in Tanga Town, an urbane port community where there is a deep-rooted history of Swahili architecture, culture, and language. The Swahili connections to this research will become more apparent in discussions of local ethnomedical systems.

3.1.4.3 Maasai culture

Maasai are certainly a minority in Tanga Region, and their Nilotic language and semi-pastoral lifestyle are distinct from that of Bantu groups. Although they are low in numbers in Tanga Region’s population, they are well represented as medicinal plant vendors and therefore are an important part of this research. This trend began about ten years ago and in the last few years their presence as medicine vendors has grown considerably. Maasai will be discussed in more detail later in this chapter in the context of medicinal plant vendors.
3.1.5 Health services and concerns in Tanga

Tanga Region's largest hospital is Bombo, the government referral hospital. In addition to the government operated health centers (three) and dispensaries (17), there are at least ten other smaller private hospitals and health centers in Tanga Town. According to the Tanga Municipal Health Officer (Personal communication January 6, 2006) Tanga Town has three large pharmacies and 178 small shops that sell pharmaceuticals\(^1\). In areas outside Tanga Town (including Lushoto and Muheza Districts where research was conducted) health services and facilities are much less available. Hospitals in Muheza and Lushoto Districts are private (usually mission based, not government operated), and often preferred to the government hospitals. Health centers and dispensaries are common in small towns, but villages often must rely on volunteer village health workers who are supplied periodically by larger facilities or organizations in District or Regional Centers. Although the situation is improving, the lack of adequate medical supplies and pharmaceuticals is common in government and private facilities alike.

Major health concerns in Tanzania include HIV/AIDS, malaria, tuberculosis, schistosomiasis, typhoid fever, leprosy, lymphatic filariasis, meningitis, and pneumonia. Diseases of surfeit are also becoming more apparent as diabetes and obesity are increasing, especially in urban areas, a worldwide trend for people whose economies and livelihoods are in transition.

Over 1.8 million adults in Tanzania are estimated to be living with HIV/AIDS and

\(^1\) Pharmacies and medicine shops are called \textit{duka la dawa}, singular, but often smaller shops are called \textit{duka la dawa baridi}, literally “cold medicine shop.” This relates to the hot/cold dichotomy in many ethnomedical systems. In this case the adjective “cold” sets these smaller shops apart from larger pharmacies that have a much wider selection including prescription medicines that are perceived to be more potent, although these are never called “hot” medicine shops.
AIDS is now the major cause of illness and death among Tanzanian adults. According to the World Health Organization's assessment, annual deaths in Tanzania due to HIV/AIDS are 160,000 (World Health Organization 2007). The HIV/AIDS prevalence in Tanzania ranges from 2% to over 14% and is strongly linked to demographic and geographic variation (World Health Organization 2005). On average, about 8% of people in Tanzania are HIV-positive. In Tanga Region, the prevalence is estimated at about 11%. Still, HIV/AIDS cases are heavily under-reported, and it is estimated that only one out of five cases are reported nationally. The lack of health services and facilities and the high prevalence of chronic conditions such as malaria, HIV, and other infections mean that medicinal plants play an important role in the health care of Tanzanians. Below are figures for Tanzania, Kenya for relatively equivalent comparison, and the USA to for a different perspective.

Table 3.1. Tanzania Health Statistics

<table>
<thead>
<tr>
<th>Population (2005)</th>
<th>Tanzania</th>
<th>Kenya</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>38,329,000</td>
<td>34,256,000</td>
<td>298,213,000</td>
</tr>
<tr>
<td>No. Physicians / 1000 people (USA 2000; Tanzania 2002; Kenya 2004)</td>
<td>0.02</td>
<td>0.14</td>
<td>2.56</td>
</tr>
<tr>
<td>HIV prevalence among adults, 15-49 years (2003)</td>
<td>8.8%</td>
<td>6.7%</td>
<td>0.6%</td>
</tr>
<tr>
<td>People with advanced HIV receiving antiretroviral combination therapy (2005)</td>
<td>7%</td>
<td>24%</td>
<td>&gt;75%</td>
</tr>
<tr>
<td>Annual Deaths due to HIV/AIDS (2003)</td>
<td>160,000</td>
<td>150,000</td>
<td>14,000</td>
</tr>
<tr>
<td>Malaria in children 0-4 years who sleep under a bednet (1995-2005) **</td>
<td>30%</td>
<td>15%</td>
<td>N/A</td>
</tr>
</tbody>
</table>

All data in table adapted from WHO (2007) except that noted by ** which is from UNICEF (2007)
3.2 Research Participants

Of the seven administrative districts in Tanga Region, this dissertation concerns three: Tanga, Muheza, and Lushoto Districts. The places and people featured in my research are connected through medicinal plant pathways beginning with their sources where they are gathered by the hands of harvesters until they reach the hands of consumers. My study population includes multiple actors, sites, and agendas rather than a bounded physical space or cultural group and reflects the diversity of people and places involved in the procurement, distribution, and use of medicinal flora. This ranges from the local level with harvesters, healers, vendors, and consumers of medicinal plants, to the district and national levels where the policies and procedures that affect the harvest, sale, and use of medicinal plants operate.

Although the categories “consumer,” “healer,” “vendor,” and “harvester” are not mutually exclusive, they are useful for conceptualizing the salient characteristics of each group, the different roles they play, and their relationships with each other. Of course there is overlap (e.g., some healers are also vendors, some vendors are also harvesters, some harvesters are vendors or healers in training, etc.), but research participants who belong to multiple groups identify more closely with one group than the other(s). For example, healers who also collect their own medicinal plants certainly identify first as healers, not harvesters; consumers who collect for home use do not consider themselves to be harvesters in a commercial sense; and few urban vendors (and no Maasai vendors) self-identify as healers. In the following sections I will describe consumers, healers, vendors, hospital health workers, harvesters, and official resource managers, all of whom are stakeholders and actors in the medicinal plant chain.
3.2.1 Consumers

To describe the consumers of medicinal plants in Tanga is to describe the entire population of more than 1.6 million, as no ethnic, socioeconomic, religious, or other demographic trait distinguishes medicinal plant users from non-users. In general, the overwhelming majority of the population uses (or has used) medicinal plants. The variation in sources, species, and frequency of medicinal plant use is associated with ethnic, socioeconomic, and demographic characteristics, which will be discussed in the findings.

3.2.2 Healers

Throughout Tanzania and perhaps even throughout East Africa, Tanga Region is known for its numerous powerful healers and medicinal plant specialists. Many times, I heard (Tanzanian) visitors to Tanga talk about their reluctance to hang their clothes out to dry, to be out after dark, or to cross paths with a healer, spirit, or witch because it would make them vulnerable to Tanga's powerful beings and forces.

Tanga certainly does have a large number of healers, although the exact numbers are hard to estimate. In 2005, the Secretary for the National Union of Traditional Healers and Birth Attendants (Chama cha Waganga na Wakunga Asilia Tanzania, CHAWATIATA), the most active healer organization in the Tanga Region, reported almost 13,000 registered members, although he and other healers agree that the actual number of healers and birth attendants is more than five times that (Halfan Kaniki, personal communication October 13, 2005).
3.2.3 Market and street vendors

In this research, vendors are defined as those who sell plant medicines publicly and are different from healers who work exclusively out of their homes or private offices to treat patients. Elsewhere in Africa commercial medicinal plant sales are characterized predominantly by vendors in shops (called *muthi traders* in South Africa) and regular markets (often called *hawkers*). Tanga vendors are more varied. Some work independently from established shops or markets and instead work out of semi-permanent kiosks, from tables set up along the road, or from tarps on the ground. Tanga also has mobile vendors who represent another mode for selling plant medicines. They frequent busy areas such as the bust stop, walk around town, and go door to door. Middlemen were rarely found to be a part of the medicinal plant market chain in Tanga, with most plant material being delivered to vendors by the harvesters themselves or purchased by the vendors directly from the harvesters.

Because Maasai and Sambaa are the primary ethnic groups involved in the commercial trade of medicinal plants in this research in Tanga, Muheza, and Lushoto Districts, they deserve special attention. They are distinct from each other in a number of ways, yet their traditional homelands border each other, and this is relevant to the findings which will be elaborated in chapter six.

3.2.3.1 Maasai vendors

The Maasai are an iconic indigenous group of East African pastoralists that have traditionally followed fertile grazing areas across Tanzania and Kenya for their herds, primarily Small East African Zebu (*Bos indicus* L. Bovidae). Cattle are absolutely
central to Maasai identity and subsistence. In the Tanga Region, Maasai live in low-lying grasslands and plains areas that are suitable for pasture for their cattle. Maasai are distinct from the other ethno-linguistic groups in Tanga for a number of reasons. First, their language group is Nilotic, and they speak Maa, while the rest of the African groups in Tanga are from the Bantu ethno-linguistic group. Speaking Swahili as a second language for a Bantu speaker is much more intuitive because of the similar language structure and pronunciation than for a Maa speaker. As a result, Maasai people’s ability to communicate easily with the general population of Tanga is challenged. Second, while local traditional religious ideas and practices are typically integrated into Christianity and Islam, the vast majority of Maasai identify as Christian, while the vast majority of Tanga residents identify as Muslim. Third, Maasai are traditionally pastoralists, not agriculturalists, hunters, or fishers as are the other groups in Tanga. Maasai are also distinct due to their unique style of dress, diet (which excludes fish and fowl), and adherence to cultural lifestyles that are perceived as more traditional than their Bantu neighbors who have more widely adopted western practices.

Easily spotted by their shaved heads in the case of women and long thin ochre colored braids in the case of young adult men, bright beaded jewelry, and distinctive red or blue tunics, Maasai stand out in Tanga. Tanzanian urban dwellers see them as outsiders, or “deviant country bumpkins” (May and McCabe 2004). At the same time, Maasai are also revered by many people in Tanga as trustworthy, strong, tough people who have held fast to their culture as expert herders, and masters of their natural environment with the ability to defend themselves against and even kill large mammals like lions. Maasai are also known for their adeptness in utilizing wild plants for foods.
(consumed in meat soups) and medicines. For Maasai, plant and medicine are the same word, *oljani*. This local reputation, although essentially a stereotype, carries with it a certain cultural cache and it affects how Maasai are perceived, accepted, and integrated into urban life, which is particularly relevant to their role as medicinal plant vendors.

The gazetting of National Parks and Game Reserves, as well as the expanding agricultural areas of other ethnic groups has meant that Maasai grazing areas are smaller and less accessible (sometimes completely off limits) and their lifestyles have had to change accordingly. Due to increasing scarcity of pasture over the last century, combined with an increasing population, and relatively stable cattle numbers Maasai have become less nomadic and more reliant on agriculture (primarily maize, *Z. mays*) while becoming increasingly poorer. Often families live in permanent settlements while young or adult men take the herds to distant available forage. Today, only a minority of Maasai subsist on a pastoral existence void of agriculture.

In the 1980s Maasai were evicted from their grazing areas in northeast Tanga with the establishment of Mkomazi Game Reserve. This brought about stock loss, impoverishment, and hardship. In doing so, it also threatened the very key to Maasai identity. In response, they have diversified their livelihoods by increasingly incorporating more sheep (East African Fat-tailed sheep, a breed of *Ovis aries* L. Bovidae) and goats (Maasai Goats derived from *Capra hircus aegagrus* L. Bovidae) into their stock, and by integrating much more agriculture into their subsistence patterns. Maasai have also become entrepreneurs in urban areas. About 10 years after their eviction, Maasai began to noticeably migrate to urban areas to search for work due to increasing poverty and loss of livestock (Ibrahim and Ibrahim 1998; May and McCabe...
First in larger cities like Dar es Salaam and Arusha, and later in Tanga Town, Moran 'Maasai men of the warrior age-set group' became night watchmen and security guards. They easily adapted to and were accepted into these positions due to their reputation as fierce fighters. While in the past Moran went into the bush as an integral part of establishing their “moranhood,” now they go to the “urban bush” to show their strength and capabilities (Alicia Davis, Personal Communication 2007). Older women began to sell plant medicines, as they are admired repositories of knowledge about plant medicines.

In Tanga town, almost all Maasai vendors are women, many of them elderly and widowed or daughters of widows. “Maasai [women] past reproductive age are sometimes no longer taken care of by their husbands, the positive side of this being their greater independence” (Ibrahim and Ibrahim 1998) which includes going to town and selling medicines, thereby enabling the women more power through income-generation and control over income (Brockington 2001) in a male dominated society. These women are often neighbors at home and come to town together. They work together, share medicines to sell, and send earnings back home together when one of them returns home (Ibrahim and Ibrahim 1998). All of the Maasai vendors in Tanga also make and sell beaded jewelry. Both local and visiting people (Tanga has very few tourists) buy the beadwork.

The growing number of increasingly younger Maasai men seen in urban areas is a reflection of changing lifestyles and increasing struggles to generate income. In Tanga town, they are neophyte vendors of plant medicines, a domain previously occupied by older women. (This has also been reported as a new phenomenon in Arusha by Ibrahim and Ibrahim 1998:141). Usually these young men are itinerant vendors, which is
different from the elderly women who stay in town for extended periods and work from the same locations. Interestingly, a smaller number of young Maasai men are also being commissioned to work in urban women’s hair salons as the Moran style of hair plaiting has become fashionable for women.

3.2.3.2 Sambaa vendors

The Sambaa (also called Shambaa) live in the Usambara Mountains of Tanga, primarily in Lushoto District. “By their own definition, the Shambaa are the people who live in Shambaai, a cool high area above 3,400 feet....The term ‘Shambaai’ is used as the name of the particular mountain block in which the Shambaa live, but it is also an indigenous category for understanding the natural environment. Shambaai is a highland zone with identifiable plants and climate. A number of superficial characteristics of the zone are immediately apparent, even to the casual observer. The mountain rainfall is more abundant than that of the surrounding plains; banana plants, important to the Shambaa economy, grow well; the wild vegetation is green and lush” (Feierman 1974:18).

About 1700 years ago, Bantu people first settled in these mountains. A group of them later united under a common king and became the Sambaa (Ehret 1998). Today, the Sambaa still comprise 70-80% of the population in the area. They are subsistence farmers, skillfully adapted to a mountain environment. “By taking a single ecological zone, understanding its complexity with a thoroughness incomprehensible to even a rural westerner, developing a rich and subtle language with a profusion of terms for the
understanding of local ecology, planting dozens of crops to which the environment was peculiarly suited, the farmer sought to defeat famine, to cheat death” (Feiennan 1974:19).

Today, their diet consists primarily of maize (*Z. mays*), beans (*P. vulgaris*), bananas (*M. sapientium, M. paradisiacal*), cassava (*M. esculenta*), taro (*Colocasia esculentum*), sweet potatoes (*Ipomoea batatas* (L.) Lam. Convolvulaceae) and wild harvested and cultivated leafy greens (e.g, *Bidens pilosa* L. Asteraceae, *Solanum nigrum* L. Solanaceae, *Amaranthus spinosus* L. Amaranthaceae). Relatively few farmers also have enough resources to keep goats, sheep, or cattle, although some do. Sambaa are also known for their expertise in medicinal plants used in health care; rain making; attracting love, luck, and business; warding off witchcraft and evil spirits; and protective charms (Schlage, et al. 2000:84).

The population density has increased dramatically in the Usambara mountains. For example, in the West Usambaras, the population increased 23 fold from 1900 to 1988, growing from about 15,000 to 357,000 (Newmark 2002:26). Today there are about 200 people/km² with some areas as high as 400 people/km². To put this in perspective, the average population density for Tanzania is 25 people/km² (Newmark 2002:27). This increase is the result of a growing Sambaa population, and migration to the area by other ethnic groups. An obvious consequence is that the amount of available farmland has decreased and subsistence agriculture is not an option for everyone as it once was.

The Sambaa have responded to this need by becoming entrepreneurial in a number of ways. They have extended their farming areas into the plains (*nyika*) at the foot of the mountains of *Shambaii*. They are also practiced in transporting and selling produce from their rural farms to urban areas, selling used clothing, and opening small
dry-goods shops, depending on the resources available to them for start-up. Like the Maasai, another example of Sambaa entrepreneurialism is selling plant medicines in urban areas that are traditionally used back home.

3.2.3.3 Shop vendors

Unlike the Sambaa and Maasai vendors whose kiosks and roadside stands have emerged over the past two decades, standard traditional medicine shops were established generations ago in commercial areas. The medicines sold in these shops, locally called dawa za kiarambu ‘Arabic medicines’ or dawa za kihindi ‘Indian medicines’ are imported from across the Indian Ocean (India or Arabian Peninsula) to Mombassa, Kenya where they are purchased in bulk and brought to Tanga. These shops and their goods hearken back to ancient trade routes between East Africa, and the Arabian Peninsula and India, which was facilitated by Swahili people. It is in the context of these ancient relationships that the legacy of this trade is apparent in contemporary local medical practices that combine medicines derived from Arabia, India, and local sites. These vendors usually identify as Indian, Arabic, or Swahili, have permanent shops (not kiosks or market stalls) and sell their medicines in individual doses or in bulk.

The variety in both the type and amounts of products (medicinal and non-medicinal) is greater in these shops than in kiosks or market stalls. The overlap between culinary, cosmetic, and medicinal uses for natural products is evident in the shops’ offerings which include medicines, spices, oils, exudates, soils/clay, minerals, and incense, among other items derived from natural products. These are used variously (depending on the context) as foods, medicines, or cosmetics. Locally harvested plant,
animal, and mineral products comprise a very small portion of the total products sold in these shops. Unlike market or street vendors, these shop keeper-vendors also sell a wide range of manufactured medicines and other products (e.g., dried goods, cosmetics, religious texts, incense, foodstuffs) from South Asia, China, and Arabia.

3.2.4 Hospital health workers

There are very few cases where biomedical hospital health workers distribute plant medicines, but they are an important part of this discussion on medicinal plant management in Tanga because the amount of plant material they distribute is significantly more than that distributed by any individual vendor or healer. The most prominent example is the Tanga AIDS Working Group (TAWG), a Tanzanian non-profit, non-governmental organization. In spite of the common dichotomy of hospital (allopathic, pharmaceutical-based) medicine and traditional (often holistic and plant-based) medicine, they do intersect in important ways, most prominently in the context of HIV/AIDS. Throughout the Tanga Region, health workers from TAWG provide People Living with HIV/AIDS (PLWA) with plant and other medicines to address the opportunistic infections of HIV/AIDS. Their main office is in Tanga Town (on the grounds of the government regional referral hospital) and they have offices in four other districts: Pangani, Muheza, Handeni, and Lushoto. The plant medicines they distribute (primarily four species) are provided to TAWG by one healer, who has trained his own assistants that he oversees in harvesting, processing, and packaging the medicines. Since TAWG began working in 1990 their programs, based on local knowledge, medicinal plants, and collaboration between biomedical health workers and healers, have continued
to expand to address HIV/AIDS (McMillen 2004). Medicinal plants are central to the existence of this organization and its mission. Even since anti-retroviral therapies (ARVs) have become increasingly available, some PLWA continue to use medicinal plants, a subject that will be discussed in the findings.

3.2.5 Harvesters

Because Tanga Region is known, on one hand, for its high levels of biodiversity and endemism, and on the other hand for its notable number and diversity of medicinal plant specialists, it is not surprising that a number of people are also involved in the commercial collection of medicinal plants. Harvesters are usually the urban vendors’ kin or neighbors from their home villages, as most urban residents still maintain close links to their rural home villages through family members that still live there. Medicinal plant gatherers in Southern Africa have relatives living in source areas (away from urban commercial centers where they are sold) so harvesting trips are combined with social visits (Cocks, et al. 2004:481), a trend that is also true in Tanga. Since most of the vendors in Tanga are Sambaa and Maasai, this means that most of them are supplied by their Sambaa and Maasai family and neighbors, respectively.

Throughout Africa, harvesters are typically from societies’ lower socioeconomic status levels (Cocks, et al. 2004:480; Cunningham 1991; Williams 2004). "Wild plant harvesting is especially the preserve of the most economically marginalized people in rural societies, often including landless people, minorities and women. Migrant pastoralists and those practicing transhumance are other groups who frequently pick MAPs [medicinal and aromatic plants] to sell for supplementary income, as they guard
their flocks or herds" (Hamilton and Hamilton 2006:260). Compared to vendors, harvesters often profit much less from medicinal plant sales. In sub-Saharan Africa, poor, rural people—particularly women and sectors of the community with limited alternative income generating opportunities—most often rely on medicinal plant harvesting for income generation (Botha, et al. 2004b; Cunningham 1991; Mander 1998:38). While these harvesters are dependent upon vendors for access to markets, the vendors are also reliant on the harvesters for their own livelihoods. Obviously, without their suppliers, vendors would have nothing to vend. This relationship is especially important in Tanga where most vendors have personal long-term relationships with the harvesters they buy from whether they are blood-relatives or fictive kin.

While in the past medicinal plants were commonly collected directly by their consumers, another household member, or a specialist, now increasing urbanization, growing populations, and rising unemployment have simultaneously created a demand for medicines in urban areas and a group of workers to meet that demand in rural areas. Despite the difficulty of the physically demanding work itself, collectors find medicinal plant harvesting a relatively simple fall-back source of income because of the “ease of access and low capital or skill thresholds to entry” (Arnold and Pérez 1998). This shift in who collects and how has raised concerns. In Southern Africa (Cunningham 1991; Williams, et al. 2000) and in the Himalayas (Ghimire, et al. 2004) collecting is often done by untrained, commercial gatherers with no other income sources and little concern for the long term viability of the plant populations they harvest, a trend that certainly applies in Tanga as well. Open access to harvestable plant populations and lack of private land ownership facilitate the mining (rather than management) of medicinal plant resources,
but this is not the only mode of collection I observed in Tanga. Some healers and vendors have trained their harvesters, and some healers also collect for vendors. These harvesters pride themselves on being distinct from untrained, indifferent gatherers. Further, most commercial harvesters take personal pride in their cultural and family-specific knowledge of medicinal plants. The knowledge and associated skill set is linked to status for some collectors, compared to the collection of other forest products such as green vegetables, fruits, or fuel wood. These medicinal plant harvesters can become locally valued as specialists by their neighbors.

As the most elusive link in the medicinal plant market chain, commercial harvesters usually slip through the cracks of research (see Botha et al 2004b:43; Cunningham 1991; Williams 2002) but they are an essential element of medicinal plant markets as well as critical stakeholders in research and conservation. Harvesters lead us to collection areas, the selection of which is highly influenced by social circumstances of the harvesters and not just ecological conditions. This will be explored in Chapter Eight.

3.2.6 Village environmental committees and district, regional, and national natural resource managers: external influences on the medicinal plant market chain

Because this research is interested in the management of medicinal plants and the conservation implications for those species and their habitats in general, I interacted frequently with regional, district, and local forestry officers and natural resource managers, as well as local village environmental and forest committees made up of volunteer village residents. Although they are not directly involved in the medicinal plant market chain, these people affect how and where people harvest. Their actions are shaped by government policies and localized concerns and objectives. To learn about
policies and official management goals and challenges to meeting those goals, I compare local perspectives of resource users with those of official resource managers.

3.3 Research Places

The selection of research sites was based on their importance to and role in the Tanga medicinal plant market chain. The research sites include both commercial locations (where plants are sold and distributed) and source locations (where the plants are harvested). Here, I first characterize each commercial site in terms of its socio-economic and market features. Next, I describe the land use and ecological characteristics for source locations. In this study, the primary commercial sites include Tanga Town (urban city), Muheza town (semi-urban medium sized town), and Mlalo town (rural and remote small town). These were identified by surveying a wider range of towns and villages for medicinal plant vending activity, and selecting a sample to represent diverse populations (human and plant) and geographic settings. I also selected commercial sites based on a preference for more vendors who deal in high volumes versus fewer vendors who deal in low volumes, and of course the willingness of local vendors to participate in the research. The chosen source locations for medicinal plants are directly linked to the suppliers for the vendors in the commercial sites.
3.3.1 Commercial areas

![Map of Research Area (Tanga Region) showing Commercial Sites](http://recommend.org/Expedia_maps.htm)

Figure 2. Map\(^1\) of Research Area (Tanga Region) showing Commercial Sites

3.3.1.1 Tanga Town, Tanga District – Urban City

Tanga District is the smallest but most densely populated in the region. Its population of 243,580 (Tanzania National Website 2003) is concentrated primarily in Tanga Town, and its residents enjoy more goods and services than residents of other districts. Although the percentage of people living below the poverty line is substantial, at 19%, this is significantly less than other districts, such as Muheza and Lushoto Districts which have 38% of residents below the poverty line (Tanzania Government 2007).

Tanga Town is a commercial and residential mix that takes advantage of the physical infrastructure remaining from the German and British colonial periods (1884-1914, and 1914-1961, respectively). In the area surrounding town, paved roads, piped

\(^1\) http://recommend.org/Expedia_maps.htm
water, and electricity are not common. Cinderblock and mud structures with palm thatch or corrugated iron roofs are typical. Because of its location on the coast, fishing and travel by sea are common. In town, residents frequent about ten daily markets of different sizes where food (animal and vegetable) and other plant products are sold. Medicinal plants can also be purchased at most of these markets, usually amidst spices and other culinary offerings. Only a minority of markets have regular vendors that specialize in medicinal plants. Most markets simply have a few vendors that sell health related natural products such as chewing sticks, clay for eating, and luffa (*Luffa acutangula* Miller Cucurbitaceae) sponges, for example, amongst produce, house wares or spices.

Employment motivated migration has created culturally heterogeneous Tanga, but the town maintains strong roots and to Swahili aesthetics that manifest in architecture, music, cuisine, and language (i.e., distinctly Swahili diction and vocabulary). Tanga District is a microcosm of all the ethnic groups in the Region, including Zigua, Sambaa, Digo, and Bondei. As mentioned, Maasai are historically not urban dwellers, but over the past decade their presence in Tanga Town has increased.

Although the vast majority of Tanga Region is Muslim, the influence of Islam on the local rhythm, movement, and structure of daily life in Tanga Town is especially noticeable. The dress of both men and women adheres more closely to Muslim guidelines (especially evident on Fridays, the most important weekday to go to the mosque). The voices of young children as they recite and repeat passages from the Qur’ān pour out of madrassa (Islamic religion school) windows. The *adhan*, the call to prayer five times a day, broadcast on P.A. systems from numerous mosques throughout
town signals a break in the workday and the temporary closure of shops when men visit the mosques. The month of Ramadan is marked by shortened work days, fasting during the day, and the preparation of and feasting on special foods at night. Other ritual events are also influenced by local Islamic practices such as holidays including *maulidi* (which commemorates the birth of the Prophet Mohammed during the third month of the Islamic calendar), funerals, and weddings (many of which are held just before Ramadan). A belief in the healing power of the Qur'ān and things associated with Allah and the Prophet Muhammad are also important elements that set the tone for daily life. Thus, Islam is also enmeshed in local ethnomedical systems and the broader research setting.

3.3.1.2 Muheza Town, Muheza District - Medium sized town

Important institutions, landmarks, and activities in Muheza District are based around the Amani botanical garden and the Amani Nature Reserve (which has a higher conservation status than the Serengeti), offices for the National Institute for Malaria Research, sisal and tea plantations, ecotourism, a butterfly farming project (supported by the Tanzania Forest Conservation Group, an NGO), and timber extraction. Muheza is also known for its production and sale of citrus fruits (oranges and tangerines).

The most important commercial area in Muheza District is Muheza Town (about a half hour drive from Tanga Town), at the foot of the East Usambaras. It has no paved streets and its major features center around a bus stop, large mosque, daily food market, and the mission hospital (Tuele Hospital). Muheza also has one weekly market that features used clothing (imported), new locally sewn clothing, textiles, and house wares. Its location on a major highway between Tanga and Dar es Salaam means that Muheza is
an important transfer point for people, produce, and timber. Compared to Tanga Town it is much smaller and has much less wealth. Compared to Lushoto Town, it is located more centrally with respect to major transportation routes, but is not nearly as active in the medicinal plant trade as is the more remote and smaller town of Mlalo in Lushoto District. Although it is the traditional homeland of the Bondei, none of the medicinal plant vendors encountered in Muheza are Bondei.

Despite its proximity to high and low elevation forested areas which are potential sources of commercial medicinal plants, there are only three vendors who regularly sell daily from semi-permanent stalls outside the market. Inside the structure of the daily market, a few vendors sell Arabic medicines and a handful of locally harvested ones among produce, spices, and utensils that populate their stalls. Maasai vendors station themselves together outside the daily market and away from the other medicinal vendors. (During this research period, the Maasai vendors had ironically set up small tables to display their medicines on a corner next to a sign that read “No vending in this area.” This illustrates the peripheral space typically Maasai occupy in urban life.) Their presence as vendors is intermittent in Muheza Town, whereas the other vendors are found at their tables and kiosks daily.

3.3.1.3 Mlalo, Lushoto District - Rural and remote small town

Mlalo is a small town at 1,300 masl and is about 40 km up the mountain from Lushoto Town, the largest town in the Lushoto District. (Mlalo is about 110 km from Tanga as the bird flies, but about 6-7 hrs from Tanga on public transportation.) A peculiar artifact of the European colonists’ presence in Mlalo town is how it is
geographically divided along religious lines. The majority of the Christian population lives on one side of the river (a tributary to Umba River) that bisects the town, while the majority of the Muslim population lives on the other side. Still, religion is not divisive among the population of Mlalo. Christians and Muslims interact in schools, markets, business, etc., just as they do in other Tanzanian towns where religious populations are integrated. The town itself consists of one dirt road (extremely dusty or extremely muddy depending on the time of year) lined with shops that lead up to a bus stand which is outlined with more shops. Adjacent to that and across the river is another square lined with shops. This is where the market is held twice a week. Fruits, vegetables, dried goods, household goods, knives, and plant medicines are brought from remote mountain villages where they are produced. Textiles, secondhand clothing, and tools from larger cities are brought by visiting merchants. The Mlalo market has its own section of medicinal plant vendors who congregate to buy and sell their medicines. This offers an opportunity for bulking (combining the collections of various harvesters) of medicinal plants for purchase by middlemen and vendors from larger cities. All the medicinal plant vendors in this market are Sambaa.

Features of the major commercial sites: Tanga, Muheza, and Mlalo are summarized in Table 3.2 on the following page.
### Table 3.2. Commercial Research Sites – Demographic, Health, and Environmental Details

<table>
<thead>
<tr>
<th>Research Location</th>
<th>Population Town* (District)</th>
<th>Main Ethnic Groups</th>
<th>District-wide Govt Health Services++</th>
<th>Markets</th>
<th>Medicinal Plant Vendors</th>
<th>Environment</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tanga Town,</strong> Tanga District</td>
<td>Town: 235,919 (256,918)</td>
<td>Digo, Sambaa, Bondei, Zigua</td>
<td>Hospital -1 Health Cntr -3 Dispensary-17</td>
<td>10 Daily, 1 three times/week</td>
<td>Shops, Kiosks, Market, Roadside, Roaming</td>
<td>Coastal arid plains, coastal forest remnants, mangrove swamps</td>
<td>One of the ten largest urban centers in Tanzania; Urban core with outlying industry and farms; Important location in route between Mombassa (Kenya) and Dar es Salaam.</td>
</tr>
<tr>
<td><strong>Muheza Town,</strong> Muheza District</td>
<td>Town: 17,430 (294,787)</td>
<td>Bondei, Sambaa</td>
<td>Hospital-0 Health Cntr- 4 Dispensary-40</td>
<td>1 Daily, 1 weekly</td>
<td>Market, Tables, Roadside, Roaming</td>
<td>Moist Lowland forest at the foothills of the Usambara mountains, somewhat elevated coastal plains</td>
<td>Point of transfer for passengers and goods going between Tanga, Dar es Salaam, and Arusha; Near Amani Nature Reserve.</td>
</tr>
<tr>
<td><strong>Mlalo Town,</strong> Lushoto District</td>
<td>Town: 15,970 (443,286)</td>
<td>Sambaa</td>
<td>Hospital-0 Health Cntr-7 Dispensary-32</td>
<td>1 twice/ week</td>
<td>Market, roadside</td>
<td>Moist Usambara Mountain Rainforest bordering lowland Umba plains.</td>
<td>Natural forests exist in reserves, remaining areas are farmed and are fuelwood lots; Mlalo town is in proximity to multiple protected forests.</td>
</tr>
</tbody>
</table>

*2007 calculation (projection) for Towns are from - [http://www.world-gazetteer.com](http://www.world-gazetteer.com)
3.3.1.4 Sites that were not chosen and why

Amani is a forest block in the East Usambara Mountains in proximity to Muheza town below. I expected it would be an important location for the medicinal plant trade. As a forest, it is a potential source area for plant medicines and because of its location, transporting the medicines to market is relatively simple. Amani is in proximity to Muheza Town which has middle size markets and is located on a highly traveled road that leads to larger cities (e.g., Tanga and Dar es Salaam) where market options expand considerably. Although healers who live in Amani expressed their frustration about non-resident harvesters who take medicinal plants from "their" forest, I did not find strong evidence to support their claims of widespread commercial harvest of medicinal plants. Instead, surveys of markets in Amani, Muheza Town, Mlalo, and Tanga Town lacked commercial medicinal plants said to be harvested from Amani. Further, neither Muheza nor Tanga vendors cited their harvesters as being from Amani or sourcing plants from Amani. (This is not to say that there is no commercial medicinal plant activity, it simply means that Amani did not emerge as an important site. This could be in part because of its protective status, which is among the highest in the nation, and its high profile due to conservation and research activities promoted by international organizations. These factors could have easily influenced people's hesitancy to discuss extractive activities there, but I argue that it also means that less extraction actually happens.) The pay schedule set by the tea plantations in Amani determines the frequency of markets which is every fortnight. I surveyed markets in four different areas around Amani and spoke with local vendors and residents to learn about medicinal plant harvest and sale in the area. (I also surveyed the market in Maramba, situated outside Mtai forest reserve in the
In my survey of markets in Amani, only a couple of medicinal plant vendors were present and they, like most of the other vendors in the market, were not residents of Amani. Among the medicinal plants sold openly in Amani, only a couple were said to be harvested there. In terms of medicinal plant harvest, Amani seems to be more of an important source location for residents of the area and not for commercial harvesting.

Korogwe, Handeni, and Pangani Districts were not included in this research period because of time restraints. Although I observed four vendors who sold plant medicines regularly in Korogwe town, its similarity to other already established research sites meant that it would likely have contributed little new information about the medicinal plant market chain in Tanga. Korogwe town shares a similar size and environment with Muheza. Both are located at the base of the Usambara Mountains, and both are populated by Bondeni and Sambaa. I speculate that many of the medicines would be the same as those in Tanga and Muheza sold by Sambaa. In fact, I documented an exchange of medicines between Korogwe vendors and Tanga vendors, which supports the idea of their medicines being similar. When popular Tanga vendors’ stocks were depleted and their harvesters had not yet delivered, they often resorted to buying or borrowing from Korogwe vendors.

In the case of Handeni District, both the environment (arid scrub forests) and the local people (Zigua) are different from those in Tanga, Muheza, and Korogwe Districts. Their medicinal plants would have been different and contributed new information to the medicinal plant market chain in Tanga; however, because Handeni was not identified as an important source location for Tanga Town (the major commercial center), it was
excluded from this research period. Notably, one commercial medicinal plant sold in Tanga, Muheza and Lushoto, locally called *mdaula*, was said to be found only in Handeni District in Tanga (as well as other areas outside Tanga Region). I did not include Pangani because it did not emerge as an important source area or commercial area for commercial medicinal plants in Tanga Town.

### 3.3.2 Source locations

Source areas for commercial medicinal plants were sampled in Tanga, Muheza, and Lushoto Districts. Sites were selected by working with participating vendors to connect with their supplying harvesters. I accompanied these harvesters to observe their harvesting practices and to collect voucher specimens in the areas where they collect. I selected for a variety of locations in terms of ecological characteristics and habitat disturbance levels in order to better understand the range of possibilities in collection.

#### 3.3.2.1 Land use and land tenure characterizations of source areas

Guided by the perspectives of harvesters and the characteristics they find significant in deciding where to collect medicinal plants, I will describe geographic areas based on the land use and tenure of the areas. Although they are not mutually exclusive, each site most closely corresponds with one of three categories:

- Private Cultivation or Residential Areas
- Open-access, Public lands
- Protected and Private Areas
3.3.2.2 Private cultivation or residential areas

These are obvious anthropogenic environments, characterized by private individual land rights such as home gardens and in-use farms. These areas tend not to be widely harvested for commercial purposes, but rather by consumers themselves for immediate use at home. Permission to harvest from the landowner is considered best, but not necessarily practiced by the harvester. Areas Included:

Tanga District: Urban Home gardens (Tanga Town Wards: Makorora, Raskazone, Ngamiani); Active farms in Tongoni Ward

Lushoto District: Semi-rural home gardens and farms (Mission area -Mlalo), Rural home gardens and remote farms (Subvillage of Bagai, Mlalo)

3.3.2.3 Open-access, public lands

These are disturbed areas of anthropogenic nature such as abandoned or fallow farms and plantations, grazing areas, roadside areas, and secondary growth forests. Although an inactive farm or an area used for grazing may be owned privately, the fact that it is not in use (i.e., farmed or tended) or inhabited by the landowner means that harvesters do not find it necessary to seek permission to harvest there. In this study, public lands consisted of anthropogenic wooded grasslands and savannah with small patches for thicket and uninhabited (largely open) areas.

Tanga District: Mtakuja, Tongoni, Pongwe

Muheza District: Amboni, Lusanga, Mazola

Lushoto Districts: Bagai village, Mlola village, Lewa village
3.3.2.4 Protected and privately owned areas

This category is broader than a forest reserve in the conventional sense. It includes forests that are the property of, and managed and protected by, either the national, district, or village government; by the military; or by families who own and manage them as traditional forests. Most of these collection areas are in montane forests. An exception is the military property which is in a coastal area of Tanga District. I accompanied harvesters in an area that borders military property (not within it) although they reported harvesting from within the military property with permission from and payment to on-site military personnel. Although fewer species are commercially harvested from protected montane forest areas, they are perhaps harvested more intensively than commercially harvested species from lowland and coastal areas. In other words, fewer species come from these montane forested areas, but the amounts harvested per species may be more than the amounts harvested per lowland species. (Coastal Forest Reserves exist, but they are not included in this research as the harvesters appear not to rely on them as sources for medicinal plants, based on interviews and observations of collection.)Unlike private cultivation or residential areas and open-access public lands, people know they must get permission or harvest secretly from protected and privately owned areas.

Lushoto District:

Shagayo Forest Reserve (gazetted by the national government and in the process of becoming a jointly managed forest with the villages surrounding it)

Mtumbi Forest Reserve (jointly managed by villages and Lushoto District Government)

Mlola Village Forest (managed by the villages surrounding the forest)
3.3.2.5 Ecological characterizations of source areas

From an ecological and conservation perspective, habitat types and biodiversity of these source areas for commercially collected medicinal plants are important to differentiate. Local characterization of geographic and climactic areas are described as either *joto* ‘hot,’ which corresponds with dryer areas of lower altitude and higher temperatures, or *baridi* ‘cold,’ which corresponds with wetter, cooler areas of higher elevation. Sambaa people also describe these areas as *nyika* ‘plains’ and *shambaai* ‘mountains’ (Feierman 1974:18). These emic categories overlap with etic ecological characterizations of Tanga’s coastal and montane environments, and I will describe them here in more detail. They also relate to two areas found within Tanga’s borders that are part of recognized “hotspots” due to their high levels of biodiversity and endemism.

They are: 1) The East African Coastal Forests, a mosaic of lowland forest patches that span from northern Kenya to southern Mozambique; and 2) Eastern Afromontane Forests which incorporate the fragmented yet biogeographically similar montane areas from the North in the Eastern Arc Mountains (Tanzania and Kenya), the Southern Rift, the Albertine Rift, and the Ethiopian Highlands (Ethiopia) (Mittermeier, et al. 2005). Of all the Eastern Afromontane Forests, those in the Eastern Arc Mountains have the highest levels of biodiversity and endemism. Lushoto, an important medicinal plant collection area, is located in the West Usambara Mountains, which are part of the Eastern Arc
Mountains. The Eastern Arc Mountains will be discussed here instead of the larger Eastern Afromontane Forest hotspot.

The rates at which these coastal and montane forests are becoming degraded are alarming. Literature that documents the urgency of their preservation continues to grow as the forested areas continue to shrink. Because the source areas for medicinal plants fall within these areas, their harvest can be considered a potential threat to biodiversity. At the same time, medicinal plants can be considered threatened themselves, due to being part of the composition of these areas which are increasingly degraded.

Table 3.3. Hotspot Habitat and Biomes

<table>
<thead>
<tr>
<th>Area</th>
<th>Original extent km²</th>
<th>Remaining habitat km²</th>
<th>Predominant biome(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Forests of Eastern Africa Hotspot¹</td>
<td>291,250</td>
<td>29,125 (10%)</td>
<td>Tropical &amp; Subtropical Moist Broadleaf Forests</td>
</tr>
<tr>
<td>Eastern Afromontane Hotspot¹</td>
<td>1,017,806</td>
<td>106,870 (11%)</td>
<td>Tropical &amp; Subtropical Moist Broadleaf Forests; Montane Grasslands and Shrublands</td>
</tr>
<tr>
<td>Eastern Arc Mountain Forests²</td>
<td>23,658</td>
<td>5,340 (23%)</td>
<td>Forests: Dry Montane, montane, montane, submontane, lowland, drylowland³</td>
</tr>
<tr>
<td>West Usambara Forests²</td>
<td>2,050</td>
<td>328 (16%)</td>
<td>Forests: Upper montane, montane, submontane</td>
</tr>
</tbody>
</table>

¹ Mittermeier, et al 2005; ² Derived from Newmark 1998; ³ Lovett 1993

3.3.2.6 Biodiversity of hotspots

Although they are present, charismatic megafauna are now relatively few in these hotspots. Instead, their biodiversity is represented by less well known but unique plants, small primates such as bush babies (Galagoides sp.) and other small mammals including Abbott's duiker (Cephalophus spadix) and the elephant shrew (Rynchocyon petersi),
birds such as sunbirds (Nectarinia sp.) and thrushes (Turdus sp.), and reptiles including the three-horned Chameleons (Chamaeleo deremensis). Among the notable plants in the Eastern Arc are African violets (Saintpaulia sp.), 13 endemic African primroses (Streptocarpus sp.), at least 50 endemic species of balsam (Impatiens sp.), and a number of endemic begonias (Begonia sp.). Coastal Forests have and 11 species of wild coffee, of which eight are endemic (Clarke et al. 2000 cited in Mittermeier, et al. 2005).

3.3.2.7 East African Coastal Forests

![Map of East African Coastal Forest Hotspot](image)

Figure 3. Map\(^1\) of East African Coastal Forest Hotspot

This area was previously characterized as Inhambane within his Zanzibar-Inhambane Regional Mosaic. Later, it was included as part of the Swahilian Regional Center of Plant Endemism, and the World Wildlife Fund (WWF) divided it into the

\(^1\) Conservation International [www.biodiversityhotspots.org/](http://www.biodiversityhotspots.org/)
Northern and Southern Zanzibar-Inhambane Coastal Forest Mosaic Ecoregions (Mittermeier et al. 2005). Clearly, these areas have been the subject of much attention from biogeographers, botanists, ecologists, and conservationists. For our purposes, it is important to know that Tanga’s Coastal forests are part of the Coastal Forests of Eastern Africa Hotspot (as defined by Conservation International). The total land area covered by this hotspot is around 291,250 km$^2$ (Mittermeier, et al. 2005), only a fraction of which exists in Tanga. The discussion below focuses on the coastal forest mosaic in Tanga.

The area is tropical with high temperatures (about 23°C) and high humidity almost year round. There are two rainy seasons (long, April-June; short, November-December) and with an average rainfall between 900 and 1,400 mm/year. The vegetation is characterized by a complex mix of moist forests (for example, at the base of the Eastern Arc Mountains) and drier forests with coastal thicket, fire-climax savanna woodlands, seasonal and permanent swamps, and littoral habitats that include mangrove vegetation (Mittermeier, et al. 2005). This complexity is partly natural, but thousands of years of anthropogenic activities are thought to be more influential in shaping the vegetation of this area. Trees dominate the coastal forest flora, with some of the more abundant species being Afzelia quanzensis, Albizia sp., Bombax rhodogaphalon, Combretum schumannii, Croton sp., Cussonia zimmermannii, Cynometra sp., Dialium sp., Diospyros sp., Grewia sp., Hymenaea verrucosa, Manilkara sp., Millettia stuhlmanni, Nesogordonia holtzii, Ricinodendron heudelotii, Scorodophloeus fischeri, Sterculia appendiculata, Sorindeia madagascariensis, Xyilia africana, and Zanthoxylum sp. Many of these have uses as medicines, and/or fuelwood. Lianas, shrubs, herbs, grasses, sedges, ferns, and various epiphytes are also common (Mittermeier, et al. 2005).
In addition to the entire fragmented hotspot being biodiverse, forest patches within the hotspot are themselves biologically distinct from each other. For example, forests that are only 100 km apart can differ in 80% of their plants (Clarke et al. 2000 cited in Mittermeier, et al. 2005), and 70% of their millipedes (Hoffmann 2000 cited in Mittermeier, et al. 2005). The entire Coastal Forests of Eastern Africa Hotspot contains an estimated 4,050 plant species within around 1,050 plant genera, of which 1,750 plant species and 28 genera are endemic; most of the endemic genera are monotypic. The lowland forest habitat is the most biologically valuable, with at least 554 endemic plant species and 18 of the 28 described endemic genera confined entirely to it (Clarke et al. 2000; G.P. Clarke, unpubl., cited in Mittermeier, et al. 2005).

The non-forested areas of the coastal strip of eastern Africa (i.e., swamp, wooded grassland, coastal margins) cover at least 275,000 km² and at least 812 endemic plants and members of 10 endemic genera have been recorded from there (0.3 endemic plants per 100 km² of habitat) (Burgess, et al. 2003). The coastal forests themselves cover a smaller area but have more endemics with total of 6,259 km² (8.8 endemics per 100 km² of habitat) (Burgess, et al. 2003). Clearly, it is the forest patches that have the highest biodiversity importance per unit area. Interestingly, in my research the coastal strip seems to be more utilized as a source area for medicinal plants, compared to coastal forests.

In Tanzania there are no protected coastal forests larger than 40 km² (Younge et al. 2002 cited in Mittermeier, et al. 2005). “The important forests are primarily managed as Forest Reserves by impoverished forestry departments at the District level, where the primary focus is on income generation to support District development projects.”
These patches of lowland forest habitat are threatened by an expanding population that relies on them to meet their subsistence and livelihood needs.

3.3.2.8 Eastern Arc Mountain Forests

Figure 4. Map of Eastern Afromontane Hotspot

Figure 5. Map of Eastern Arc Mountain Forests Detail

1 www.biodiversityhotspots.org/
2 www.easternarc.org/html/map.html
While the entire Eastern Afromontane Hotspot holds nearly 7,600 species of plants, of which more than 2,350 are endemic, current estimates suggest there are over 2,000 plant species in 800 genera in the Eastern Arc Mountains, of which at least 800 species (and probably well over 1,000) and around 40 genera are believed to be endemic (Lovett 1998). Endemic plants are not restricted to forests, and are also found in montane grasslands, wetland areas, on rocky outcrops, and in the drier rainshadow (west and north) areas.

The Eastern Arc Mountains and their forest communities consist of a complex of ranges and peaks (up to 2200 masl in the Usambara Mountains) that are among the oldest in Africa. The Eastern Arc is defined as a chain of ancient crystalline Precambrian basement mountains that stretch from the Taita Hills in Kenya to the Udzungwa Mountains in South Central Tanzania, which uplifted at least 30 million years ago. Even though periodic drying trends affected much of the rest of Africa, the proximity of the Eastern Arc Mountains to the Indian Ocean has afforded them relatively moist conditions (Lovett 1993). Over evolutionary time, this has contributed to the highly distinctive nature of the animals and plants that inhabit each montane region. Based on this and other evidence, Burgess and coauthors (Burgess, et al. 2007) hypothesize that the Eastern Arc has exceptional rates of endemism because it is a center of specialization and because it is an area where species avoid extinction. Vegetation types include dry montane, upper montane, montane, submontane and lowland forests, with Afromontane grassland and heathland plant communities at higher altitudes. The biota is noted for very high levels of regional endemism as well as many locally endemic species of plants and animals restricted to single ranges.
The research site in Mlalo, Lushoto is situated in the West Usambaras, one block of mountains in the Eastern Arc Mountain chain. Mean temperature values range from 16.3 - 24.9 °C for the Usambaras, with peak rains between March and May and again around November (Rodgers and Homewood 1982:201). These mountains in particular are noted for their unique biology and geography. “The Usambara Mountains, despite their small extent, have one of the most diversified floras in the world and are probably unique in the large number of phytogeographical elements they harbour, and in the extreme diversity and abruptness of change shown by the vegetation” (Rodgers and Homewood 1982:204). They support “five strictly endemic vertebrates and another 19 species that are only found in the Eastern Arc. There are also 27 Eastern Arc endemic trees. This high biodiversity value is also found in invertebrates and in shrubs and herbs. Although biodiversity surveys are probably not complete, some parts of the West Usambara forests have been well studied over the past 100 years” (Eastern Arc Mountains Conservation Endowment Fund 2005 cited in Burgess, et al. 2007). The West Usambaras are also known as an important source of timber, much of which has already been exploited, and for East African sandalwood (*Osyris lanceolata* Hochst. & Steud. Santalaceae) which has been overharvested to meet market demands for the cosmetics industry abroad. *O. lanceolata* is also prized locally for its medicinal value.

### 3.4 Conclusion

Due to its heterogeneous and distinctive features, the Tanga Region of Tanzania is an interesting place to investigate the social and ecological context of the medicinal plant market chain and medicinal plant management as it intersects with resource management
and conservation. Medicinal plants play a role in local ethnomedical systems, economies, and interpersonal relationships. Research participants represent the range of stakeholders who participate in the acquisition, distribution, and consumption of medicinal plants. Commercial research sites exemplify a range of market situations and distribution modes for medicinal plants. Source locations in this research illustrate the significance of ecology, land use, and situation in an eco-cultural landscape in investigating medicinal plant source areas.
CHAPTER 4. RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

This study is based on ethnographic and ethnobotanical methods that combine quantitative and qualitative approaches to explore the pathways medicinal plants follow from their point of harvest to their time of use. It also examines differences in local ecological knowledge among participants of diverse socio-demographic backgrounds (which can be tested statistically), and the influence of economic and cultural factors (which are inferred from qualitative data, and quantitative comparison).

After reviewing decades of ethnobiological studies on local ecological knowledge, Reyes-García and co-authors (2006b) call for more replication of methods to facilitate cross cultural comparison, and they recommend using a greater variety of methods in each study to verify knowledge. My study addresses these recommendations by following established guidelines for examining commercial medicinal plants (Cunningham 1997; Cunningham 2001), using standard methods and software for data analyses, including EtimateS (Coldwell 1998), following Williams and co-authors (2005; 2007) and SAS ®, and using triangulation—the process of employing a variety of techniques to explore the same domains of knowledge to verify findings.

Preliminary research was conducted from June to September 2004. The primary research was conducted during 18 consecutive months from April 2005 to August 2006. All research was conducted in Swahili except in the case of working with the Maasai when Maa was used to supplement Swahili.
The majority of the research was conducted without an assistant, with the following exceptions. In cases when Maasai participants' Swahili was minimal, a Maasai research assistant, Mr. Mbessere E. Lukumay, was used to assist with translations and clarifications. He is a livestock specialist and outreach educator employed by Tanga Municipality who is fluent in Maa and Swahili, and proficient in English. He lives outside of Tanga Town with his family and cattle. For household surveys in two areas, assistants helped locate households and establish the legitimacy of household interviews. In one urban neighborhood of Tanga Town, I was assisted by Shabani Dossantos, a Digo and recent high school graduate who was born and raised in Tanga Town. He is active in local government and dedicated to a number of non-profit education and environmental organizations. In a rural-remote area of Lushoto I was assisted by the sub-village chairperson Hashim Rajabu. He is a Sambaa farmer with primary school education and lives with his family in the same sub-village where he assisted me. Initial and repeat reconnaissance surveys of local markets and commercial areas to assess the locations, types, and numbers of medicinal plant vendors in Tanga town area was accomplished with assistance of Sarah Zimbwe and Mshihiri Tumbo of Tanga Town. Ms. Zimbwe identifies with the Nyamwezi ethnic group although she also has Sambaa ancestry. She has lived in Tanga Town for the majority of her life, has professional training in computers and bookkeeping, and has worked for various non-profit and for-profit ventures in Tanga. She is fluent in Swahili and English. Mr. Tumbo is a Digo from Pangani, Tanga who now lives in Tanga Town with his family. He is fluent in Swahili and Digo and knows basic English. He has a secondary education and has worked on a number of health and botanical projects in Tanga. Preliminary interviews were conducted
with assistance from Sarah Zimbwe and Charles Rapp when my Swahili was getting back up to speed. Charles Rapp is currently a university student in Tanzania, studying environmental science. In the interest of efficiently completing the local ecological knowledge survey, Salehe Zimbwe and Sulimani Omar assisted me by conducting surveys. Mr. Zimbwe is a college graduate from Tanga who works as a data entry and computer specialist for the TAWG. Mr. Omar, originally from Zanzibar, is TAWG’s Indigenous Knowledge Coordinator. Both are fluent in Swahili and English.

4.2 Data Collection Methods and Schedule

My research design transitions from flexible, less structured methods to more specific and structured methods. It is also cyclical with periods of planning, collecting data, feeding back findings to participants and advisors (in order to confirm or correct them), refining the next steps in the research plan, collecting additional data, and repeating the cycle. Inherent to this design is the participation of local stakeholders in refining research priorities and techniques for achieving research goals — goals that are based (in part) on local stakeholders’ suggestions and interests that I became aware of through earlier field research in Tanga (1998-1999; 2000).

Methods employed initially and used throughout the research period include participant observation, exploratory surveys of commercial and market areas, and unstructured, informal interviews. These sharpened my understanding of the context and specific details of medicinal plant management and use, which was necessary for designing subsequent semi-structured interviews, and later inventories of vendors’ and healers’ stocks. Next, semi-structured interviews assessed the backgrounds and
experiences of healers, vendors, and harvesters and helped to elaborate connections among these roles. The interviews also asked about participants' clients or customers, sources of plants, and harvesting experience. Participants freely listed the most important plants to their work, the most expensive plants, the plants most in demand, and the plants hardest to obtain. Because it required an in-depth understanding of important plants and associated knowledge, which could only be gained after considerable data had been collected and analyzed, a structured local ecological knowledge survey was conducted at the end of the research period. Focus groups and feedback meetings were held regularly throughout the research period as a way to share and confirm findings, as well as refine the research design. (Details of the themes explored in these meetings are described on pages 13-14.) I regularly (quarterly or more often) consulted local experts: one herbalist-healer (Mohommed Kassomo), one vendor (Miraji Shemkai), one Islamic scholar-healer (Sharifu Muhana), and two professors from Sokoine University of Agriculture who specialize in forestry and natural resource management (Drs. John Kessy and Emanuel Luoga). The research benefited from my consultation with other local experts but I did not meet with them as regularly. I also kept a personal journal throughout the research process, which aided in capturing details and changes I observed in the research setting.

Table 4.1 on the following pages details my research methods and schedule.
<table>
<thead>
<tr>
<th>Method</th>
<th>Number of Participants</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informal conversations &amp; unstructured interviews</td>
<td>&gt;100</td>
<td>May – September 2004 ; April 2005 to August 2006 (continuous)</td>
</tr>
</tbody>
</table>
| Focus groups / feedback meetings            | 5-10 Individuals per meeting, except *  
Harvesters = 3 meetings  
Bantu Vendors = 3 meetings  
Maasai Vendors = 3 meetings  
Healers = 5 meetings  
PLWHA = 2 meetings (1 men, 1 women)  
Village environmental committees = 2 meetings  
Tanga AIDS Working Group =1 meeting  
All Participants =1 meeting* (* about 40 attendees) | 31 May 2005 – 15 August 2006 |
| Participation & observation                 | e.g., of harvest, vending, preparation, administration of plant medicines; healing rituals; establishing medicinal plant garden | May – September 2004; April 2005 - August 2006 (continuous) |
| Market visits and reconnaissance surveys     | N/A                    | June – September 2004  
April 2005 - July 2006 (ongoing)             |
| Field excursions to observe medicinal plant harvest & collect voucher specimen | About 3 people participated on each trip, a number of which participated in multiple trips | 1,2,5,6 September 2004; 4-6 August 2005; 5 May 2005; 5, 18-25 September 2005; 8 December 2005  
8 January 2006; 24-25 February 2006; 1, 9,12,14,19 March 2006; 30 April 2006; 6, 16 July 2006 |
| Semi-structured interviews with specialists  | Total = 60             |                                            |
| Vendors (local medicinal plants) = 29       |                        | May 2005- January 2006                   |
| Vendors (imported medicines) = 5             |                        | June 2005 – July 2005                    |
| Healers = 15                                |                        | May 2005- July 2006                     |
| Semi-structured household interviews | Total = 112  
Rural, Montane (Lushoto) = 30  
Urban, Coastal (Tanga) = 82 | November 2005-March 2006 |
|-------------------------------------|-------------------------------|-----------------------------|
| Inventories of Specialists' medicinal plant stocks | Total = 42  
Vendors (local medicinal plants) = 28  
Healers = 14 | August 2005-March 2006  
August 2005 –May 2006 |
| Local Ecological Knowledge Survey | Total =74  
Vendors (of local medicines only) = 27  
Harvesters = 19  
Healers = 28 | 15-20, 25,-28, 30-31 July 2006  
2-3 August 2006 |
4.3 Obtaining Consent

4.3.1 Essential Consent

Institutional Review Board (IRB): The University of Hawai‘i Committee on Human Studies determined my research to be exempt from the Department of Health and Human Services regulations, 45 CFR Part 46, as specified by section 46.101(b)(2).


Participants’ Prior Informed Consent: Prior to collecting data, all potential participants were read an agreement to participate in the research and officially asked to participate. Agreements were tailored for specialists (Appendix A and Appendix B) and non-specialists (Appendix C and Appendix D). Each potential participant also received a written copy of the agreement. (All agreements were read aloud in Swahili. In the case of Maasai, they were also translated into Maa by the research assistant.) All who were invited to participate in the research agreed, and participated to some degree although not all participated fully in all the activities to which they were invited. For example, three healers and two vendors preferred not to participate in inventories of their stocks but participated in interviews or focus groups. As the research process continued, participants who had already consented to participate initially were asked again for permission before moving forward in additional steps of the research process (from semi-structured interviews to inventories to LEK surveys). This request was made orally in reference to the terms of the previous agreement.
4.3.2 Supplementary Consent

I requested permission to involve members and residents of local stakeholder groups from their leaders. Permission was granted and letters of support were obtained from: the National Secretary of the Chama cha Waganga na Wakunga Asilia Tanzania (CHAWATIATA) ‘Union of Traditional Healers and Midwives of Tanzania), the Officer of Natural Resources for Tanga Region, local government authorities (e.g., Village Chairpersons in Mlalo, Lushoto Villages, Maramba Division Secretary in Muheza District, and Division Heads of urban areas that were surveyed in household interviews in Tanga Town). Passing through these official channels encouraged participants to become involved in the research because it strengthened the legitimacy of the work, demonstrated it had official support, and thereby quelled anxiety people may have had that their participation would have been frowned upon by authorities.

4.4 Sampling
4.4.1 Selection of Research Locations

I focused on the commercial trade because preliminary research indicated that those plants are harvested in greater quantity and with more frequency than plants harvested either by healers or by individual consumers for their own use at home. For comparison I also explored medicinal plants commonly used by healers and by lay people, but this was a smaller part of my study. I began in Tanga Town, the region’s largest population and commercial district, as a point of entry for connecting with vendors, healers, and other distributors of medicinal plants. Based on market reconnaissance surveys of towns in Muheza and Lushoto Districts, I involved other areas
(Muheza Town and Mlalo, Lushoto). Vendors and healers in these areas connected me with their supplying harvesters who led me to source areas for medicinal plants (coastal habitats of Tanga District, lowland forest remnants of Muheza District, and montane habitats in Lushoto Districts). Source areas were often the original home areas for vendors who have since relocated to more urban locales such as Tanga Town. The selection of specific source areas for the study was influenced by the willingness and ability of harvesters to lead me to source areas and the logistics of accompanying them on actual harvesting events. Usually this required a combination of mutual trust between me and the collector(s) and a good deal of luck that the planned collection excursion would not be thwarted by a last minute change of plans due to transportation failure, weather changes, a sick relative, or a funeral—frequent occurrences in Tanga daily life.

4.4.2 Selection of Principal Participants

In all cases, the selection of participants was limited to adults with deliberate efforts to include a geographic and cultural range of people involved in the management and use of medicinal plants. Through my earlier research (1998-1999, 2000) on the interaction between hospital health workers and healers and the local use of medicinal plants (McMillen 2004), I had come to know a number of healers in Tanga town, including some of the most well-known ones as well as those who had interacted with the Tanga AIDS Working Group. Sampling was purposeful. I began with healers I already had connections with and, with their cooperation, I incorporated snowball sampling (Bernard 1995:97), seeking a balance of men and women and a variety of types of
healers, and also purposefully seeking out those who harvest medicinal plants in large quantities.

Vendors were identified through reconnaissance surveys of commercial areas with medicinal plant vendors. The busiest vendors (i.e., those repeatedly observed with the most customers) and those who dealt with larger amounts of plant material were prioritized for recruitment, but the sample also included vendors at the opposite end of the spectrum. Individually and on a rolling basis, I invited as many vendors to participate in the research as time allowed. Seventy percent of vendors (who primarily sold locally harvested medicinal plants) observed in the investigative reconnaissance surveys participated in semi-structured interviews, inventories, and the local ecological knowledge survey. Participating vendors also facilitated snowball sampling by voluntarily referring their relatives who are involved in the trade (either as vendors or harvesters) or connecting me to their non-kin harvesters who supply them with medicinal plants. Including individuals connected through the medicinal plant market (from sale to source) was important to understanding the social and business networks and pathways that direct medicinal plants.

Harvesters were recruited for participation by snowball sampling with the assistance of healers and vendors who were already participants in the research. This technique helped to define details of the medicinal plant market chain as well as establish rapport with harvesters because the healers and vendors conveyed their endorsement of my work and intentions. Medicinal plant harvesters are the most difficult link in the market chain to identify, and make and maintain contact with because they represent the most hidden link in the medicinal plant market chain. Recruiting them in the research
was challenging but essential to understanding the management and harvest of these plants. Although fewer harvesters participated in the research compared to healers and vendors, a sub-sample of the harvesters' semi-structured interviews are complemented by ethnographic techniques including in-depth, informal, repeat interviews and participation and observation of their daily lives and collecting activities. Table 4.2 on the following page detail the role, ethnicity, location, religion, and gender of the main study populations in semi-structured interviews, inventories and the LEK survey. Vendor\(^1\) denotes those that primarily sell locally harvested medicinal plants, and Vendor\(^2\) denotes those that primarily sell imported medicines.
Table 4.2. Demographic Characteristics of Participating Harvesters, Healers, and Vendors

<table>
<thead>
<tr>
<th>Semi-structured Interviews (N=64)</th>
<th>Inventories of Medicinal Plants (N=51)</th>
<th>Local Ecological Knowledge Survey (N=74)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Role</strong></td>
<td><strong>Role</strong></td>
<td><strong>Role</strong></td>
</tr>
<tr>
<td>Harvester 19%</td>
<td>Harvester 0%</td>
<td>Harvester 26%</td>
</tr>
<tr>
<td>Healer 31%</td>
<td>Healer 33%</td>
<td>Healer 36%</td>
</tr>
<tr>
<td>Vendor1 50%</td>
<td>Vendor1 55%</td>
<td>Vendor1 38%</td>
</tr>
<tr>
<td>Vendor2 0%</td>
<td>Vendor2 12%</td>
<td>Vendor2 0%</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td><strong>Ethnicity</strong></td>
<td><strong>Ethnicity</strong></td>
</tr>
<tr>
<td>Sambaa 59%</td>
<td>Sambaa 61%</td>
<td>Sambaa 65%</td>
</tr>
<tr>
<td>Zigua 6%</td>
<td>Zigua 8%</td>
<td>Zigua 7%</td>
</tr>
<tr>
<td>Digo 8%</td>
<td>Digo 6%</td>
<td>Digo 7%</td>
</tr>
<tr>
<td>Bondei 3%</td>
<td>Bondei 0%</td>
<td>Bondei 3%</td>
</tr>
<tr>
<td>Maasai 11%</td>
<td>Maasai 14%</td>
<td>Maasai 8%</td>
</tr>
<tr>
<td>Other 13%</td>
<td>Other 12%</td>
<td>Other 11%</td>
</tr>
<tr>
<td><strong>District</strong></td>
<td><strong>District</strong></td>
<td><strong>District</strong></td>
</tr>
<tr>
<td>Tanga 61%</td>
<td>Tanga 67%</td>
<td>Tanga 61%</td>
</tr>
<tr>
<td>Lushoto 27%</td>
<td>Lushoto 14%</td>
<td>Lushoto 27%</td>
</tr>
<tr>
<td>Muheza 13%</td>
<td>Muheza 20%</td>
<td>Muheza 12%</td>
</tr>
<tr>
<td><strong>Religion</strong></td>
<td><strong>Religion</strong></td>
<td><strong>Religion</strong></td>
</tr>
<tr>
<td>Muslim 78%</td>
<td>Muslim 80%</td>
<td>Muslim 82%</td>
</tr>
<tr>
<td>Christian 22%</td>
<td>Christian 18%</td>
<td>Christian 18%</td>
</tr>
<tr>
<td>Other 0%</td>
<td>Other 2%</td>
<td>Other 0%</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td><strong>Gender</strong></td>
<td><strong>Gender</strong></td>
</tr>
<tr>
<td>Male 73%</td>
<td>Male 88%</td>
<td>Male 78%</td>
</tr>
<tr>
<td>Female 27%</td>
<td>Female 12%</td>
<td>Female 22%</td>
</tr>
</tbody>
</table>

Vendor1 = local; Vendor2 = imported
The recruitment of participants for focus groups and feedback meetings varied depending on the reason for meeting. In initial meetings I introduced myself and my work, invited further participation from attendees, and gathered preliminary data on the social and economic context of medicinal plant management and use. For example, participants were asked about customary, legal, religious, and cultural rules that influence resource management especially that of medicinal plants and how it has changed over time; the availability of medicinal plants over time; what makes them more or less available; who the stakeholders are in the realm of medicinal plants; and local concerns. Subsequently I held separate meetings with healers, vendors, and harvesters who had already participated in interviews. Meetings were purposely composed of participants who already knew each other (relatives or working relationships), and/or people who shared the same gender, and/or specialization (e.g., urban vendors, healers who communicate with spirits, etc.). In these meetings I was able to learn and confirm different names for plants, to discuss preferred sources for plants—place names, and habitat types, land use types; to discuss if any plants are scarce and why, if and how commercial plants are also traditional; harvesting techniques including pre- and proscriptions, the diseases and problems they most often treat, who their customers are, and relationships (e.g., kin and mentor) among stakeholders in the medicinal plant market chain. In later meetings I shared my results from inventories and interviews which also enabled me to confirm and further define my findings about the plants that are most relied upon, most inventoried, and considered hardest to get. This multi-factorial design also facilitated comparisons among different groups. Even more importantly, holding meetings with participants that considered themselves to be peers facilitated a non-
judgmental environment where participants could share their views and experiences freely because they already knew and trusted each other.

Meetings usually lasted about two and a half hours, including breaks (but ranged from one hour to four and a half hours). In Tanga town, most meetings were held in a room at the Tanga Municipal Library, a public space that would not favor any one group or participant. Based on their own comfort levels and their preference for a more convenient location, meetings with HIV positive people and Maasai vendors were held in a meeting room at the Tanga AIDS Working Group’s Information Center, which is within thirty meters of where the Maasai sell their medicines and is the same location where the HIV support group meets each week. Meetings with healers in Mlalo, Lushoto were held at their CHAWATIATA (healer’s union) office. Meetings with healers in Amani (Muheza District) were held at the Amani Nature Reserve meeting room. All meetings were tape recorded and detailed notes were taken for analysis; participants’ quotes were often transcribed verbatim.

Many ethnomedical studies focus exclusively on specialists (healers), and ignore the widespread comprehension and use of plant medicines by everyday people. To balance esoteric knowledge of healers and commercial data from vendors and harvesters with local ethnomedical knowledge of consumers, I also included consumers of medicinal plants. I conducted two focus groups (one with men, and one with women) with people living with AIDS to discuss their views of, and experiences with, plant medicines and pharmaceuticals. These individuals are all members of a support group for people living positively with HIV/AIDS who were recruited by the group’s leaders.
To learn more about the everyday use of medicinal plants I also conducted household interviews and inventoried plants in the home gardens of 112 families in five areas: urban and rural, montane and coastal, affluent and poor. Typically the household heads responded, but in cases when other family members were present, they also contributed to our discussions. Households were randomly chosen from censuses of the five residential populations. These areas were chosen because they are near key commercial or source locations for the medicinal plant trade and they represent a range of geographic, ethnic, and economic groups. Each community was sampled at a minimum of 5% of the total number of households (following Boyd, et al. 1981). Time permitted the largest population (urban, mid-lower class, coastal) to be sampled at 5% and the smallest community (rural, poor, montane) to be sampled at 37% intensity. Although none of these five samples is representative in terms of statistical probability, they are sufficient to achieve the goal of learning about diverse populations’ experiences with and views on medicinal plants. In addition, the validity of findings from these household surveys is strengthened because it is supported by ethnographic data which were gathered in these same communities throughout the research period.

Table 4.3. Household Survey Details

<table>
<thead>
<tr>
<th>Location</th>
<th>Description of population</th>
<th>Administrative Unit</th>
<th>No. of interviewed Households</th>
<th>Sampling Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanga Town, Tanga (coastal)</td>
<td>Urban, affluent</td>
<td>Kata ‘ward’</td>
<td>10</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>Urban, upper class</td>
<td>Kata ‘ward’</td>
<td>12</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td>Urban, mid-lower class</td>
<td>Kata ‘ward’</td>
<td>60</td>
<td>5%</td>
</tr>
<tr>
<td>Mlalo, Lushoto (montane)</td>
<td>Rural, middle class</td>
<td>Kitongoji ‘sub-village’</td>
<td>15</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Rural, remote, very poor</td>
<td>Kitongoji ‘sub-village’</td>
<td>15</td>
<td>37%</td>
</tr>
</tbody>
</table>

104
4.4.3 Supplementary Participants

Health workers, forestry staff, and resident members of village environmental committees were invited to participate based on their proximity to important commercial or source locations for medicinal plants and their influence on resource management. The health workers included TAWG Director, TAWG nurses (two), TAWG Indigenous Knowledge Coordinator, pharmacist, pediatrician, and the Mlalo Clinical Officer / HIV Coordinator. (All are men except the two nurses and the Mlalo Clinical Officer / HIV Coordinator.) Forestry staff included the Tanga Catchment Forestry Director, the Amani Nature Reserve Director, Forestry Officers (five), Tanzania Forestry Research Institute Director, Tanzania Tree Seed Institute Research Specialist, and Tanga’s Mangrove Project Director (who was involved in detail throughout the research process). (All are men except for one Forestry Officer.) I met with one village environmental committee in the East Usambaras and three in the West Usambaras. The number of attendees varied by village and ranged from two to sixteen. Meetings with these committees of resident villagers focused on their rights, responsibilities, goals, and concerns in forestry management in general and for medicinal plants in particular. Joint forestry management was also discussed with these committees. In summary, these individuals participated in informal repeat interviews, or informal group interviews which helped to expand my comprehension of the intricate political, economic, and social factors that influence medicinal plant management and use.
4.4.4 Compensation for Research Participants

Based on my awareness of local practices and guidance from local advisors, research participants were compensated in various ways. Many participants were involved in multiple phases of the research, and this affected how they were compensated. As an initial gift, they were given *kanga*, a pair of matching fabrics with a pattern, border, and proverb or saying. *Kanga* are not only the traditional clothing for Tanzanian women, they have innumerable other uses (as baby slings, aprons, blankets, towels, etc.), and are often given as gifts. Male participants were asked to give the *kanga* to their wives, daughters, or mothers, which had the unexpected yet desirable effect of being further connected to the participants’ social networks. For subsequent official interviews and inventories with vendors, healers, and harvesters, participants were compensated with 3-5,000 TSH ($3-5) for their time. (In 2006 the minimum wage for a day laborer was $2 day.) For official field collection, participants were paid 5-10,000 TSh ($5-10), depending on the time and labor involved. All participants in the LEK survey received 5,000 TSh ($5). Since most of the participants were visited multiple times and participated in many informal conversations that contributed to the research, a gift was not appropriate for each time, but additional improvised gifts were given based on the participant and the situation. For example, with the help of Alicia Davis who was conducting research in Tarangire National Park, I obtained dried elephant dung and gave it to Maasai vendors. Elephant dung is locally prized as a medicine and their access to it had become extremely limited since they had been relocated from their home area in the Umba Plains. I gave Arabic medicines from Mombassa to an Islamic scholar/healer in Tanga; I gave gloves, knives, and shoes to various harvesters; and I gave fruit tree
seedlings to vendors and healers. For some healers and vendors who expressed interest, I gave them copies of books with local and scientific plant names.

Participation in household surveys was done on a voluntary basis, and no gifts were given because of the relatively short time required by the survey. One exception is the case of the remote, rural, poor sub-village where participants were given spiced tea leaves. As a frequent guest and temporary resident in this very small and poor community, it was appropriate for me to follow local customs of gift-giving by visitors, which was often reciprocated by residents with gifts of fruit from their farms. For urban areas of higher economic status, residents did not expect or give gifts.

Participants in focus groups and feedback meetings were reimbursed for their transportation and given between 2-5,000 TSh ($2-5), depending on the location and time involved. In remote, rural areas they were given less, based on recommendations from local authorities. In addition, attendees of the final feedback meeting were all also presented with Warburgia stuhlmanii Engl. Canellacea seedlings, as a sign of appreciation.

4.5 Market Methods

Market surveys and inventories (Cunningham 2001a; Martin 1995:191-200; Trager 1995) included taking stock of what types of vendors were present and where, conducting semi-structured interviews with vendors, and eventually conducting complete inventories of vendors’ medicinal plant stocks.

I interacted with most vendors for at least four months before I felt comfortable asking to inventory their stocks. I wanted to understand the context of the lists the
inventories would generate, and more importantly I wanted to ensure the vendors understood the goals of my research, which did not include bioprospecting—something that needed to be clarified and restated. I also wanted to ensure vendors were confident that sharing information with me would not put their livelihoods or knowledge at risk. Research on medicinal plants raises many eyebrows. I went slowly and never asked about the uses of plants, which put people at ease and made them more interested in fully participating.

Not all studies can afford four months of groundwork before inventorying stocks. An acceptable compromise may be to establish rapport and ask about the most important plants instead. The strong agreement between plants the vendors identify as most important and those most apparent in their stocks in Tanga and in Johannesburg (Williams 2007b) means that in future research, if time were limited and inventories were not possible, questioning vendors about their most important plants would be an appropriate starting point or compromise.

Inventories cataloged all medicines (locally harvested and imported) and the part sold (whether it was plant, animal, mineral); form (whole plant part or processed); and sources. General pricing information was also obtained.

These methods served to answer the following questions: 1) Which species (or ethnospecies) are traded and where are they coming from? 2) What is the extent of trade in medicinal plants in the region? 3) Which key species are traded that are collected in the region? 4) What are the key source areas in the region? 5) What is the relationship (links in the market chain, similarities and differences) between the urban markets and rural markets nearer source areas? I followed the methodological guidelines for
identifying commercial species as priorities for conservation (Cunningham 1997; Cunningham 2001b) by identifying species most sold; those locally perceived as most popular, scarce, and expensive; and those that are potentially at risk based on ecological insights. The larger goal was to understand market chain (key people, plants, places) and describe it from source to user.

4.6 Identification of Botanical Species and Ethnospecies

Specimens of plants were collected with healers, harvesters, and vendors according to standard methods and deposited at the National Herbarium of Tanzania (NHT) for identification. Duplicates were sent to the Missouri Botanical Garden (MO).

The relationships between botanical species names and ethnospecies names were verified for the top 25% most popularly sold ethnospecies (Table 7.3), for the four species used by TAWG, for the medicinal plants most inventoried in home gardens (Table 6.7) and when time allowed, for other medicines inventoried and plants collected. These ethnospecies-botanical species names were verified by having a minimum of four different individuals from at least two different geographic areas identify them by ethnospecies. These four individuals who identified the plant by ethnospecies were either present at the time of collection of the voucher specimen or they were shown a prepared voucher specimen and asked about all the names that applied to it. This helped to reconcile the taxonomic name when I suspected that multiple ethnospecies were referring to the same bioscientific species, as in the case of *Zanthoxylum chalybeum* Engl. var. *chalybeum*. Rutaceae, which is called *oliosuki* by Maasai, *hombo muungu* by Sambaa, and *mjafari* by Islamic healers. It also helped to clarify when one ethnospecies referred
to multiple species, as is the case with msangaze which is both Cassia afrofistula Brenan var. afrofistula and C. abbreviata Oliv. subsp beareana (Holmes) Brenan Fabaceae.

Identifying as many possible ethnospecies names for the nine species used in the LEK survey (discussed next) was essential because the participants’ successful identification of the plants determined which ones they were questioned about and therefore it determined their potential scores. In order to be as comprehensive as possible, I compiled a list of possible ethnospecies names that were accepted as correct based on my own field experience, as well as consulting a local expert (herbalist healer, Mohammed Kassomo), and texts with published translations that I found to be reputable and useful in the field (Greenway 1940; Heine and Legère. 1995; Ruffo, et al. 2002; Sangai 1963; Schlage, et al. 2000). A list of the nine species and the corresponding ethnospecies names that were accepted as answers for the LEK survey can be found in Appendix E. The number of ethnospecies that I accepted as positive identifications for the nine botanical species exceeded the number that was actually mentioned by participants in surveys, which minimized the chance that a participant used a name that was not on the list. It was rare for someone to identify a voucher by a name that was not a listed ethnospecies. In most cases participants’ answers that were recorded as zero (plant not identified) was the result of them responding “I don’t know” and not because they gave a name that was not on the list.

4.7 Local Ecological Knowledge Survey

The LEK survey built upon findings from interviews, market surveys, and inventories. It was the most structured element of the research and demanded an
understanding of key plants, people, and places in the pathways medicinal plants follow from their sources to their consumption. It also demanded an understanding of the domains of knowledge related to medicinal plants. These details were important to the design of the survey and the way responses were assessed.

Harvesters, healers, and vendors from Tanga, Muheza, and Lushoto participated. Nine commonly known species were selected as the focus of the LEK survey; these were chosen based on their popularity in the market and their relative intensity of harvest. Six of the nine are among the top 25\% of species most inventoried with vendors, and three are popularly known medicinal plants that are distributed by TAWG to their clients. At least five (duplicate) voucher specimens of all nine species were collected for the purposes of the survey. One set was deposited at NHT, and one at MO. The remaining specimens were used in the survey. Three sets were available as visual prompts for the survey participants. This enabled three surveys to be conducted at once which facilitated efficient completion of the surveys in a short time. When the quality and appearance of voucher specimens became degraded (they tattered and changed color due to being dried-out and handled), they were replaced so that participants would have the best material to use as prompts to demonstrate their knowledge. In addition to using standard voucher specimens in the survey, the part of the plant used medicinally (roots and or bark) was also collected (except in the case of *Artemisia afra* Jacq. Ex Willd. Asteraceae, because typically only the vegetative part is used medicinally and the roots/bark are not sold commercially).

Using portable, tangible prompts was essential for this survey because they enabled us to conduct a large number of surveys quickly, to bring the prompts to the
participants, and to standardize (and thereby control) the prompts used in each survey (and can be repeated in subsequent research). These plants came from different habitats and elevations. Visiting them in situ by doing “walks in the woods” or “tree trails” as other researchers have done would have required much more time from each participant (at least two full days), increased expenses for the research (to transport participants who live in different areas to the same places to look at the plants) and, therefore, drastically limited the number of survey participants.

4.7.1 Procedure for LEK Survey

The survey was pre-tested on two harvesters, two healers, and two vendors. In order to give participants as much information about the plants as possible (and thus, to improve their chances of correctly identifying the plants) photographs of the nine species (shots taken from a distance showing the whole plant, and close-up shots showing unique characteristics of the plant such as flowers or thorns) were used in addition to the vouchers and the root/bark samples. However, these photographs only confused participants who expressed difficulty in evaluating the scale of the photos and the images within them. Photographs were therefore eliminated from the actual surveys. In pre-tests the participants demonstrated great competency in identifying and familiarity in handling the vegetative plant parts, roots, and barks. After the pre-tests some questions were eliminated to shorten the survey because participants who were able to identify seven or more species required well over two hours to complete the survey. I felt this was an unreasonable amount of time. Not only would it risk inflicting boredom and exhaustion, it would demand too much from participants and their daily responsibilities.
The majority of participants (69 of 74) had already been involved in an earlier phase of the research (interviews, meetings, plant collection). Those who had not were referred by participating relatives or associates. Involving the same participants in multiple phases of the research added continuity to the findings, and pleased participants who appreciated being able to see the research in its final phase. They recognized how their earlier participation and the knowledge they shared culminated in the LEK survey, and overwhelmingly they found it an enjoyable and gratifying exercise that allowed them to showcase their knowledge and expertise.

To minimize the possibility that early participants informed later participants about the species and questions involved a number of techniques were used. 1) Groups of participants were called to meet at a specific place and specific time where they waited together until called individually to participate in the survey, and left the premises where the others were still waiting. 2) Surveys were completed in a short time span in each area (Tanga Town, Muheza Town, and Mlalo Town). 3) Participants were asked not to share their responses with the others until all the surveys had been completed. 4) Participants were not told if their answers were “correct” or “incorrect,” rather each answer was valued and accepted neutrally. Participants who asked researchers to verify “correct” responses during the survey were told that all questions would be answered in the final feedback meeting, not during the individual surveys themselves.

Questions consisted of short answer, yes/no, and multiple choice that can generally be categorized as personal questions (about cultural, demographic, experience with medicinal plants), questions about culturally based knowledge (regarding songs, stories, or proverbs that reference the plants; other uses; pre- and proscriptions for
harvesting the plants) questions about ecologically based knowledge (regarding the plants’ habitats, distribution, means of reproduction). Participants were first asked 15 socio-economic, cultural, and demographic questions. Next they were shown all nine voucher specimens and asked to identify them. If a name was given that was not on the list of possible names, they were asked to name all other names known for the plant and if one matched the list of acceptable names it was accepted. (See Appendix E for the botanical names and local names.) Then participants were shown the plant parts used medicinally (bark and/ or roots) for eight of the nine species (excluding A. afr a, as previously explained) and asked to identify them. Interviewers did not volunteer the information that the vouchers matched the samples of roots and bark (although many participants recognized this quickly). Voucher specimen and roots/bark were not displayed in any specific order. Participants were encouraged to look at them in the order they preferred. They were permitted to touch, smell, and taste the material. They were also permitted to crush leaves or break pieces of bark in order to release their scents. Each voucher and root/ bark sample that was identified correctly (based on a list of local ethnospecies) was noted. For each of the nine species that were identified correctly (either by the specimen or by the roots/bark), participants were asked a standard set of up to 22 questions. Some of the questions consist of sub-questions for further specification and other questions could be skipped, depending on earlier responses that made those questions irrelevant. Questions centered on the plant’s importance and uses (other than medicinal); location (geographic locale, habitat type, land use type); distribution; abundance (and changes in abundance); whether or not s/he had personally ever harvested the plant; special places or times for harvesting that affect its strength; pre- or
proscriptions for harvesting this plant and whether or not s/he follows these; if the plant is cultivated; how it reproduces; if there is a way of harvesting it that encourages its growth; descriptions of its flowers, fruits, animals that use it (for food or habitat); time until it is of acceptable size/age to harvest; and government regulations relating to the plant. The surveys typically lasted for about 30 minutes, but if a participant knew all nine of the plants, the process took up to two hours.

4.7.2 Calculation of LEK Scores

Questions were assessed to calculate ecologically based knowledge scores and culturally based knowledge scores. Following Ticktin (1999) and Joyal (1996), ecologically based knowledge was rated as 0 = no knowledge, or completely incorrect response; 1 = some correct knowledge (which may include some incorrect knowledge); 2 = detailed and correct knowledge.

4.7.2.1 Ecologically Based Knowledge Questions

<table>
<thead>
<tr>
<th>Topic</th>
<th>Type of Question</th>
<th>Possible Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat type</td>
<td>Multiple choice</td>
<td>2</td>
</tr>
<tr>
<td>Reproduction</td>
<td>Multiple choice</td>
<td>2</td>
</tr>
<tr>
<td>Flowers present</td>
<td>Yes / No</td>
<td>1</td>
</tr>
<tr>
<td>Description of flowers</td>
<td>Short answer</td>
<td>1</td>
</tr>
<tr>
<td>Fruits present</td>
<td>Yes / No</td>
<td>1</td>
</tr>
<tr>
<td>Description of fruit</td>
<td>Short answer</td>
<td>1</td>
</tr>
<tr>
<td>Animals that eat the seeds, fruits</td>
<td>Short answer</td>
<td>1</td>
</tr>
</tbody>
</table>
Responses were compared against primarily the *Flora of Tropical East Africa*\(^1\) as well as other published, reputable sources (Chapman, et al. 1999; Fordham 1983; Holmes 1995; Mbuya, et al. 1994; Missouri Botanical Garden 2007; Palmer and Pitman 1976; Ruffo, et al. 2002). Personal communication with C.K. Ruffo,\(^2\) supplemented the literature and was especially useful in the cases of animal associations. The information on seed dispersal (phrased as “animals that eat the fruit or seeds” in the question) was minimal in the literature so any knowledge that resembled published descriptions or seemed plausible was given one point. Because the question specifically asked about insects or animals that “eat the seeds and fruits” of the plants (not specifically disperse seed) some participants’ responses included goats and sheep and these were also accepted as correct even though they are not published seed dispersers.

For *Ocotea usambarensis*: Verdcourt, B. 1996. Lauraceae. Rotterdam: A.A. Balkema

\(^2\) C.K. Ruffo is a Tanzanian researcher with over 50 years of experience on forestry, environment, ethnobotany, and especially the medicinal and food uses of plants. He is a co-author of *Edible Wild Plants of Tanzania* (Ruffo et al 2002), and has collaborated in research, teaching, and applied work with the forestry and beekeeping division, universities, and international organizations. He is currently on staff at the Tanzania Tree Seed Institute in Morogoro, Tanzania.

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4.7.2.2 Culturally Based Knowledge Questions

These were all open ended short answer questions. Responses were rated as 0 = no knowledge (usually participants said “I don’t know”) or 1 = knowledge. Points were given for all answers and none was discounted as wrong because the goal was to assess knowledge, not to look for consistency among responses. Answers were highly variable, which is related to the esoteric and idiosyncratic nature of culturally based knowledge of medicinal plants and also to the limitations of the method which is better suited to questions with shorter, more direct answers about less sensitive topics. Although a number of researchers have used the cultural consensus model (Romney, et al. 1986) to assess knowledge, the questions in this survey do not meet the model’s assumption that there is a culturally correct answer for every question. In addition the model cannot accommodate “I don’t know” answers, so it is not applicable (Weller 1998:401) and was not used. Moerman has critiqued consensus analysis as a technique to assess the efficacy of medicinal plants. Researchers have asserted that the model predicts that idiosyncratic use of plant medicines implies inactivity, but his own data from North America shows that a lack of cross-cultural agreement on the uses of some plants relates to an etic understanding of “efficacy” and not to a lack of efficacy from an emic perspective (2007). He also shows that narrowly distributed plants necessarily have a lower cultural consensus because they are available to fewer people (Moerman 2007:453). In the context of this study his findings are a cautionary warning to the applicability of the model, and I argue — quantitative methods in general — when they are not complemented by strong ethnographic data and ecological information about the plants at hand.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Type of Question</th>
<th>Possible Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example of story, song, saying, history of the plant</td>
<td>Short answer</td>
<td>1</td>
</tr>
<tr>
<td>Uses other than medicine</td>
<td>Short answer</td>
<td>1/usage</td>
</tr>
<tr>
<td>Special harvest time</td>
<td>Short answer</td>
<td>1</td>
</tr>
<tr>
<td>Special harvest place</td>
<td>Short answer</td>
<td>1</td>
</tr>
<tr>
<td>Pre/proscription</td>
<td>Short answer</td>
<td>1</td>
</tr>
<tr>
<td>Result for not adhering to pre/proscription</td>
<td>Short answer</td>
<td>1</td>
</tr>
<tr>
<td>Way to harvest to encourage growth</td>
<td>Short answer</td>
<td>1</td>
</tr>
</tbody>
</table>

Aggregate scores (for all plants) were computed for each participant’s culturally-based knowledge and ecologically based knowledge. The total LEK score consists of both those scores plus the number of plants identified (one point for identifying either the voucher specimen or the root/bark, and two points if both the specimen and the root/bark were identified). These scores are computed as a means to compare knowledge about nine species among participants. It does not (and cannot) assess their overall ability and knowledge of medicinal plants generally.

4.7.3 Benefits and Drawbacks of LEK Survey

The benefits and drawbacks of the LEK survey relate to the selection and inclusion of species. Because the practices and knowledge associated with medicinal plants are particular to the plant and the circumstances of its collection, it was necessary to focus on distinct species to capture relevant details and the survey achieved this. Using vouchers and working with particular species also enabled me to verify that the participants and I were talking about the same plants. Further, knowing the species names allowed me to draw from existing published data on these plants (both cultural and ecological) and compare these with participants’ responses.
The down side of using particular species in the survey is that it is impossible to choose ones that are most important to or most appropriate for all participants. In this case, the survey favored vendors over healers because six of the nine LEK survey plants were among the most popular species inventoried in vendors' stocks. Interviews with and observations of healers and consumers made it evident that these plants are also known by non-vendors, too, which is why I included them. I did not choose species only known to vendors. Although the survey was biased toward vendor knowledge, this was appropriate because of the emphasis on market dynamics in the research.

4.8 Analyses

Ethnographic methods for data analysis are based on content analysis which integrates "qualitative and quantitative, positivistic and interpretive methods" (Bernard 1995:339) by looking for common themes and exploring hypotheses. These analyses were applied to all qualitative data from interview notes, field notes, and the LEK survey responses. They and inform, contextualize, and validate the conclusions drawn from the statistical methods. Findings are included in Chapters Five to Eleven.

Analyses for quantitative data were also analyzed in a number of ways. With EstimateS software (Coldwell 1998), I used non-parametric statistics and diversity indices to evaluate the sample size of inventoried medicinal plant stocks and to make my data amenable to comparison with data from other locations. This is covered in detail in Chapter Seven.

To analyze data from the LEK survey I used SAS® software (Version 9.1 of the SAS System for Windows, copyright 2002-2003 SAS Institute Inc.). First I used
multivariate analyses (Principal Components Analyses) to look at the relationships among LEK scores and socio-demographic variables. Hypotheses about the significance of relationships between LEK levels and specific social and demographic variables are tested by computing the Spearman correlation coefficients. To compare scores among groups, data were first tested for normality of sample (primarily by using the Normality Probability Plot, but also with the Shapiro-Wilk, Kolmogorov-Smirnov, Cramer-von Mises, and Anderson-Darling tests). To test for homogeneity of variance the Levene test was used. Data were not normally distributed so non-parametric statistics (Kruscal Wallis) was used. This is covered in detail in Chapter Nine.
CHAPTER 5. ETHNOMEDICAL AND ECONOMIC DIMENSIONS OF MEDICINAL PLANT ACQUISITION AND USE

5.1 Introduction

This chapter describes the context of medicinal plants and the dimensions that contribute to patterns of acquisition and use. I provide detail on local ethnomedical systems and beliefs, common diseases treated by plant medicines, and reasons why people use plant medicines. I also discuss economic factors such as price and livelihoods that mediate botanical medicine procurement and consumption.

Plant medicine use is rooted in cultural traditions. Harvesters, healers, and vendors insist that the majority of the medicines they harvest and distribute have a long history of use. "Hii miti ni ya jadi" 'these plants are inherited,' they emphasized, which underscores the strong influence that traditional knowledge plays in the medicinal plant market. When people migrate from their rural villages to urban areas their use of medicinal plants does not cease, but the plants they use and the ways in which they acquire them change. Instead of harvesting medicines from nearby fallows, savannas, or forests, they acquire them from vendors and healers. As residents of culturally diverse places, urbanites draw from a wealth of ethnomedical knowledge and practices, not just their own. Thus, the logistical circumstances of residence affect ethnomedical beliefs and practices. Understanding the diversity of local ethnomedical systems is key to understanding medicinal plant use.
5.2 Ethnomedical Systems

Although there are distinct ethnic groups and identities in Tanga, they do not correspond with distinct medical systems or treatments. This follows the trend that has been observed in other areas of sub-Saharan Africa (Feierman and Janzen 1992). Groups do have unique traits, but they share many others. These grow out of common experiences of disease, health concerns, access to multiple medical systems (including biomedicine), and living under similar environmental conditions. They are reflected in diverse people’s shared vocabulary for disease terms and explanatory models for disease. A person’s ethnic identity does not determine which medicines he or she will use, although it does influence the ones s/he knows personally.

As individual actors who make their own decisions about treatment, people are more likely to view all local non-biomedical systems as a single entity than to distinguish among them. Diverse people use the same medicinal plants, visit healers from other ethnic groups, learn from their neighbors, and buy and sell medicines to and from each other. Treatment typically begins with self medication and home remedies. If these do not bring about the desired effect, other medicines (local plants or pharmaceuticals) and practitioners are sought until the problem resolves. This opens the door to trying medicines that differ from familiar ones.

For some consumers, exotic medicines and specialists from outside one’s own group are often perceived to be more potent than ones from within one’s own culture. The allure of exotic medicines brings people of different ethnicities and cultures into contact in ways that are not a part of their daily routines. In Nigeria, Hausa revere Yoruba (from Niger) for their healing abilities (Last 1992) and in Northern Tanzania,
Iraqw perceive Bantu healers from the Tanga Region to be especially effective (Rekdal 1999). Biomedicines are attractive to many different cultures worldwide, in part because they represent modernity, the west, and technology. People can deliberately associate themselves with those qualities through using pharmaceuticals (van der Geest and Whyte 1989). In other cases, a condition may call for a “traditional” remedy. For example, the condition *kambako* relates to blocked sinuses and is locally understood to result from too much red meat eating. Because the Maasai are renown for their diet which is high in red meat, Bantu people in Tanga see Maasai as specialists for treating this condition and prefer to use their plant medicines when they suffer from *kambako*.

Contrastingly, specific circumstances motivate some people to have a strong preference to be treated by a member of their own ethnic group (or one that is closely related). In cases of *tambiko* ‘ancestor/ spirit veneration ceremonies’ this is especially important as these rituals are specific to each ethnic group. These examples of preference for familiar or exotic medicines illustrate the influence of culture on what are perceived as appropriate medicines, a phenomenon that was referred to in Chapter Two, Section 2.3.3, which described medicines as cultural artifacts with symbolic potency. Perceptions of efficacy are culturally constructed, based on the appearance, origin, and means of administration of medicines.

5.2.2 Swahili medicine and diseases

In Tanga, *dawa za Kiswahili* ‘Swahili medicine’ broadly designates local medicines that are not pharmaceutical products, but one does not have to identify as a Swahili person in order to use Swahili medicines. People who identify as Maasai,
Sambaa, Zigua, Bondei and others in Tanga practice and use Swahili medicine. Frequently the term is used to distinguish medicines that treat spirit-caused or supernatural problems.

With regard to health and healing, coastal Swahili people have a reputation for being powerful healers, and integrating locally harvested plants, readings from the Qur'ān, majini ‘spirits,’ misimu ‘ancestral spirits’ and plant parts imported from the Arabian Peninsula and from India (usually called dawa za kiarabu) into therapies. Like Swahili culture, Swahili ethnomedical systems are a cosmopolitan hybrid that combines local African elements (ancestors, plants, animals, and minerals) with Arabic elements (Qur'ān, natural products that originate from across the Indian Ocean). Beckerleg’s account of medicine shops in coastal Kenya (1994) resonates with my depiction of Swahili ethnomedical systems as cosmopolitan. She observed medicine shops of great uniformity that specialized in raw materials, primarily of plant origin. Some were local plants, but the majority the plant medicines in these shops were imported from India and many are known by Indian, Arabic, and Swahili names.

Local understandings of disease categories in sub-Saharan Africa distinguish between those of supernatural causes and natural causes (Gessler, et al. 1995; Kayombo, et al. 2007), also referred to as personalistic and naturalistic causes. Supernatural or personalistic causes for disease are attributed to bad spirits, the evil eye, and transgressions against ancestors, while naturalistic causes include pollution and contagion. These can be further differentiated into subcategories related to environmental pollution, ancestors, spirits, and social influences such as witchcraft (Green 1999). In Tanga, these dual categories are expressed as magonjwa ya Kiswahili
‘Swahili diseases’ and *magonjwa ya kawaida* ‘normal diseases’ that can be diagnosed and treated by biomedical staff and pharmaceuticals. Swahili diseases are influenced or caused by non-human spirits, ancestral spirits, or witchcraft and these can also be at the root of a normal disease manifestation. If a disease does not respond to biomedical treatment, the ultimate cause is thought to be personalistic and related to spirits or supernatural causes (Beckerleg 1994; Gessler, et al. 1995; Green 1999). The solution for such a complex problem demands a combination of both medicine types – biomedical and Swahili.

### 5.2.3 Witchcraft and magic

Throughout Tanzania (Abrahams 1994; Gessler, et al. 1995; Green 1999:42-43; Swantz 1979) and perhaps particularly in Tanga, good and bad spirits, witches, sorcery, and magic are part of people’s everyday lives and worldviews. They also influence health and well being as they are enmeshed in local understandings of disease etiology, appropriate modes of treatment, and expected outcomes of treatment. Giles (1987) offers an informative description of the dialectic expression of the spirits and the healers they possess to culture and society along the Swahili coast. These spirits represent outside groups (e.g., Arabic, Somali, Maasai, and European) that have impinged on Swahili development over time. At the same time the “possession cults” emphasize the centrality of local influences – African, pagan, mainland, and slave – on Swahili society (1987). Spirits are central to healing rituals for many healers in Tanga.

Just as it is known for its healers, Tanga is also known for its *wachawi* ‘witches,’ men and women who use their powers malevolently. Because witches also use some of
the same plants and other medicines that healers use, they are sometimes conflated with healers by outsiders; and sometimes healers are also accused of being witches by locals. But healers understand the categories to be discrete with the primary distinction being that witches use their powers to bring harm to others, and healers use them to improve others’ conditions. The boundaries between categories of healer types and even witches can be quite fluid and are not agreed upon by all. While none of the people involved in this research claimed to be witches or use their power to bring harm to others, they all have stories about such people and in some cases talked about how their own knowledge of plants, spirits, or rituals could be used malevolently.

Witchcraft is associated with situations of misfortune where jealousy, betrayal, or injustice is felt. Witchcraft helps explain the unexplainable — how your husband was seduced by another woman, how your once-profitable business is now failing, how your coworker turned into a pig, or how you lost your wife, brother, and both your children to AIDS. Although the role of witchcraft in disease causation and misfortune has been over emphasized in the literature among Bantu people (Green 1999:70), it should not be discounted. In Tanga, witchcraft certainly is among the reasons cited for physical or mental illness and plays into local disease explanatory models. Healers are called upon to remove curses and witchcraft, as well as to confer protection against witchcraft, the evil eye, and ill-doers.

*Mazingwaombe* ‘magic’ is distinct from witchcraft in that it is not necessarily used to bring physical harm to someone. It is more associated with cunning, trickery, and superhuman powers. For example, I heard many stories of famous healers who *ruka na ungo* ‘skip with a winnowing basket’ or magically fly over forests and villages as if on a
magic carpet. Other examples are *bundugo*, a medicine that makes thrown punches and fired bullets deflect, and *cheo fungariza*, a medicine that enables one to appear, disappear, or change form. Stories circulated around Tanga about thieves who used magic to get strangers to willingly give away all their pocket money, without question or struggle. Magic medicines, like other medicines, are comprised of botanical material. These are not advertised or widely available from public vendors and must be obtained from healers or witches who work out of the public eye.

5.2.4 Plant part and preparation of local medicines

In some parts of the world, researchers have pointed out that herbaceous material, leaves in particular, are the plant parts most often used for medicines. This has been documented in Brazil with healers, vendors, and home users of plant medicines (Gazzaneo, et al. 2005; Hanazaki, et al. 2006); with vendors in Bolivia (Macla, et al. 2005), Surinam (van Andel, et al. 2007) Mexico (Linares and Bye 2007).

Tree bark and roots also dominate medicinal plant markets in other areas of Africa such as Morocco (Martin, et al. 2007), Mozambique (Krog, et al. 2004), East Africa generally (Marshall 1998) and in Uganda specifically (Kyoshabire 1998:44), and Southern Africa generally (Marshall 1998; van Wyk, et al. 1997 cited in Zschocke, et al. 2000). Specifically in Mozambique roots accounted for 50% of commercial medicines in Maputo markets (Krog, et al. 2004). In South Africa, bark accounts for one-third of all commercial medicines (Grace, et al. 2002). In Johannesburg, 34% of plants sold are bark.

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1 Bark medicines from these small local markets around Bwindi Impenetrable Forest include *Ocotea usambarensis* and *Myrica salicifolia* (a synonym for *Morella*)
closely followed by roots (Williams 2003:55); in KwaZulu-Natal markets 27% of plants are bark, and another 27% roots (not including bulbs or tubers) (Mander 1998:71). The markets of the Eastern Cape (Cocks, et al. 2004), the Lowveld (Botha, et al. 2004b) are also noted for the strong presence of roots and bark.

Gazzaneo and coauthors connect the preference for leaves to communities who live near humid forests, like those in South and Central America, where leaves are widely abundant year round. They note that communities in dry regions more tend to use bark, which is available all year round when leaves are not (2005:6). This is supported by the findings from drier regions where bark and/or roots (including modified roots such as tubers and bulbs) are most often collected for medicinal use, as is the case in a semi-arid region of northeastern Brazil (Monteiro, et al. 2006), and in Miombo woodlands (a type of African savanna) of Morogoro, Tanzania (Luoga, et al. 2000:333). This might also help explain the high presence of bark and roots as many of the African medicinal plant markets mentioned above also source plants from dryer versus humid regions.

Kyoshabire noted that healers’ preferences for plant parts within the same Ugandan community are gendered. Among specialists around Bwindi Impenetrable Forest, men collect more roots and bark, and women collect more leaves (Kyoshabire 1998). This is linked to the gendered preference for habitats, which was shown to be statistically significant with men primarily collect roots and bark from older successional areas including forests, and women collect herbaceous material from mature fallow and bushy thicket habitats (Kyoshabire 1998:44). The pattern of women preferring disturbed and cultivated areas for medicinal plant harvest was also noted in Brazil (Hanazaki, et al. salicifolia, the binomial used in this dissertation). Bark from both of these species are
Kyoshabire suggests that perhaps women use herbs from successional vegetation nearer their residence because, as traditional birth attendants, the cases they treat (birth, sick child, problems in birth) are of an emergency nature and so they do not have time to go far to collect medicines (1998:57). Hanazaki and coauthors attribute the gendered difference in habitat preference to women’s limited mobility compared to men’s greater mobility due to their work which includes working in forests (2006:904). For women, disturbed and cultivated areas are located in proximity to residential areas, and thus are more accessible than forests are to men. The preference for specific habitat types is also discussed in Chapter Eight.

In Tanga, the preference for plant part seems to be more based on level of specialization and commercialization than proximity to a specific habitat type. Healers I encountered who live on the borders of tropical forests in the Usambaras use leaves, which are available year round, but also rely heavily on bark and roots. This trend has been documented by others with healers in the East Usambaras (Mshana 2004; Ruffo, et al. 1989:206; Schwartz 1999:13).

For home use, I learned that people in Tanga are more likely to gather vegetative parts (typically leaves) from anthropogenic areas and use them fresh by preparing a decoction to drink, poultice to apply topically, or a vapor bath to inhale. This contrasts with medicines from vendors and, to some degree, herbalist-healers (who differ from healers who use tungurf), who rely more on dried roots and bark. Often vendors’ and healers’ root and bark medicines are ground into powder so they can be stored until they are needed and is also important to Tanga markets.

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2 Processing raw plant material into powders is a way for harvesters to add value to their product. There is a dispute about whether grinding by hand (with a large mortar and pestle used for maize or cassava) or
are used. Powders are also locally regarded as a medium that can more precisely be translated into measured doses.

Healers who work from home (out of the public eye) and deal with spirits, more commonly use leaves than other healers and vendors. Their medicines are typically dried and or burned and mixed with honey or coconut oil, and stored in tunguri (medicine gourds used in healing that involve majini 'spirits'). These often treat spirit related or supernatural problems and are applied topically to the skin—on the forehead, chest, back, and or stomach. Nicking the skin with a razorblade and then applying the medicine was more common in past years, but has become less practiced by healers who understand the risks of HIV/AIDS transmission through reusing razors on multiple patients. As a compromise, many healers who continue the practice now ask each patient to bring his/her own new razor blade. The application of these medicines is efficient, as only small amounts are needed. This contrasts with the vendors who use larger amounts of raw material (usually bark and roots) for their medicines, which are most often ingested. Healers also prepare medicines as washes for the body or as inhalation baths (often times these are also leaves).

Customers buy plant medicines by the dose in measured spoonfuls that are folded into small packets made of newspaper. They follow instructions from vendors and healers how to make them into decoctions or infusions. Usually medicines are combinations of multiple plants that are combined once the customer has explained her/his problem to the vendor. As a way of adding value to the medicines, some vendors also sell prepared infusions and decoctions to be consumed on the spot.

machine grinding produce better medicines. Advocates of pounding by hand say that the grinding machines weaken the strength of the plants. Perhaps this is an artifact of modernity at odds with tradition.
For all types of medicines (home use, healer prepared, or commercial) common admixtures are sugarcane, lime juice, salt, and honey; infusions are made with tea or water; decoctions are made with water; common delivery systems are coconut oil and honey for topical applications.

5.2.5 Animal parts in medicines

In Tanga, animal parts comprise a very small proportion of local medicines compared to plant-based medicines. These animal parts are sold by independent vendors and in markets but they are not openly displayed, especially if they are non-domesticated, wild species—presumably because vendors do not want to risk confrontation with authorities. Animal parts are most typically purchased and used by healers who deal with spirits. A medicine made from a specific animal is understood to imbue the consumer with the qualities of that animal. For example, medicine made from the hairball, nose, patch of fur, or bone from a lion (*Panthera leo* L. Felidae) will make you strong and fierce, and cause people to be intimidated by you. Pangolins (*Manis temminckii* Smuts Manidae) are described as is very shy and difficult to spot. To see one, you must be lucky, thus its scales bring about good luck. Bones, skin, noses and tails of hyena (*Crocuta crocuta* Erxleben Hyaenidae) and goat (*Capra aegagrus*), and hedgehog (*Atelerix* spp. Erinaceidae) skin with the quills are also sold. Healers who prepare *kombe* ‘cup’ medicines use porcupine (*Hystrix* spp. Hystricidae) quills as pens which are dipped in special ink (sometimes made from saffron) and used to write out prescribed passages from the Qur’ān on paper. The patient soaks the paper in water and drinks and/or bathes with the medicine-infused water. Dried elephant (*Loxodonta africana* Blumenbach
Elephantidae) dung is an animal product that consists of processed vegetative matter. It is probably the most frequently sold and used animal product in local medical practices, across ethnic groups and generations, among lay consumers and specialists alike. Typically it is mixed with other dried vegetative plant parts and burned as a treatment for chango, a condition of young children characterized by frightened behavior and sudden crying, especially throughout the night. Gorgonia species of coral are found in shallow, muddy, nutrient rich waters and areas where inflows of fresh water meet with sea water. Red snapper and other fish are attracted to areas with this species of coral (personal communication, Kolombo 2006) and, accordingly, fragments of Gorgonia are used as a medicine described as mvuto ‘attractor,’ which is used to attract business. Tubipora musica Tubipoidae, a soft coral that is listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora, is also used by healers as a local medicine. A list of animal parts seen for sale in Tanga is found as Appendix F.

Non-animal, non-vegetable products are also sold for medicinal use. These include sulfur (often used for skin problems), and makata which refers to types of rock that are rich in minerals and used for stomach problems and to induce vomiting, especially to purge poisons. Clay is also commonly sold in markets next to medicines, although it is not locally considered to be a medicine. It is eaten almost exclusively by women to satisfy cravings, particularly during pregnancy.

5.2.6 Medicines from the Qur'ān

In discussions about the origins of plant medicines, many Tanga vendors and healers distinguished certain plants insisting “mti hnu umeandikwa Koroani,” “this plant
is written about in the Qur’ān. The most commonly named plant associated with the Qur’ān is locally called mjafari, which is said to be an Arabic name (further strengthening the contention that it is found in the Qur’ān). Other local names include mlunugulungu / mrungrungrungu (Swahili and Nyamwezi), hombo mungu (Sambaa), and muungu-ngoma (Zigua). All of these names are related to the word mungu, which is the Swahili word for god. This species, called oloisuki by Maasai vendors, is also valued by Maasai although it is not distinguished as a sacred plant. This plant, Zanthoxylum chalybeum Engl. Var. chalybeum Rutaceae is a deciduous shrub or tree which grows up to ten meters high found in dry bushland and wooded grassland from 5-1550 masl (Kokwaro 1982). It has distinctive grooved and knobby bark with black spines. The leaves also have spines and an attractive scent with savory and citrus characteristics. The leaves are dried and pounded, and the resulting flour is used to make mlenda, a staple food for Zigua people who prepare it as a porridge. Although this plant is said to be identified as a medicine in the Qur’ān, it is not classified by locals as a dawa za kiarabu because it is a local tree, not one that is shipped from the Arabian Peninsula.

While the Qur’ān is considered to be the direct word of God as conveyed through Muhammad, hadith are accounts of and quotes from Muhammad that were orally transmitted and later recorded. Using a software program called The Alim (ISL Software Corporation 2000), I searched the Qur’ān and hadith for references to medicines and healing to learn how medicinal plants are described and identified. This search yielded no medical information from the Qur’ān itself, but the following references to medicines were made in hadith:

1. Black cumin seeds provide healing for all diseases except death,
2. Honey is given for abdominal problems,
3. Camel milk mixed with camel urine is given as a general medicine,
4. Ash from burnt palm leaves treats wounds,
5. Water from an edible fungus (Kam 'a) treats eyes, and
6. Indian incense or Ud Al-Hindi heals seven diseases including pleurisy.

Today small black seeds, locally called habati soda, are imported to Tanzania from Ethiopia and sold in many Arabic medicine shops. Habati soda seeds and seed oil are promoted as a panacea and are locally identified as medicines in the Qur'an. They may indeed be the same seeds referred to in the hadith, they may be related to them, or they may be given power because they have assumed that position as a substitute. An ancient Arabic text based on hadith called al-Tibb al-Nabawi, (Medicine of the Prophet) written by Ibn Qayyim al-Jawziyya, a Muslim theologian and practicing physician who lived in the late 13th and early 14th centuries (Sa'id 1998:xiv) provides clues. It describes Al-habba al-sawdâ, small black seeds that match the description of habati soda, and is likely the origin of the locally used name habati soda. These seeds are identified as Nigella sativa L. Ranunculaceae, or black cumin (Ibn Qayyim 1998).

Camels are no longer kept in Tanga, so obtaining their milk or urine is not easy. (The main commercial area of Tanga Town is still called Ngamiani literally meaning 'in the camels' which denotes the place where Arabs kept their camels centuries ago.) The medicinal properties of camel products were not referenced by research participants.

Burning leaves for topical applications, especially to treat skin rash and fungus, is common, but participants did not mention burning palm leaves or the process of burning as “originating from the Qur'an.” Although some mushrooms are eaten in Tanga, I learned of none used medicinally. Incense, ubani or uddi, is used on many occasions including healing ceremonies and to keep away bad spirits, but it is generally not regarded as a treatment. Ibn Qayyim identifies 'ūd as Aquilaria malaccensis Lam. (A.
Thymelaeaceae, or aloe wood, and describes it as being used internally and externally — as a perfume, fumigant to purify the air, and having the following effects:

“It opens obstructions, breaks winds, disperses excess moisture, strengthens the intestines, invigorates and gladdens the heart, and is beneficial for the brain. It strengthens the senses, restricts the belly, and is beneficial for incontinence originating from cold of the bladder” (1998:245). (See Ibn Qayyim 1998 for more details on an Islamic approach to achieve spiritual and physical health.) The incense actually is derived from a resin that is produced when *Aquilaria spp.* are subjected to fungal attacks (Soehartono and Newton 2002), and is not a product of the tree itself. In summary, while medicinal plant specialists in Tanga connect specific plants (including local ones) to the Qur’ān, the only references to medicinal plants I found were in hadīth, and both of them, *habati soda* and *uddi*, are imported to Tanga; they are not locally harvested.

Claiming specific medicines are recorded in and advocated by the Qur’ān infuses great power into them and their practitioners. Since the Qur’ān is considered to be a literal text, any claims that a plant or medicine is from the Qur’ān carry substantial weight. In Tanga, Arabic texts that are about Islam or reference Muhammad often are conflated categorically with the Qur’ān by lay people, especially those with limited literacy. Islamic scholars (sheiks) I spoke with said this is a misunderstanding on local people’s part. In practice however, the result is that specific plants, most notably *Z. chalybeum*, are understood to be very special plants from God for multiple ethnic groups.

5.2.6 Dawa za Kiarabu ‘Arabic Medicines’
Imported medicines from Arabia and India are important components of ethnomedical practices along the Swahili Coast. In Kenya, Beckerleg noted the shops that sell them and their use by both specialists and lay people (Beckerleg 1994). In my sample, 67% (75 of 112) of households that participated in interviews said they have used Arabic medicines. Generally, these are very fragrant and many people cited using them to keep away bad spirits. *Mvuje* is used in children's amulets to keep away bad spirits. *Mvuje* refers to the imported, commercially produced, hard paste from India made from the roots of *Ferula assa-foetida* L. Apiaceae. It is used in Indian cooking. Locally, *mvuje* also refers to the exotic plant *Murraya Koenig* ex L. Rutaceae 'curry leaf' which is commonly cultivated in Tanga home gardens. Incense is also commonly used to repel evil spirits or attract good ones. Other common applications of fragrant *dawa za kiarabu* are muscle rubs for sore and paralyzed muscles. Locally cultivated examples of *dawa za kiarabu* all have culinary value as well and they include: *karafuu* 'clove', *iliki* 'cardamom', *mdalasini* 'cinnamon', *manjano* 'turmeric', *kumamanga* 'nutmeg', *pilipili manga* 'black pepper,' and *tangawizi* 'ginger.' Imported spices from across the Indian Ocean (e.g., cumin seeds, mustard seeds, anise, and coriander seeds) are also part of local ethnomedical practices. Imported and locally produced spices/medicines are all sold from Arabic or Indian medicine shops, and are among the most common *dawa za kiarabu*.

Also popular are imported items such as *haltiti* (unknown meaning), *karafuu maiti* 'clove corpse' (commercially produced product imported from China that resembles the smell and color of moth balls), *ubani maka* 'incense of Mecca' (resin form), *udi* 'incense' (stick form), *shubiri* 'aloe' (black pungent resin, uncertain if it is actually derived from aloe), and *marashi* 'rose water.'
Although many of these items are also used in cooking and sold in produce markets, the context in which these medicines are sold has a very different meaning. Produce markets are mundane loci of daily activity. Purchasing the same ingredients outside of these markets from specialty medicine shops frequented by specialists and stocked with exotic items has a different meaning. An exception is that local residents of Indian descent buy their spices from these shops as well, but not because they were sent by healers. They tend not to frequent Swahili healers and instead go to Ayurvedic practitioners or knowledgeable family members when they choose not to use biomedicine. Many local healers send their patients to such shops with a list of the necessary ingredients to purchase for their medicines. Often the healers use an Arabic or other-than-Swahili word for a spice which both protects their knowledge and practices and keeps it in the realm of the specialist. Shop owners and their employees are very familiar with Swahili, Indian, Arabic, and other names for these plants. The patients then return to their healers with the medicines and the healer prepares them.

5.2.7 Chinese Medicine

There are no shops that specialize in Chinese medicine in Tanga, but Tanga town has two general stores and at least one pharmacy that sell imported, packaged, prepared, Chinese medicines. These are regarded as a novelty compared to Arabic medicine shops, to which people are very accustomed. Only 12% (13 of 112) of households interviewed reported having used Chinese medicines and all of these were in urban areas. People had tried them for toothache, muscles, skin problems, high blood pressure, or as vitamins. In Tanga there are no Traditional Chinese Medicine (TCM) clinics, but they
exist in the larger cities of Dar es Salaam and Arusha. One man living with HIV/AIDS explained that before he came to Tanga he was being treated by a TCM doctor in Dar es Salaam, but that the doctor soon advised him to seek help elsewhere.

![Figure 6](image)

**Figure 6. Displays of Chinese medicine and their Swahili explanations**

Problems treated include malaria, ulcers, hernia, eyes, and teeth

Chinese medicine sellers are local people (not ethnic Chinese) who are often involved in pyramid business schemes and in trade-show like presentations of their wares. The prices of Chinese medicines are comparable to biomedical pharmaceuticals.

### 5.2.8 Health and disease concerns from a local perspective

The list in Figure 7 below is displayed by a prominent vendor in Tanga Town at his kiosk. Based on my evaluation of ten vendors' signs, it is typical of what most vendors display. Following the photograph is a translation of the list. Treatments for those diseases/problems with asterisks (*) are commonly advertised by vendors. Some of the conditions were not translated as their meanings are not literal and are obscure even to some vendors and healers themselves. This image illustrates salient health and disease concerns in Tanga.
These framed lists are seen as signs of professionalism and legitimacy of one’s practice. Certificates from the local healer’s organization or from the local health officer acknowledging that this person is recognized as a specialist are other tools of the trade that are desired by vendors and healers. Lists that are not framed or typed are seen as less professional, but tattered and worn lists are not uncommon and vendors who display these consider themselves more professional than vendors who do not display them. A list may not be particular to the vendor that displays it. Instead they are often inherited or photocopied, which means in some cases the name of the vendor and the diseases he purports to treat are not accurate. Still, even these are displayed proudly.

Figure 7. Tanga Town Vendor’s Posting of What he Treats
Translation of sign on previous page: The following diseases [are treated here]. Traditional healer [on site], every medicine is here, if you don’t understand [what is written], ask.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Syphilis</td>
<td>19. Urine with blood</td>
</tr>
<tr>
<td>2. Dysmenorrhea*</td>
<td>20. Fungus in genitals</td>
</tr>
<tr>
<td>4. Child with itchy body</td>
<td>22. Sinuses / allergies *</td>
</tr>
<tr>
<td>5. Ambiguous problem for infant</td>
<td>23. Swollen glands</td>
</tr>
<tr>
<td>6. Gonorrheaohoea</td>
<td>24. Malaria*</td>
</tr>
<tr>
<td>7. Swollen glands</td>
<td>25. Cough</td>
</tr>
<tr>
<td>8. Malaria*</td>
<td>26. Low Male potency*</td>
</tr>
<tr>
<td>9. Cough</td>
<td>27. No Male potency*</td>
</tr>
<tr>
<td>10. Low Male potency*</td>
<td>28. Failure to get pregnant*</td>
</tr>
<tr>
<td>11. Heart</td>
<td>29. Hernia (internal)*</td>
</tr>
<tr>
<td>12. No Male potency*</td>
<td>30. Hernia (external)*</td>
</tr>
<tr>
<td>13. Failure to get pregnant*</td>
<td>31. Malaise</td>
</tr>
<tr>
<td>14. Hernia (internal)*</td>
<td>32. Diarrhea with blood</td>
</tr>
<tr>
<td>15. Hernia (external)*</td>
<td>33. Stinky teeth</td>
</tr>
<tr>
<td>16. Malaise</td>
<td>34. Constipation</td>
</tr>
<tr>
<td>17. Diarrhea with blood</td>
<td>35. Urine with blood</td>
</tr>
<tr>
<td>18. Stinky teeth</td>
<td>36. Fungus in genitals</td>
</tr>
<tr>
<td>19. Urine with blood</td>
<td>20. Low Male potency*</td>
</tr>
<tr>
<td>20. Fungus in genitals</td>
<td>21. Failure to get pregnant*</td>
</tr>
<tr>
<td>21. Bad dreams</td>
<td>22. Hernia (internal)*</td>
</tr>
<tr>
<td>22. Sinuses / allergies *</td>
<td>23. Hernia (external)*</td>
</tr>
<tr>
<td>23. Swollen glands</td>
<td>24. Malaria*</td>
</tr>
<tr>
<td>25. Urine with blood</td>
<td>26. Low Male potency*</td>
</tr>
<tr>
<td>26. Fungus in genitals</td>
<td>27. Failure to get pregnant*</td>
</tr>
<tr>
<td>27. Low Male potency*</td>
<td>28. Hernia (internal)*</td>
</tr>
<tr>
<td>28. Sinuses / allergies *</td>
<td>29. Hernia (external)*</td>
</tr>
<tr>
<td>29. Swollen glands</td>
<td>30. Malaria*</td>
</tr>
<tr>
<td>30. Cough</td>
<td>31. Constipation</td>
</tr>
<tr>
<td>31. Low Male potency*</td>
<td>32. Urine with blood</td>
</tr>
<tr>
<td>32. Failure to get pregnant*</td>
<td>33. Fungus in genitals</td>
</tr>
<tr>
<td>33. Hernia (internal)*</td>
<td>34. Low Male potency*</td>
</tr>
<tr>
<td>34. Hernia (external)*</td>
<td>35. Sinuses / allergies *</td>
</tr>
<tr>
<td>35. Malaria*</td>
<td>36. Low Male potency*</td>
</tr>
<tr>
<td>36. Constipation</td>
<td>37. Sinuses / allergies *</td>
</tr>
</tbody>
</table>

In Arusha (Ibrahim and Ibrahim 1998) and in Tanga, most Maasai vendors display a list (usually typed and framed) of diseases they treat and the price of those medicines. These lists are especially helpful for Maasai vendors to communicate with their customers, since the Maasai are not usually as literate or fluent in Swahili as other Bantu groups. However, they do not design or type the lists themselves, so the names of the diseases and the choices of the diseases listed are more likely to reflect the views of the Bantu workers in office supply and services shops who prepare them. For example, in Tanga, Maasai typed lists included *ndele* (medicine to attract love) and *kismarti* (medicine to attract luck) which are commonly found on Bantu vendors’ lists, but when asked, those Maasai vendors admitted to not knowing what those were.
5.2.9 Descriptions of common problems treated by local plant medicines

Many problems or disease categories advertised by vendors, are also salient terms commonly known by healers and consumers. In most cases, plant medicines are the preferred treatment for the examples listed below. (Exceptions are malaria and HIV, which pharmaceuticals are also commonly used to treat.)

Chango: According to local understandings of anatomy and physiology chango is the tumbo kubwa ‘big stomach’ ndani ya tumbo ‘inside the gut.’ It also houses the uterus (in the case of women). Chango, also a general disease category, is understood as ugonjwa wa kawaida ‘a normal disease’ caused by uchafuko wa tumbo ‘pollution / dirtiness of the stomach’ which is why its desirable to safisha tumbo mara /cwa mara ‘clean out the stomach from time to time’ and why the desired action of the medicine to treat chango should be to cleanse with visible signs of egress like diarrhea, vomiting, and/or urine. “Dirtying the stomach” can be caused by drinking cold water, menstruation, eating foods that do not agree with your body (chilies, lime, too much sugar, fruit, “dry” rice/ugali/bread with no sauce), eating late or not eating enough (especially when doing physically strenuous work), and hot weather. Different symptoms of chango call for different plant medicines. Depending on the type of chango, the appropriate medicine should teleza ‘be viscous,’ baridi ‘cold’ (here baridi connotes a smooth taste) or chungu ‘bitter.’ Chango causes a host of problems in the lower abdominal area including hernia, infertility, erectile dysfunction, menstruation irregularities, constipation, watery stools, gurgling or growling stomach, gas, stomach pains, hydrocele (the scrotal swelling that results from elephantiasis), prolapsed rectum, and more. It also makes otherwise healthy people vulnerable to problems they could usually suppress, like malaria or flu.
Mchango: Sometimes chango and mchango are conflated but there are four types of mchango that are seen as distinct from the other manifestations of chango as described above. Two are children’s diseases and the other two can affect both adults and children. ‘Michango ya watoto ‘children’s chango’ has two types. The first is degedege ‘convulsions’ and is often associated (by health care workers) with the convulsions from cerebral malaria. From an emic perspective, however, even if the convulsions are associated with malaria and high fevers as a proximate causes of the convulsions, the ultimate cause is shetani or pepo mbaya ‘bad spirits,’ which young children are particularly vulnerable to. Degedege is believed to only be treatable by local medicines and many people believe if the child is treated by hospital workers (especially with an injection) it will result in the death of the child.

Another type of mchango for children is mchango wa kushtuka, described as when a child is startled at night, awakens and cries (for no apparent reason). Some associate it with the full moon and the new moon. Dried elephant dung is used in the treatment for this condition (often by burning it with other plant parts to chase away evil spirits).

Other types of mchango that can affect children and adults include mchango wa moto ‘hot mchango’ and it refers to the condition of kushwa mwili mzima ‘itching all over the body’ or kushwa sehemu za siri ‘itching in secret/private parts.’ Some believe it to be an allergy to malaria medications, which is interesting considering that some of these pharmaceuticals have sulfides and allergic reaction to sulfides include itching and swelling. Mchango wa kifafa refers to convulsions (that are not degedege and
not associated with malaria or high fever). It is characterized by people falling down, convulsing, and foaming at the mouth. Epilepsy is the biomedical analog.

**Malaria:** This is often used as a general word used to describe fever, and not clinical malaria. The misdiagnosis of and self-treatment for malaria is a problem lamented by Tanga health workers. As an epidemic disease that should be treated immediately, a person who presents fever, body aches, headaches, malaise is often assumed to have malaria and s/he may choose to self-medicate with pharmaceuticals or plant medicines. Even in cases when a diagnostic blood smear is done at clinics malaria is often over-diagnosed, according to local doctors. From an emic perspective malaria is understood to be caused by mosquitoes and its prevalence is associated with environmental conditions. For example it is believed to be more prevalent on the coast compared to in the mountains, which is true. Many people use plant medicines to treat malaria because the pharmaceuticals are too strong or are ineffective. Bitter medicines (plant or pills) are considered signifiers of a proper treatment. Signs of egress through vomiting or diarrhea are desirable indicators that medicines are working. Many people plant malaria medicines around their homes although these differ from the most common plants sold by vendors for malaria.

**Upungufu wa nguvu:** ‘Loss of [sexual] strength.’ This is primarily a concern for men. Healers and vendors described it as a result of chango. Some also discussed it as being caused by *mafuta mchanganiko* ‘a mixture of oils.’ There is distrust about cooking oils that are now imported from Asia. Very greasy food in general is considered unhealthy, but suspicion of foreign oils was included in four individuals’ explanatory models for diseases. Many healers and vendors have *upungufu wa nguvu* or *nguvu za*
kiume ‘male strength’ as the first disease on their list. Such a prominent place merits attention and caused me to ask if men in Tanga suffered greatly from this problem and why. Both vendors and healers explained that advertising treatment for ‘loss of strength’ draws customers. Once clients approach the vendors, they talk to them to find out what their ‘real’ problem is and thus treat that along with the sexual performance problems. One vendor explained that men are too stubborn to seek health assistance and tolerate pain and problems until the problem of sexual performance becomes an issue, then they seek assistance immediately. Sometimes this medicine is called mkayati ‘aphrodisiac.’ Usually this medicine takes the form of chewing specific roots such as *Mondia whitei* which is also a medicine for chango – stomach problems. This is even given prophylactically to young boy babies to avoid sexual problems later in life. Certain foods such as peanuts and octopus are also said to increase male strength, but these are not classified as medicines.

**Uchovu:** Many men (and to some degree women) who are day laborers in urban areas or work in farms are regular customers of *dawa ya muku*, the treatment for *uchovu* ‘exhaustion.’ It is also said to treat hangover. Although *uchovu* it is not considered a disease, but rather a condition, it is among the most popular reasons people use plant medicines. It is always a combination of many plants, sometimes burned, always ground into a powder and then prepared as an infusion for drinking. Many urban people drink this regularly at the kiosks in Tanga town.

**Kambako:** This is best described as sinus blockage or draining. Symptoms are itchy and or blocked ears, painful or loose feeling teeth, and sore face. It is said to be caused by eating too much meat, especially fatty meat from cows and sheep (not goat),
but can also be the result of eating *dagaa* ‘sardines’ (which are a staple protein) and shark (which is a luxury item) if they do not agree with your constitution/body. It is also understood to result from chango which causes a blockage in veins/arteries. Local Bantu people often explained that although Maasai eat a lot of meat, they eat it with the *dawa* ‘medicine’ so they aren’t affected by kambako. Indeed, Maasai often eat meat stews cooked with plants. The medicine for Kambako is usually snorted, which induces sneezing to clear nasal passages. It can also be prepared as a decoction or infusion.

*Magonjwa ya watoto:* Treating children with plant medicines is commonplace. Many adults who claimed not to use plant medicines themselves said they had been given them as a child and they also gave them to their children. Usually these are to treat mchango associated with high fevers (discussed above), skin problems, crying fits, and bedwetting. In addition, most children are adorned with *hirizi* ‘protective charms’ and these can be seen tied around their wrists or neck. Typically, these are tightly wrapped pieces of *mvuje* (described previously under 5.2.6 *Dawa za Kiarabu*). It also has a strong smell and both of these are used to keep away bad sprits. Often the medicines to treat children are those that grow in disturbed areas around the home and/or are planted or growing near homes.

*Kisukari:* ‘Diabetes’ symptoms recognized locally include frequent urination and urine that attracts ants. Diets rich in sugar and fat are understood to be the causes of diabetes. Other chronic diseases like *kansa* ‘cancer,’ and *presha* ‘high or low blood pressure’ are also commonly treated with plant medicines. These are long term treatments, sometimes said to cure, other times said to manage the disease.
**Magonjwa ya zinaa:** Literally this category means ‘diseases of adultery’ and refers to sexually transmitted diseases, commonly syphilis and gonorrhea. The stigma attached to these diseases is obvious from its association with adultery. People avoid clinics and discretely seek plant medicines once they experience symptoms such as pus discharges or burning sensations when urinating.

**UKIMWI (Ukosefu wa Kujikinga Mwilini):** ‘lack of immune protection in the body’ is the acronym for HIV/AIDS in Swahili. No vendors and only a few healers in Tanga advertised treating UKIMWI. At first, most claimed they do not serve those patients and if they do receive them, they refer them to the clinic or hospital. However, further discussions revealed that these vendors are visited by such customers. The difference is that they do not ask for medicine for UKIMWI, they ask for medicine to treat the opportunistic infections that result from it. The result is that many vendors and healers treat HIV positive people unknowingly. This trend has also been observed in Dar es Salaam, Tanzania and in South Africa (Kayombo, et al. 2007). Most Tanga vendors and healers said they do not treat HIV but they can help a person who is not yet too sick to **sogeza muda** ‘move time along.’ Contrastingly, at an annual event to recognize traditional healers sponsored by the Ministry of Health in 2004, a central theme was to promote HIV/AIDS awareness and education. Eleven out of eleven healers or healer groups questioned said they treat HIV/AIDS, some claiming that they can **ponyesha kabissa** ‘cure it completely.’ There were approximately fifty tables (each representing a healer or healer group) and nearly all of them advertised treating UKIMWI. Perhaps it depends on the venue. Or perhaps the discrepancy is related to the origin of the healer. Many of the heaters at the event were from Dar es Salaam. In Tanga, fewer claim to treat
it, perhaps because many I talked to had participated in HIV education workshops held by TAWG. In the workshops TAWG strongly encourages healers not to advertise curing HIV and advises them to refer patients to the hospital and to TAWG so they can work together to provide testing and care. Many people first use plant medicines before they go to the hospital for HIV testing.

**New Diseases:** This designation combines medicines vendors only recently have begun to advertise, includes medicine to lose weight and medicine to stop smoking.

**Non-somatic Problems:** Plant medicine use demonstrates a broad understanding of health. Vendors commonly advertise treating the following problems along with their advertisements for malaria, chango, and skin problems.

<table>
<thead>
<tr>
<th>Table 5.1 Non-somatic Problems Treated by Vendors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Swahili</strong></td>
</tr>
</tbody>
</table>
| *Kurudisha mtu aliyepoetea,*  
*Mtu aliyemba, kumwita mtu* | 'to call / return a person who has gotten lost or is far away' |
| *Kupatanisha watu* | 'to cause people make-up [after an argument]' |
| *Kinga ya mwili/* *ya shamba/* *ya ngombe/* *ya nyumba* | 'protection for your body/ farm/ cattle/ home' |
| *Kuafuta mchumba* | 'to find a fiancé' |
| *Biashara* | '[successful] business' |
| *Mvuto* | 'attractor' [for customers, money] |
| *Kuungwana, kiguna kwa watoto na akina mama* | 'in a civil manner, to bring together a mother and child after grumbling' |
| *Ndele* | 'love medicine' [to attract a lover] |
| *Mkosi* | 'jinx' [to remove a jinx] |

5.2.10  **Health worker perspectives of plant medicine use**

Biomedical health workers are often quick to dismiss traditional medicine (Green 1999:11). The dismissal of traditional medicine is facilitated by the hegemony of biomedicine and governments that reinforce and promote each other (Waldram
Local medical knowledge is rejected, ridiculed, and downgraded through governmental, educational, and religious institutions (Waldram 2000:617). As the medical system for the state and its population, biomedicine has defined efficacy and the procedures by which it is determined. It has shown traditional medicine to be ineffective. For this investigative service, governments offer protection to biomedical institutions (Waldram 2000:618). Health workers often talk about medicinal plants in the context of the problems they cause when people use them at the same time as pharmaceuticals or use them as a first line of treatment before seeking assistance from the hospital which delays the biomedical treatment. The clinical officer and HIV/AIDS coordinator in Mlalo, Lushoto explained that everyone who is sick in her district uses plant medicines first (for everything, but particularly for malaria and HIV). “When they don’t get better, they come to the hospital for help,” she said.

Due to TAWG’s presence (in Tanga town especially, where their main office is on the grounds of the Regional Referral Hospital), plant medicines appear to be more accepted by the biomedical establishment because they are dispensed by nurses and medical officers who work for TAWG. At the same time TAWG is an NGO, not a government institution. The government hospital staff, who may cooperate with TAWG and consult their clients, do not necessarily advocate the use of plant medicines. Healers are still widely discredited by health workers.

Although these tensions exist, there are examples where plant medicines have been accepted or tolerated by health workers, usually in the case of HIV/AIDS (McMillen 2004) and especially before ARVs became widely available through government programs (starting in 2005). In Tanga Town (and to a much lesser extent in
Mlalo, Lushoto) biomedical health workers have seen plant medicines as a way
tupunguza ukali wa UKIMWI ‘to reduce the severity of HIV.’ There are other examples
in Eastern and Southern African where healers and biomedical health workers are
2007).

5.2.11 Polypharmacy: simultaneous use of medicines

Most people are not strict adherents of either pharmaceutical or botanical
medicines, rather they commonly use them in tandem or serially. Focus groups (one with
men and one with women) with members of a support group for people living positively
with HIV/AIDS in Tanga provided a way to learn about how and why people use
multiple kinds of medicines, including botanical ones. As members of the support group,
they all vow to be open about their HIV status and to be active in doing outreach and
community HIV/AIDS education. They are very forthcoming about their own personal
struggles and journeys through suffering before they were diagnosed with HIV and
received treatment and improved. Of the nine men, only two were taking anti-retroviral
therapies (ARVs), seven were using plant medicines from TAWG. Of the seven women,
all were currently using ARVs but all had begun treatment by using plant medicines
either through TAWG or other means. I opened the men’s discussion by asking if they
had ever used plant medicines, one man explained:

Tunazitumia kuanzia kuzaliwa, hata kabla ya kuzaliwa kwasababu
mama zetu wanapewa dawa za miti wakiwa na mimba na sisi
tulizipata vilevile. Pia tukiwa watoto wachanga tunapewa dawa za
miti. Pia ni lazima tutumie dawa za miti kwa magonjwa wa
Kiswahili. Ni asilia yetu.
We all use them beginning with birth, even before we are born because our mothers are given plant medicines when they are pregnant and so we get them then, too. Also, when we are infants we are all given plant medicines. Also, we have to use plant medicines for 'Swahili diseases' [those that are caused by supernatural forces]. This is our tradition.

Three women said that when they began suffering from HIV/AIDS but had yet to be diagnosed, they thought they had been bewitched and had evil spirits which were responsible for their suffering. Thus, they were treated by healers with traditional medicines. One woman explained how her relatives took her to the Bombo (the Regional Referral Hospital) because she had not improved. There she joined TAWG, began their botanical treatment, and improved. The seven women who used the plant medicines from TAWG said that while the plants helped improve their condition, they switched to ARVs when given the chance.

TAWG clients are free to use ARVs instead of plant medicines and remain clients of TAWG. TAWG workers explicitly state that once a client begins using ARVs, they must be taken every day for the rest of their lives (because of the chance the virus will develop resistance to the drugs) and cannot be used simultaneously with plant medicines (because of the unknown contraindications and side effects), which in effect means users of ARVs must cease using plant medicines altogether. Yet, these focus groups revealed that it is common for ARV users to also use plant medicines. They do not receive them from TAWG or use them for HIV in particular, but they do buy them from local vendors (Maasai and Sambaa), shops, healers, or harvest them themselves. They adapt doses that are weaker and less frequent, in accordance with the ban on the use of plant medicines.
5.2.12 Reasons for using plant medicines

People reported that plant medicines are best for treating chronic diseases (e.g., malaria, diabetes, asthma) and less threatening problems (e.g., chango, digestion, muscles, and skin). A survey of 111 households in five areas (three urban, two rural) of Tanga and Lushoto Districts revealed that plants growing or planted around the house include medicines to treat chango, malaria, diarrhea, and children’s diseases. This overlaps with the findings from the vendors’ lists of advertised problems they treat and also with the HIV support groups’ discussion (above). The plants in Table 5.2 are those people said they rely on most as medicines, based on household surveys. Many of them are the same as those most frequently inventoried around people’s homes, as seen in Table 6.7 (in Chapter Six). These plants are very rarely sold by vendors.

<table>
<thead>
<tr>
<th>Swahili Name</th>
<th>Botanical Name</th>
<th>Households No. (%)</th>
<th>No. Areas that named it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mzungwa</td>
<td><em>Plectranthus longipes</em> vel sp. aff. Baker Lamiaceae</td>
<td>58 (48%)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td><em>Ocimum gratissimum</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maumbasha</td>
<td>L. Lamiaceae</td>
<td>28 (23%)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><em>Vernonia lasiopus</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mhasha</td>
<td>O. Hoffm. Asteraceae</td>
<td>10 (8%)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><em>Solanum incanum</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mtura</td>
<td>L. Solanaceae</td>
<td>8 (6%)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><em>Ocimum kilimandscharicum</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kivumbasi</td>
<td>Baker ex Gürke Lamiaceae</td>
<td>8 (6%)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><em>Azadirachta indica</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mwarobaini</td>
<td>A. Juss. Melliaceae</td>
<td>8 (6%)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><em>Psidium guajava</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mpera</td>
<td>L. Myrtaceae</td>
<td>6 (5%)</td>
<td>2</td>
</tr>
</tbody>
</table>

Some people who harvest and/or cultivate medicines themselves for home use also buy plant medicines in the market. The choice to harvest plants (cultivated or wild
harvested) versus purchasing market plants is related to convenience. Plants that are cultivated or wild harvested for home use are used for first aid and for routine, everyday problems (e.g., malaria, headache, to stop a wound from bleeding, toothache, to keep away evil spirits). Healers also cultivate or harvest nearby plants that are used in situations that are urgent, such as childbirth or convulsions. Convenience also influences why people purchase plant medicines instead of harvesting them. Not everyone has easy access to the space needed to cultivate or wild harvest medicinal plants. Even people who do may be too busy to do so and simply find it easier to obtain them from the market, where they are already prepared as powders or are ready to drink. For example, I was surprised to see a commercial harvester getting medicines from a market vendor. I knew those same trees are ones that grown in proximity to her house because she lives near the forest reserve, and asked why she would get them at the market instead of harvesting them on her own. After all, she is a harvester. She told me that she was too busy to harvest and prepare those medicines and it was simply easier just to get them from the vendor. Another reason people purchase medicines from vendors is for chronic conditions, especially in cases when self-medication with plants harvested from around the home have not alleviated problems. In this situation, specialists are needed to be consulted, as they are considered to be adept at combining different plants to make medicines when home treatments tend to be more simple (one or two plants). Using convenience as a rule of thumb — urbanites buy more and harvest less, and rural people harvest more an buy less.

Typically, commercial plants are not the ones most widely harvested by consumers for home use. (Plants harvested for home use tend to be widespread, easy to
cultivate, and/or flourish in disturbed areas, so their ubiquity means they have no market value.) Because commercial medicinal plants primarily have their roots in local ethnomedical systems with a history of using those plants, they are known and harvested by consumers. These are usually rural residents who live near forest reserves (such as the Sambaa) or rural residents who have knowledge of and access to medicinal trees, there is some overlap. Their harvest for home use contributes to commercial harvesting pressure, although it is difficult to say the degree to which it contributes.

The reasons for using plant medicines discussed by the HIV+ participants in the focus groups and in other open-ended informal interviews with consumers range from thinking pharmaceuticals are too kali ‘strong’ and wanting to avoid their side effects, allergies to sulfur drugs, not having enough money to pay for the prescription, better efficacy, and longer lasting effects. In the case of chango, women explained that they use plant medicines for chango because there are no pharmaceuticals that treat it. The men in the focus group explained that their decision to use pills or plants depends on money or what is easier. “Dawa za miti ni kama huduma za kwanza, unazfaribu kwana.” ‘Plant medicines are like first aid, your first try.’ They explained that if the plant medicines do not achieve the desired results, or if something stronger with an exact dose is needed, they use pills. One man explained that, in the end it is difficult to know what really helped when you combine medicines but it is a common practice.

“I was using Fanzidar for malaria, but found out I had an allergy to sulfur. Now when I get malaria, I’m in a difficult position. My relatives advised me to use plant medicines because the hospital now tells you to use Aronate [the first line treatment in chloroquine resistant areas], but that is 5,500 shillings [about $5] and sometimes I don’t have that much money. I knew that using plant medicines with ARVs was not allowed, but I have the sulfur allergy. If I use quinine I get worse, and I can’t use drugs with
sulfur so I decided to go to see [a local vendor]. He told me I had *kombako* and gave me a medicine to use three times a day. Because the medicine was very strong, and my immunity is weak, I decided to use it only twice a day. After a few days, I realized that mixing these medicines isn’t good so I stopped using the plant medicines. Still, I’m grateful that because of those medicines I’ve gone a long time without getting malaria again. I think if I would have been able to complete the dose, I wouldn’t have gotten malaria again at all.”

Another reason plant medicines are preferred is because pharmaceuticals must be taken with milk or food, otherwise they can cause gastrointestinal distress. Focus group participants explained, “If you don’t have the time or money to get the right foods, you can just pick your own plants. For those, you don’t have to buy and drink milk because they’re not strong like pills.” “You don’t have to have plenty of food to use plant medicines, but you must have it for ARVs or they’ll make you sicker.” The men explained that ARVs are easier because they do not require preparation, but they agreed that if you are not too sick you should just use plant medicines because you can stop them for periods without repercussions, unlike ARVs which must be taken daily or you risk becoming sicker. “Even though the plant medicines take time and cooking fuel to prepare, you can’t become immune to plant medicines as you do to ARVs,” one man said.

In a study from Dar es Salaam, reasons urban people visit healers over biomedical clinics or hospitals included: shorter waits, more time with the healer, more familiarity and comfort with the healer’s environment, and explanations for their problems that address the etiology in local terms (Gessler, et al. 1995).
5.3 Economic Dimensions

5.3.1 The economics of being sick

Personal strength and endurance are necessary for most people to meet the daily needs of their families. Farming is done with hand tools, construction is done with assembly lines of men who dig and empty holes, mix and haul cement, and carry cinder blocks and timber by hand. Transporting heavy loads (over one hundred pounds) of produce or charcoal via bicycle is common. Health is a resource that does not go unappreciated.

Sickness or weakened states (e.g., pregnancy) often does not substantiate stopping physically demanding work. During the 2006 flu outbreak in Europe, one vendor was surprised and laughed when he heard on the radio that people in London were not going to work because they had "flu." He explained, "Here in Africa, when we get sick we continue with work, it's normal. But there [Europe] they die!" Many people live day to day, hand to mouth. Doing hard work and struggling to feed yourself and your family is part of life. Plant medicines are a way of coping with these toils. The reasons they use them are evidence of their economic struggles.

Consider chango (the type associated with gastrointestinal pain or dysfunction), which is among the most popular complaints treated by plant medicines. The root causes of chango are eating late, not eating enough, and not eating "better food" (nutritious foods). In other words, people who do not get adequate nutrition and must cope by using medicine to help their stomachs. Medicine becomes a quick fix for an insufficient diet. This lack of food also becomes a problem though, for using the
medicines. One vendor/healer remarked, "utapataje choo kama huli?" 'how can you have a bowel movement if you don’t eat?' (The consistency and frequency of bowel movements signal proper body functioning.) Stools that are too watery, hard, frequent, or infrequent are taken as signs of illness, usually chango.

Another popular medicine that is consumed by some as a daily or twice daily tonic is dawa ya muku, which treats uchomvu ‘exhaustion/fatigue.’ People who need to recover from physically demanding work or who need to continue working hard all day are regular consumers of dawa ya muku. This is another sign of socioeconomic status and the role of medicine in helping people cope with their socio-economic conditions. Other examples are medicines to treat stinky teeth or toothaches. These are also common as most people cannot afford to visit a dentist. Upper class people or office workers are not the typical consumers of these medicines. Poor day laborers and farmers are.

As people migrate from rural areas into urban ones kutafuta maisha, kutafuta risiki ‘to find work and make a life,’ the familiar environments that are rich with plant medicines become distant and out of reach. At the same time, they become subsumed in new environments where they are confronted with the problems of making ends meet (which is almost always more difficult than expected), finding or maintaining a romantic or spousal relationship, having children, safeguarding from evil spirits and bad luck, and being healthy in mind, body, and spirit. Plant medicines are sold in urban areas to meet all of these needs and promote success in life.

Absent are pharmaceuticals that treat a stomach that has not had enough food, or a medicine to help if you are exhausted from physical labor and need to continue working,
or a pill to promote a happy marriage. These are local medicines, integral to local ethnomedical systems to meet local needs.

5.3.2 Determining prices of medicines

As with virtually everything in Tanzania, the prices of plant medicines are negotiable. These vary due to the perceived power of the medicine, the relationship of the consumer to the vendor, how busy the vendor is, and the perceived wealth of the consumer. In most cases, especially for more expensive medicines, the price is determined through maeleweano ‘negotiation’ between the vendor and consumer.

Inategemea hali ya mtu. Bei ni kulinganga na mteja – kama hospitalini. Yuko mwenyewe uwezo, na mwengine hana. ‘It depends on the person’s ability. The price goes along with customer – just like at the hospital. Some have resources and some don’t,’ said one vendor who compares his sliding scale to that of the hospital’s which have a pricing schedule based on patients’ finances. Many vendors and most healers feel an obligation to help sick people in need and this means they prefer not to turn someone away or let them leave empty handed. This is not always true. Some vendors are known for having especially high prices and sticklers for bargaining. The reverse also happens whereby vendors and especially healers often feel taken advantage of by patients who claim they have no money to pay or promise to pay at a later date and do not.

For patients of healers prices are even more flexible than they are with vendors. It seems to have little to do with how far away the plant came from and how hard it is to get, and more to do with how the healer perceives the ability of the patient. In some cases, the healer will accept nothing or next to nothing with the understanding that they
will be repaid in the future. In other cases, the healer will demand a payment up front, which may include a goat or chicken. This is particularly true for spiritual matters. For example, *kusafisha nyota*, a ritual process of spiritual and astrological realignment to turn a person’s luck around, can easily cost more than 10,000 TSh ($10). Often healers collect their own medicines so are in more control of the price compared with vendors who are must make a profit on top of what they have paid harvesters.

5.3.3 **Scarcity does not always determine price**

Higher prices of botanical medicinal products are often described as the result of resource scarcity, plant inaccessibility, and local demand (e.g., Cunningham 2001:91). Examples are medicinal plant markets in Paramaribo, Surinam (van Andel, et al. 2007), KwaZulu-Natal, South Africa (Mander 1998) and in Arusha, Tanzania among Maasai medicine vendors (Ibrahim and Ibrahim 1998). However, the logic that high prices necessarily reflect scarcity or high demand, which seems to apply in other places does not work with plant medicines in Tanga. Similarly, in South African markets, researchers found a lack of correlation between the time spent collecting medicinal plants or their scarcity and their market prices (Keirungi and Fabricius 2005; Williams 2004). Instead, prices were positively correlated with the species' perceived healing properties (Keirungi and Fabricius 2005).

In Tanga, medicinal trees that are only found at high elevations two days away (on bus and on foot) are sold at the same prices as those that are found in close proximity. The roots of *ubombo* (*Mondia whitei* (Hook. f.) Skeels Asclepiadaceae), valued by men as an aphrodisiac, are in such demand that they often vanish within hours of being
delivered to the vendor but they are not more expensive than other medicines that are in less demand. In fact, one vendor explained that he refuses to sell it because he cannot make a profit on it. His friends, neighbors, and family help themselves and just start chewing his roots without feeling obliged to pay. In essence, it is so desirable and valuable that everyone feels a right to have it. After all, “it’s free from the earth,” many consumers argue.

Only two of 28 vendors talked about the distance of a plant or demand for that plant influence its price. One of these mentioned is mzuu or sandali (*Osyris lanceolata* Hochst. & Steud. Santalaceae) which is valued for its sandalwood scent and harvested heavily to supply foreign cosmetics markets. Locally, the tree is also used medicinally, but is very hard to find in the region because it has been over-harvested for export (much of it illegally). Half of the vendors (14 of 28) said that all medicines are sold for the same price. Others commented that medicines that are combinations of different plants cost more than simple or single-ingredient medicines. Usually these mixes treat chronic diseases (e.g., diabetes, cancer). In the Uluguru Mountains of Morogoro Region in Tanzania, healers and midwives also reported charging more for chronic diseases such as asthma, arthritis and lung complications (Mahonge, et al. 2006). As in Tanga, they charge more because more medicine needs to be taken over a much longer time period for chronic diseases than for what are described as everyday sicknesses. Finally, imported medicines (from the Arabian Peninsula or India) are more expensive than locally harvested medicines, but the majority of vendors who sell locally harvested medicines do not sell these.
Locus in the market chain can also influence price, as can proximity to the source areas. Costs of transporting plant material from source areas to commercial areas is usually absorbed by the harvester or vendor without affecting the buying or selling price, except when four-ton trucks need to be rented to haul large amounts of material, as in the case with the TAWG orders. In some cases when roots and bark are ground by local machines, these fees can increase the price paid to harvesters although many still pound and grind the medicines by hand with wooden mortars and pestles.

5.3.4 Myth: people use medicinal plants because they are cheaper

It has often been explained that medicinal plants are used because they are more affordable than pharmaceuticals, but this is not true in all cases. Although the dosing schedules are not the same, comparing the prices of local plant medicines to pharmaceuticals illustrates this point. A standard dose of plant medicines consist of a packet of powdered plant material to be used three times a day for three days for 2,000 TSh (about $2). Doxycycline (a widely-used antibiotic) cost 250 Tsh (25 cents or 2 cents) per tablet, and a seven day dose would cost $1.75. Acetaminophen is only about 7 cents per tablet, but a plant medicine consumed for headache can cost 20 cents or more. Before drug-resistant malaria became an issue in Tanzania, Chloroquine and Quinine provided a very affordable treatment, pennies a tablet. Now the recommended first line treatment, Aronate, costs 5,600 TSh (about $5.60) for a full cycle. In this case, the local treatment for malaria might cost 1-2,000 TSh ($1-2) which is certainly less expensive.
Some of the most expensive medicines are for good luck, to win a court case, to attract love, and other problems beyond disease, which underscores the complex nature of pricing and how different medicines are valued locally.

5.3.5 Examples of prices for local plant medicines

**Whole Roots / Bark**

Vendors to consumers - sold by the piece or fungo ‘bunch’ (about a fist thickness or smaller)  
200 – 500 TSh ($0.20 - $0.50)

Harvesters to Vendors – varies. One harvester supplies a number of Tanga Town vendors with a guinea sack consisting of about 13 species (roots and bark) that weigh 70 - 100 kilograms  
9,000 – 10,000 TSh ($9 - $10)

**Powdered Medicines (500g-750g kopo ‘cup’)**

Harvesters to vendors  
200-500 TSh ($0.20 - $0.50)

Vendor to vendor  
500-1000 TSh ($0.50 - $1.00)

**Powdered Medicines (by the spoonful)**

Vendor to consumer - a few teaspoons  
200-500 TSh ($0.20 - $0.50)

**Glass of Prepared Medicine (usually consists of infusion made from soaking roots or mixing 2-4 teaspoons of powdered medicine)**

Vendor to consumer  
200-400 TSh ($0.20 - $0.40)

Table 5.3 below shows what the healer who provides medicinal plants for thousands of TAWG patients annually pays his harvesters. Usually there are about 800 patients actively using the monthly dose. This healer manages his staff in the processing of the raw plant material into dried, ground powders. These are most commonly prepared by
clients as decoctions for drinking. Some can also be mixed with oil or honey and applied topically, depending on the reason for using the medicine. A monthly dose for one TAWG client consists of about 1,150 total grams of prepared powders from the four plants (listed below in the table).

**Table 5.3 Prices Paid to Harvesters by a Tanga Healer**

<table>
<thead>
<tr>
<th>Species</th>
<th>Part</th>
<th>USD paid to harvester for fresh, unprocessed material / kilo (TSh)</th>
<th>Weight estimates (according to Kassomo) from fresh to processed dried material</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Steganotaenia araliacea</em></td>
<td>Tree branches</td>
<td>$0.03 (32)</td>
<td>1 kg → 0.30 kg</td>
</tr>
<tr>
<td><em>Aspilia mossambicensis</em></td>
<td>Vegetative coppice</td>
<td>$0.06 (60-67)</td>
<td>1 kg → 0.30 kg</td>
</tr>
<tr>
<td>(Oliv.) Wild Asteraceae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pyrenacantha kaurabassana</em></td>
<td>Tuber</td>
<td>$0.03 (26-36)</td>
<td>1 kg → 0.08 kg</td>
</tr>
<tr>
<td>Baill. Icacinaceae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Harrisonia abyssinica</em></td>
<td>Tree/Shrub Branches</td>
<td>$0.06 (60)</td>
<td>1 kg → 0.33 kg</td>
</tr>
<tr>
<td>Oliv. Simaroubaceae</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the figures above, one prepared monthly dose of 1,150 grams of prepared medicines costs the healer about $2.05 for the raw plant materials alone. This does not include the payments to his staff for processing or transporting the material. TAWG pays him 2,000 TSh ($2) per dose, which means that he does not make a profit or it is negligible, assuming the figures above underestimate actual prices paid / kilo. In any case, this example emphasizes that this healer will not become rich for his service to HIV positive people. Clearly, his reasons and motivation extend beyond financial. The reasons TAWG clients use these medicines is not because of their low price. All TAWG clients receive these plant medicines free of charge in addition to the counseling and treatment they receive from qualified nurses, medical officers, and physicians. But
ARVs are also free of charge and are available from the hospital for HIV positive people with viral loads <200 through a government program.

5.3.6 Livelihoods connected to medicinal plants

The medicinal plant market chain provides a source of income for a number of people, though it is seldom sufficient to be the sole or primary livelihood. Commercial harvesters are primarily subsistence farmers who collect and sell medicinal plants for supplemental income. All Bantu harvesters involved in this research are primarily subsistence farmers, except one who has a charcoal business. Some of these male harvesters also transport produce or charcoal via bicycle for income. One Maasai harvester is primarily a cattle herder.

In one mountain sub-village (bordering a forest reserve), 15 of 41 households were chosen randomly to participate in semi-structured interviews. All are poor subsistence farmers, and four of them reported harvesting plant medicines for supplemental income. In addition to the four that were chosen randomly, I know another four households in that same sub-village who are involved harvesting for income. Twenty percent (eight of 41) of households is likely a conservative estimate of the number of households in the entire sub-village who have relied on medicinal plants for supplemental income. It is likely there are additional households in the sub-village that have collected medicinal plants for income that I do not know of and were not sampled.

In Nepal, an estimated 7–10% of the population in mountain regions derive income from the harvest of local medicinal plants (Olsen and Larsen 2003:251). Of the high elevation households of the Himalayas in Gorkha District (Nepal), the figure is
much higher with 50-100% engaging in the commercial harvest of medicinal plants (Olsen and Larsen 2003:244). In this same District, fifteen households recorded the medicinal species they harvested for one year. Medicinal plant collection accounted for 15-50% of household income and was shown to be inversely other resources available such as land for farming and domesticated animals (Olsen and Larsen 2003:250) and the and availability of adult male labor. In Nepal, the trade in medicinal plants is much more developed, commercialized, and intensive whereas the trade in Tanga is almost entirely local, which likely accounts for fewer households relying on the commercial harvest of medicinal plants for income. Although rural households in the lowlands of Tanga were not included in this study, my impression is that montane households are more involved in the commercial harvest, as was found in Nepal. Unlike Nepal, much of the harvesting in Tanga —especially in the West Usambara Mountains— is done by women.

Among Maasai women, the harvest and sale of plant medicines by women —especially those without the support of an adult male— has been documented as an increasingly important source of household income for dispossessed pastoralists near Mkomazi Game Reserve in Lushoto, Tanga (Brockington 2001). In Tanga, 12% of 112 households from urban and rural areas combined reported having harvested medicinal plants for supplemental income (Table 5.4).

This demonstrates the important buffering-role that medicinal plants can play in household incomes for poor families that live in proximity to medicinal plant resources. In urban areas, there is less reliance on local medicinal plants for home use or for a supplementary source of income (4 of 82 households or 5%) compared to rural areas (9 of 30 households or 30%). One exception is a retired woman who lives in the urban,
affluent area who pays young boys to collect the fruits from her *mwarobaini* (*A. indica*) trees that line her property. She sells these by the kilo to a local business that produces soaps and candles used to treat skin problems and repel mosquitoes.

Table 5.4 Household Experience Harvesting Medicinal Plants

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
<th>N</th>
<th>Ever harvest for home use?</th>
<th>Ever harvest for income?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanga Town, Tanga (coastal)</td>
<td>Urban, affluent</td>
<td>10</td>
<td>60% (6)</td>
<td>20% (2)</td>
</tr>
<tr>
<td></td>
<td>Urban, upper class</td>
<td>12</td>
<td>33% (4)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Urban, mid to lower class</td>
<td>60</td>
<td>57% (34)</td>
<td>3% (2)</td>
</tr>
<tr>
<td>Mlalo, Lushoto (montane)</td>
<td>Rural, middle class</td>
<td>15</td>
<td>80% (12)</td>
<td>33% (5)</td>
</tr>
<tr>
<td></td>
<td>Rural, remote, very poor</td>
<td>15</td>
<td>93% (14)</td>
<td>27% (4)</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>112</td>
<td>63% (70)</td>
<td>12% (13)</td>
</tr>
</tbody>
</table>

Vendors of medicinal plants often sell other items as well (e.g., housewares, produce) to diversify their income generating possibilities. Often times, vendors are elderly men who have experience as healers and/or harvesters but are too old to continue with the manual labor of harvesting and farming. For them, tending a market stall or a kiosk offers a source of income (albeit small). Because most people still rely on subsistence farming (even urban residents still have and work farms in rural areas or pay others to do so) for their food needs, the work required during planting and harvesting seasons is prioritized over selling medicines. Many times, the primary vendor will put a family member (e.g., son or great uncle) in their kiosk to tend the business in their absence while they are away planting or harvesting at their farms. Other times, the kiosk or market stall just goes dormant.
There are examples of vendors that rely on their medicinal plant business as the primary source of income. These are the busiest vendors in Tanga town, and they even employ workers at their kiosks. One is owned and run by a vendor who employs an older uncle and three young men who work in rotating shifts preparing and distributing medicines to customers. Farther up the chain, this vendor regularly supports the livelihoods of a handful of harvesters — a group of three women from a mountain forest village, his wife’s cousin from a different mountain forest village, and one man from the lowlands. He also purchases from other harvesters opportunistically.

Many healers look down on those who make plant medicines a biashara ‘business,’ but even they rely on their work with plants to support them and their families. Healers especially are quick to disregard the validity of vendors saying, hao ni wafanya biashara, tu, hawai jui miti ‘they [vendors] are just business people, they don’t know plants.’ Bantu vendors commonly say the same about Maasai vendors.

The healer who supplies TAWG with all of their plant medicines is not representative of a typical healer’s operation, but he is important to mention here. He employs two men full time and one woman half time to work at his office/clinic. They receive plants brought in by harvesters, process (e.g., cut, dry, burn, pound, and transport them to be ground by machines), and package the medicines. He also regularly purchases from about 5-10 men who he has trained to identify and harvest plants.

Shops that sell Arabic medicines also have full time employees. In Tanga there are about five such shops that employ about seven workers total (in addition to the owners). The oldest and busiest shop in Tanga is an Indian-owned family business and employs about three full time Sambaa employees that assist customers. The less busy
shop next door employs one Sambaa, and the Sambaa (Bantu) owned shop (the smallest and least busy) is operated by its owner. Another well known and busy shop usually has about three men inside, but it is difficult to tell who is an employee, owner, or visitor. Clearly, medicinal plants offer opportunities for harvesters, vendors, healers and their employees to generate income. Table 6.4 in Chapter Six provides more detail on this subject.

5.4 Conclusion

The sociocultural and economic context in which medicinal plants are harvested and used is important for understanding the market system of which they are a part. Local ethnomedical systems are diverse and reflect cultural, logistic, economic, and health realities. Medicinal plants are not simply popular because they are less expensive. They are sometimes more expensive than pharmaceuticals. People’s decisions to use them relate to their culturally based belief systems, what medicines are available to them, and their health and well-being. The reasons people become involved in the medicinal plant market chain (as harvesters, vendors, or healers) are similarly complex and varied. These range from the need to generate supplemental income to the desire to be of service to the sick. These issues are important, but they are not the only ones that influence the market system or local ethnomedical systems. The next three chapters detail the key roles, species, and locations in medicinal plant pathways and the social aspects and ecological variables that are important to consider in understanding the context of medicinal plant procurement and management in Tanga.
CHAPTER 6. KEY ROLES IN MEDICINAL PLANT PATHWAYS

6.1 Introduction

This chapter centers on the key roles of people involved in the procurement and distribution of medicinal plants. It begins by defining key roles and their relationships, and then traces the pathways plants traverse beginning with the people who dispense them to harvesters who collect them.

6.2 Defining Key Roles: Vendors, Healers, and Harvesters

Research on the knowledge and behaviors of medicinal plant specialists and stakeholders has typically focused on vendors, healers, and harvesters and treated them as distinct groups. One important finding of this research is that "vendor," "healer," and "harvester" are best described as roles not absolute, mutually exclusive specialist categories. They do not predict or presuppose knowledge or proficiency in popularly used and sold medicinal plants. They are dynamic and overlapping roles played by individuals who may play multiple roles at one time or fulfill multiple roles serially. With that understanding, I use these categories of roles because they best describe the primary function of individuals and their relationships to each other in the medicinal plant market chain. These business networks are typically social networks based on extended family or connections to neighbors back home in rural villages. Here I define the most important roles by their primary activities in the market chain. For locally harvested plants, the market chain is simple with harvesters selling directly to vendors and very minimal instances of middlemen.
- **Vendors** buy from harvesters and sell to consumers primarily, and healers secondarily. They seldom collect plants themselves but some do harvest to supplement what they buy from harvesters. Some were commercial harvesters previous to becoming vendors and some also identify as healers.

- **Healers** distribute to patients. They tend to work from home or their *vilenge* ‘private traditional clinics’ and their practices are less commercial and more culturally-based than vendors’ practices. They typically collect the majority of their plants themselves, but some also purchase from vendors and/or place orders with harvesters. Some collect and supply other vendors or healers.

- **Harvesters** supply vendors and healers. A few also identify as healers or healers-in-training. They typically take orders for specific plants from a specific vendor or group of vendors, rather than harvesting just any medicinal plant and hoping to sell it to just any vendor.

Figure 8 illustrates the movement of medicinal plants from the time of harvest to the time of use.
Figure 8. The Movement of Medicinal Plants in Tanga

**Key to Figure**

*Middlemen are not prominent in Tanga. Only one was involved in this research.

**Tanga AIDS Working Group.**

Arrows indicate the direction of the movement of the plant.

Solid black line boxes and lines represent the primary roles in the medicinal plant pathways.

Dotted black line boxes (Middleman & TAWG) are secondary roles represented by few individuals.

Dashed red boxes and lines represent the pathways of imported medicines.
An important factor that differentiates these roles from each other is the way they obtain plant medicines. Table 6.1 shows how individuals characterized as harvesters, healers, and vendors reported obtaining their plants. Those who collect their own plants are primarily harvesters, then healers. Vendors collect few of their plants.

![Figure 9. How Plant Medicines are Obtained - across Roles](image)

**Table 6.1 Key to Figure 9.**

<table>
<thead>
<tr>
<th>Key</th>
<th>Method</th>
<th>Harvester (n=20)</th>
<th>Healer (n=28)</th>
<th>Vendor (n=27)</th>
<th>All (n=75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I harvest them all myself with my own hands.</td>
<td>80% (16)</td>
<td>57% (16)</td>
<td>15% (4)</td>
<td>48% (36)</td>
</tr>
<tr>
<td>2</td>
<td>I harvest most and get few from someone else.</td>
<td>5% (1)</td>
<td>21% (6)</td>
<td>19% (5)</td>
<td>16% (12)</td>
</tr>
<tr>
<td>3</td>
<td>I harvest about half; someone else supplies me with half.</td>
<td>5% (1)</td>
<td>7% (2)</td>
<td>19% (5)</td>
<td>11% (8)</td>
</tr>
<tr>
<td>4</td>
<td>Most are from someone else; I harvest few.</td>
<td>5% (1)</td>
<td>11% (3)</td>
<td>26% (7)</td>
<td>15% (11)</td>
</tr>
<tr>
<td>5</td>
<td>All from someone else.</td>
<td>5% (1)</td>
<td>4% (1)</td>
<td>22% (6)</td>
<td>11% (8)</td>
</tr>
</tbody>
</table>
6.2.1 Sourcing and Supplying

6.2.1.1 Harvesters

Obviously, the majority of harvesters harvest all the medicines themselves. The one who obtains them all from someone else is not primarily a harvester, rather he is a healer's assistant who receives, weighs, records, and processes plants brought in by harvesters and only occasionally harvests for the healer. He is classified as a harvester because he is clearly not a vendor or a healer, and has harvested for the healer. Commercial harvesters usually live in proximity to habitats rich in medicinal plants with market values, which facilitates their role. Those that live in more urban areas farther from habitats where commercial volumes of medicinal plants are available for harvest, typically have ties to their rural "home villages" that are in such areas. Harvesters in the Eastern Cape of South Africa were also noted to combine collection trips with social visits home (Cocks, et al. 2004:481). The majority of informal gatherers/ hawkers there harvest themselves and purchase only 20% of their material. They do not hire assistants, but rely on family members for help (Cocks, et al. 2004). This is comparable to Tanga harvesters. Harvesters are the least obvious and most mobile link in the medicinal plant market chain. These "unwitnessed and invisible commercial gatherers" (Williams 2002:21) are an essential part of the research, however, because they connect us to source areas and collection practices.

6.2.1.2 Vendors

The majority of 28 vendors interviewed reported selling primarily to consumers, and occasionally to other healers or vendors (usually as favors or exchanges). Two said
they only sell to consumers and three said they primarily sell to other healers or vendors
and sell only a little directly to consumers. Forty-eight percent of vendors obtain all
(22%) or most (26%) of the medicines they sell from harvesters. Johannesburg vendors
exceed this number with 85% of vendors who obtain their plants from commercial
harvesters (Williams 2002:21). In Tanga, sometimes these are people they have
contracted and sometimes they buy from other vendors nearer source areas. Old age and
being too busy are reasons they stated for not doing it themselves, although they all claim
the experience of harvesting at some point in their lives. This is how they learned plants;
without this experience and knowledge they would be unable to buy them in confidence.
By relying on smell, texture, and sight many vendors can recognize the plant out of its
habitat, disassociated from its wholeness, dried and cut-up, and even in powdered form.
Some vendors said they harvest medicines that require masharti ‘rules’ themselves. But
most vendors do not sell medicines with such requirements or they do not abide by the
rules. Pre- and proscriptions are more in the domain of healers’ knowledge and practices.

In terms of the regularity with which they restock, most vendors said they have no set
schedule. When something is depleted, they order more. The busier vendors said they
restock every couple of weeks or every month, but I learned that this actually depends
more on the schedule of the harvesters. Even if a vendor is desperate to buy, they must
wait until the harvester provides.

Vendors who said they harvest all their own medicines (n=4) are two Maasai
women and two Sambaa men who regularly leave Tanga Town and return to their home
villages. Five of the six vendors who get all their medicines from someone else are based
in Tanga Town. The sixth one functions more as a middle man, moving between his
home area in the Usambara mountains where he buys medicinal plants and sells them in Tanga and Mombassa towns where he buys imported medicines (dawa za kiarabu) and sells them in rural areas. Of the four vendors who are based in the Usambara Mountains (Mlalo, Lushoto) who say they get most of their medicines from someone else and harvest only a minority of what they sell, two are quite elderly, one is the middleman (just mentioned) and the fourth is a younger vendor who inherited the trade from his father and is too busy moving between different local markets (almost on a daily basis) to spend time harvesting.

The ways Tanga vendors obtain their plants follow trends with vendors in South Africa. In the Lowveld, 40% of traders “bought only” and 60% of traders “bought most and collected few” of their plants (Botha, et al. 2004b). In Johannesburg, 37% of traders buy all their plants from commercial harvesters, and 45% buys most of their plants but gathers small quantities on their own (Williams 2003:61). Street and pension day vendors, similar to itinerant vendors who would and compare most with Maasai in the Tanga sample, are about even in terms of the amounts they collect and purchase.

6.2.1.3 Healers

Most Tanga healers harvest their own medicines. Fifty-seven percent said they harvest all their own medicines, and 21% said they harvest most of their own medicines. This is comparable to findings from the Eastern Cape Province of South Africa where 69% of healers reported harvesting all their own material (Cocks, et al. 2004:482). In Tanga, healers go with one to six relatives or trainees or teachers on harvesting excursions to stock up on supplies, or harvest alone when a patient needs a medicine right
away. In a few cases some said they are now too old to do it themselves so they send
their children or their trainees, but they still consider this “harvesting themselves”
because they supervise it. Four of 17 healers whose stocks were inventoried had no or
very few medicines in stock because they often wait until the patients come and then they
go *porini* ‘to the bush’ to harvest, or because they have medicinal plants planted or
growing near their houses. One healer often brings his patients with him so they can
learn the plants and rituals associated. Most healers said they have no set schedule for
harvesting, it depends on the needs of their patients, but some have annual harvesting
excursions with other healers in their “family” (who have been trained by the same
teacher). Together they harvest medicines for the year. This precedes the annual
“homecoming” ceremony held by their mentor where all his students come back for an
annual three-day *ngoma* ‘celebration with music and dancing.’ Healers who reported not
harvesting their own medicines said it is due to old age, because they consider themselves
too busy, or because they rely heavily on imported medicines from shops (*dawa za
kiarabu*).

The majority of healers said they provide medicines primarily to their patients,
but one also provides substantial volumes of medicines to researchers and to a non-profit
organization (the Tanga AIDS Working Group). Because of harvesting, healers
experience their landscape and environment in a way that vendors typically do not.

### 6.2.1.4 Medicinal plants bind social networks

For many healers, particularly *waganga wa jadi* ‘healers who come from a family
line of healers,’ the importance of family networks and their connection to medicinal
plants is obvious. They become healers when *wanarithi mikoba* ‘they inherit the bag’ (literally)’ meaning they inherit the spirits and position of healer from a deceased relative. These healers say they are chosen by the spirits that guided their deceased healer-relative. These healers typically have not studied healing and many of them insist they did not choose to be healers and, in fact, would prefer not to be but are at the mercy of these spirits who make their lives miserable if they do not do their bidding. These same experiences that led people to become healers in Tanzania have also been documented in Dar es Salaam (Gessler, et al. 1995:150) and Tanga, Tanzania (McMillen 2004:895), in the former Zaire (Janzen 1978:196).

Vendors do not necessarily inherit their positions from their deceased ancestors, but family networks are still very important. In Tanga Town, most of the vendors are linked to one of two Sambaa lineage groups or to a group of Maasai that are related through kin relationships and their ties to their *boma* ‘home settlements’ before they were relocated and eventually moved to Tanga Town. Harvesters are also connected to those they supply through similar lines.

### 6.2.2 Sociocultural aspects of roles

Chapter three introduced sociocultural and demographic characteristics of the study population. In this chapter, the sociodemographic characteristics of the primary research population (harvesters, vendors, and healers) are detailed in Table 6.2 on page 11. The research design progressively built upon each step, so there is a significant overlap in participants from the semi-structured interviews, inventories of medicinal plants, and the local ecological knowledge survey. Vendors of imported medicines were
not a focus of this research so they were not included in semi-structured interviews or the local ecological knowledge survey, but basic information about them was captured during inventories. Harvesters did not participate in inventories because they do not typically keep stocks of medicinal plants as vendors do. The majority of participants in each phase were Muslim, Sambaa, male residents of Tanga district, and this reflects the people who are most involved in the medicinal plant trade in the three districts (Tanga, Muheza, and Lushoto) of Tanga Region. The next most dominant group in the research population is Christian, Maasai, women who live at least part time in Tanga District. The Maasai are also heavily involved in the medicinal plant trade in Tanga, but their more mobile nature, and their culture and language which are distinct from Bantu made it challenging for me to involve more of them.
Table 6.2. Demographic Characteristics of the Primary Research Population

<table>
<thead>
<tr>
<th>Semi-structured Interviews (N=67)</th>
<th>Inventories of Medicinal Plants (N=51)</th>
<th>Local Ecological Knowledge Survey (N=74)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Role</strong>&lt;sup&gt;1&lt;/sup&gt;</td>
<td><strong>Percent (No.)</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td><strong>Role</strong></td>
</tr>
<tr>
<td>Harvester</td>
<td>19% (12)</td>
<td>Harvester</td>
</tr>
<tr>
<td>Healer</td>
<td>31% (24)</td>
<td>Healer</td>
</tr>
<tr>
<td>Vendor&lt;sup&gt;1&lt;/sup&gt;</td>
<td>48% (31)</td>
<td>Vendor&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Vendor&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0%</td>
<td>Vendor&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td><strong>Ethnicity</strong></td>
</tr>
<tr>
<td>Sambaa</td>
<td>59% (40)</td>
<td>Sambaa</td>
</tr>
<tr>
<td>Zigua</td>
<td>6% (4)</td>
<td>Zigua</td>
</tr>
<tr>
<td>Digo</td>
<td>8% (5)</td>
<td>Digo</td>
</tr>
<tr>
<td>Bondei</td>
<td>3% (2)</td>
<td>Bondei</td>
</tr>
<tr>
<td>Maasai</td>
<td>11% (7)</td>
<td>Maasai</td>
</tr>
<tr>
<td>Other</td>
<td>13% (9)</td>
<td>Other</td>
</tr>
<tr>
<td><strong>District</strong></td>
<td></td>
<td><strong>District</strong></td>
</tr>
<tr>
<td>Tanga</td>
<td>61% (45)</td>
<td>Tanga</td>
</tr>
<tr>
<td>Lushoto</td>
<td>27% (18)</td>
<td>Lushoto</td>
</tr>
<tr>
<td>Muheza</td>
<td>13% (9)</td>
<td>Muheza</td>
</tr>
<tr>
<td><strong>Religion</strong></td>
<td></td>
<td><strong>Religion</strong></td>
</tr>
<tr>
<td>Muslim</td>
<td>78% (52)</td>
<td>Muslim</td>
</tr>
<tr>
<td>Christian</td>
<td>22% (15)</td>
<td>Christian</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
<td>Other</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td><strong>Gender</strong></td>
</tr>
<tr>
<td>Male</td>
<td>73% (49)</td>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
<td>27% (18)</td>
<td>Female</td>
</tr>
</tbody>
</table>

Vendor<sup>1</sup> = local; Vendor<sup>2</sup> = imported
6.2.2.1 Gender

In other African nations, women comprise a significant proportion of medicinal plant vendors. Most prominently, this has been documented in South Africa (Cocks, et al. 2004; Cunningham 2001:87; Dold and Cocks 2002; Williams 2004). Cunningham (2001:87) says that men leave the more marginal sales of medicinal plants to women and focus their own involvement in the more profitable trade of medicines from animals, which women are excluded from. The situation in Tanga is different, not just for the vendors who participated in this research but for all vendors seen during the research period. Religion and culture play a strong role in determining the gender of vendors in Tanga. In this research, the only women vendors encountered are Maasai, who all identify as Christians. There are also gendered expectations of Maasai. Men are expected to stay in the bush and live with their cattle. Those who move to urban areas and take up other livelihoods, including selling medicines, are seen by their peers as even more marginal than the Maasai women who do so.

In Tanga, the majority of vendors are men (mostly Sambaa) who overwhelmingly identify as Muslim. It is much more common for women to be healers and harvesters than vendors. Women healers often gain status and income while still adhering to social expectations of remaining in the domestic sphere.

Table 6.3. Gender Across Roles for Semi-structured interviews, Inventories, and LEK Survey Combined

<table>
<thead>
<tr>
<th>Role</th>
<th>N</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvesters</td>
<td>23</td>
<td>30% (7)</td>
<td>70% (16)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>all Sambaa</td>
<td></td>
</tr>
<tr>
<td>Healers at home</td>
<td>41</td>
<td>37% (15)</td>
<td>63% (26)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mostly Sambaa and Ziguia</td>
<td></td>
</tr>
<tr>
<td>Vendors (all types)</td>
<td>52</td>
<td>17% (9)</td>
<td>83% (43)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>all Maasai</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>116</td>
<td>27% (31)</td>
<td>73% (85)</td>
</tr>
</tbody>
</table>
Many women harvesters and all of the Maasai women vendors need to be self-sufficient because they are widows or co-wives whose husbands do not provide them with what they need to take care of themselves and their children. Women who live in proximity to rural source areas with large quantities of medicinal plants (e.g., coastal woodlands or montane forests) are as likely as men to be harvesters. Although no women Maasai harvesters were involved in this research, all of the women Maasai vendors also claim to harvest medicines themselves. Men are more likely than women to be harvesters in urban or semi-urban areas as it is acceptable for them to be away from their families and household responsibilities for extended periods of time but it is much more difficult for women to be away from their households for extended periods due to their home-based responsibilities and the preferences of Islamic culture. Urban women do not routinely collect firewood, fetch water from far away, or farm, and these also limit their away-from-home opportunities including their option to become regular harvesters. Because of their limited mobility, Muslim Sambaa women harvesters are less likely to transport their medicines far away to sell them. They bring them to the market, where vendors and middlemen buy them. Contrastingly, Christian Maasai harvesters who are also vendors travel great distances and stay away from home for weeks or months at a time to vend (see also Brockington 2001). In this research male harvesters also delivered directly to individual vendors or to healers at their kiosks or workplaces outside of formal markets.

Rural women know where to find medicinal plants because they spend a substantial part of each day collecting fuelwood. Urban and semi-urban women are more likely to purchase charcoal or firewood. The women harvesters most closely followed in
this research live in a remote montane village near the border of a national forest reserve. Because they live near the reserve and are permitted to go into ‘use zones’ for collecting dead wood for fuel, it is considerably easier for them (as residents with legitimate access) to secretly harvest medicinal plants from these zones, as well as the areas that are off limits. They are normally seen coming and going to and from the forest every day. For timber harvesters—especially non-resident ones—it is difficult to smuggle out logs or planks without being seen. Conversely, medicine harvesters can pack bark and roots into guinea sacks or tie them up in cloth and can carry them out without drawing much attention. Still, these women harvesters are fearful of being caught transporting plant material to the market and often transported it at night because the fines are steep if they are caught. One of these women harvesters was caught transporting two kopo ‘cups’ of powdered medicines to market. The standard unit of measure for commercial plant medicines is a kopo ‘cup’ which is usually measured in a reused plastic container that originally held 500 grams of cooking fat. These two cups would have brought the woman 500TSh ($0.50) when she sold them but she was fined 8,000 TSh ($8) by the village forest guard. The vendors are well aware of this risk and avoid it. “We [vendors] don’t go to harvest mkulo [Ocotea usambarensis Engl. Lauraceae] because if we’re seen in the forest, we’ll get in trouble. That’s why we order it [from the women harvesters].”

These women are a team of three, two co-wives and one aunt, who often recruit the assistance of their school-age children. When they receive a large order, they sometimes contract out some of the work to women neighbors or relatives. The women work together, but each keeps track of the material she collects, dries, and pounds and is paid for that work.
6.3 Public Dispensers of Plant Medicines: Local Medicine Vendors, Imported Medicine Shops, and Hospital Health Workers

6.3.1 Local medicine vendors

The majority of vendors in Tanga Region are located in urban Tanga Town. Accordingly, the majority of the vendors in this research are also from Tanga Town. Twenty-one of 29 (72%) vendors I identified in Tanga Town were involved in the research in some capacity. (Most of the ones I did not interview were relatives who operated satellite branches of more established vendors that I had already interviewed and inventoried.) Most vendors work out of semi-permanent free standing kiosks. “Semi-permanent” describes the moveable, easily deconstructable and reconstructable nature of their kiosks, which makes them different from conventional shops and markets that are part of established commercial zones. These kiosks appear, go dormant, disappear, and sometimes reappear in other locations depending on pressure from municipal officers or property owners (when the vendor has no permission from the property owner), when farming demands take priority over vending, when conflict escalates with a neighboring vendor, or when a more lucrative commercial area is identified. Vendors who display their medicines on tarps or small stools in high traffic areas (outside markets, near bus stands or roundabouts) or roam with their medicines on bicycle or on foot tend to sell with less regularity and predictability. Those that sell with more regularity do so in the context of established markets, or as stand-alone individual enterprises such as kiosks.

Itinerant vendors move from market to market, and town to town and only return home after extended periods (usually at least a month, but often longer). They are a minority compared to vendors who regularly sell from the same locations day after day. The mobile and unpredictable movements of itinerant vendors likely contributed to my
perception that there are few. They are certainly harder to identify and track than vendors who regularly work from the same location on a daily basis; however in Tanga they definitely seem to be the minority. In this research I define itinerant vendors as rural residents do not live in town, even temporarily or part-time. I involved no itinerant vendors in formal interviews or inventories although I did talk with some informally. These seem to be primarily Maasai.

6.3.1.1 Comparing Maasai and Sambaa vendors

The majority of vendors are either Maasai or Sambaa, and the differences between these two groups merit discussion. They diverge in the following areas: specialist roles, primary residency, collection, customers, and inter-cultural variation.

Specialist roles: First, medicinal plant knowledge is widely distributed in Maasai culture and there is no specialist "herbalist" role (Ibrahim and Ibrahim 1998). Maasai vendors in Arusha explained that “everybody has this knowledge, nobody is specialized” (Ibrahim and Ibrahim 1998:148) and Maasai vendors in Tanga reiterated this. Specialist roles in Maasai culture include the laibon who is a priest/medicine man/forecasters of the future. Laibon do know more about plant applications than the average Maasai, but according to the Maasai vendors in Tanga, the medicines they sell have nothing to do with what laibon use. Further, none of the Maasai vendors are laibon or their descendants. It is not relevant to their work as vendors of medicinal plants.

On the other hand, Sambaa (and other Bantu) vendors link their knowledge of plants directly to specialized mganga ‘healer’ knowledge. The medicines Sambaa vendors sell certainly are also used by healers, and many are also commonly known by
most rural Sambaa. In fact, a number of Sambaa vendors also call themselves healers and or are descendants of healers who have taught them about plant medicines.

In Tanga town, almost all of the Sambaa vendors can be linked to one healer, Mzee Ally (Mzee ‘elder’ is a title of respect, usually used for older men), who first came to Tanga Town (from the Usambara Mountains) and began selling plant medicines in 1988. Of the thirteen Sambaa vendors I identified in Tanga Town, eight claim to have roots in Zaizo village (Mzee Ally’s home village) or to Mzee Ally himself. His eldest son, now one of the most successful vendors in town, explains that his father became successful, in part, because he cured a man who later gave him a space to establish a kiosk and sell his medicines. This space is situated in a busy commercial area and it gave him visibility and made him accessible to growing numbers of customers. Distinct from other vendors, Mzee Ally started a new system by preparing medicines in advance so customers could drink them on the spot after purchase. This convenience attracted many more customers who avoid having to go home and boil water, cook the roots/bark, or soak them overnight. Mzee Ally saved them time as well as the water, fuel, and the pot necessary to prepare the medicines. He also spared them from curious eyes of neighbors who would wonder what they were cooking and why. This confluence of factors made him very popular and successful. By the time Mzee Ally passed away (in 2000) his nephew and sons had already established themselves as vendors. Now they are joined by their friends and relatives who have continued on with the business he started.

Primary residency: Maasai prioritize their responsibilities at ‘home’ with their families and herds, which means they leave town more often than Sambaa (and other Bantu) vendors. When asked if they preferred life in town or in their rural areas, the
women Maasai vendors unanimously preferred rural life. When in town, they do not have permanent residencies. Instead, they rent a room and sleep together, usually for a couple of weeks to a month, until they return to their bomas ‘settlements.’ I do not consider these vendors to be itinerant because they come to town regularly and stay for extended periods between periods at home.

Although a growing number of Maasai vendors are itinerant and should be followed up in future research, I did not officially interview or inventory their stocks because of the importance I placed on developing trust and rapport over an extended period first — something that was made impossible by the nature of the itinerant vendors’ mobile and unpredictable movements.

When Maasai vendors leave town to return home, they sometimes have a daughter or niece take over their vending, but it is not uncommon for them to just pack up and leave the vending until they return. Maasai vendors also travel from town to town selling their medicines and beads. One younger (twenty-something) Maasai woman who sold medicines and beads with her widowed mother in Tanga Town spends extended periods (from June through August) in Zanzibar each year because it is the high season for tourists (especially Italians) and they pay good prices for the beaded jewelry she makes.

Contrastingly, Sambaa (and other Bantu) vendors are more adjusted to urban life and they are primarily town residents with their wives and children. They see their main responsibilities as being in town near their families and their existing and potential customers. They consider themselves too busy to continually return to their rural home.
villages to collect medicinal plants, although they do return occasionally usually for
family events or farming responsibilities.

**Collection:** The Maasai vendors are more likely to collect medicines themselves
because they return to their rural homes more often. They or their relatives collect plants
to be sold when they return to town. This trend was also noted in Arusha by Ibrahim and
Ibrahim (1998). Because the Sambaa vendors return to their rural villages less often, they
rely on their relatives and other harvesters to supply them with plants from home to sell
in town.

**Customers:** Although I never observed a Maasai customer consulting or buying
medicines from a Maasai vendor, I observed many Sambaa customers buy from Sambaa
vendors on a daily basis. Non-Maasai Bantu customers buy from Maasai because of their
reputations as skilled masters of plants. Sambaa buy from Sambaa because of their
common ethnicity and link to home in the Usambara Mountains which bonds them
together. An urban Sambaa does not forget the plants he grew up using in his home
village. Instead, he relies on his real or fictive *kaka* ‘brother,’ *mjombe* ‘uncle,’ or *babu*
‘grandfather’ in town to supply him with *fivi* (*Artemisia afra* Jacq. ex Willd. Asteraceae)
when he feels malaria coming on, or *ulenge* (*Senecio syringifolius* O. Hoffm. Asteraceae)
when his child’s skin breaks out in rashes. Interestingly, I also saw Maasai, especially
itinerant Maasai vendors, buying from Bantu vendors. If their supplies are depleted
before they are ready or able to afford the trip home, they buy medicines from other
vendors and re-sell to their own customers.

**Cultural identity:** Geographically, the Maasai are distributed over a much wider
area than the Sambaa. Maasai are found throughout Kenya and Tanzania, while Sambaa
are all from the Usambara Mountains (or their foothills) in Tanga Region only. Although I have been using “Maasai” as if it were one ethnic group, sub-groups of Maasai are distinct from each other based on language, colors of jewelry and clothing, and home territories. All Sambaa, however, are Sambaa from one area with one language.

6.3.1.2 Socioeconomic variation in vendors

The variation in vendors with their mode of vending, how they operate, and how they obtain plants is linked to socioeconomic status as shown in Table 6.4 below.
<table>
<thead>
<tr>
<th>Socioeconomic Status</th>
<th>Imported Medicine Shop</th>
<th>Market Stalls</th>
<th>Free-standing Kiosk</th>
<th>Table on Street</th>
<th>Tarp/Stool on Street/Mobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest</td>
<td>Owner/ Long term Renter from building owner</td>
<td>Daily Rent paid to municipal market</td>
<td>Rent paid to property owner for use of space</td>
<td>Rent paid to property owner for use of space</td>
<td>No rent paid</td>
</tr>
<tr>
<td>Middle</td>
<td>Owner/ Long term Renter from building owner</td>
<td>Daily Rent paid to municipal market</td>
<td>Rent paid to property owner for use of space</td>
<td>Rent paid to property owner for use of space</td>
<td>No rent paid</td>
</tr>
<tr>
<td>Mid-High</td>
<td>Owner/ Long term Renter from building owner</td>
<td>Daily Rent paid to municipal market</td>
<td>Rent paid to property owner for use of space</td>
<td>Rent paid to property owner for use of space</td>
<td>No rent paid</td>
</tr>
<tr>
<td>Mid-Low</td>
<td>Owner/ Long term Renter from building owner</td>
<td>Daily Rent paid to municipal market</td>
<td>Rent paid to property owner for use of space</td>
<td>Rent paid to property owner for use of space</td>
<td>No rent paid</td>
</tr>
<tr>
<td>Lowest</td>
<td>Owner/ Long term Renter from building owner</td>
<td>Daily Rent paid to municipal market</td>
<td>Rent paid to property owner for use of space</td>
<td>Rent paid to property owner for use of space</td>
<td>No rent paid</td>
</tr>
<tr>
<td>Regularity</td>
<td>Permanent</td>
<td>Very Regular</td>
<td>Fairly Regular</td>
<td>Less Regular</td>
<td>Irregular</td>
</tr>
<tr>
<td>Method of obtaining plants</td>
<td>Buys all</td>
<td>Buys most/all</td>
<td>Buys most/all</td>
<td>Harvests/supplied by others</td>
<td>Harvests/supplied by others</td>
</tr>
<tr>
<td>Variety and sources of medicines</td>
<td>Widest variety, mostly imported</td>
<td>Mid-range variety, most locally harvested</td>
<td>Mid-range variety, locally harvested</td>
<td>Mid-range variety, locally harvested</td>
<td>Smallest variety, locally harvested</td>
</tr>
<tr>
<td>Full-time Employees</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Assistants</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Example</td>
<td>Arabic/Indian Medicine Shops - men</td>
<td>Sambaa men</td>
<td>Sambaa young-mid age men</td>
<td>Sambaa older men</td>
<td>Maasai women</td>
</tr>
<tr>
<td>No. in Tanga Town</td>
<td>5</td>
<td>5</td>
<td>11</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>No. in all 3 Research Loci</td>
<td>5</td>
<td>12</td>
<td>11</td>
<td>7</td>
<td>16</td>
</tr>
</tbody>
</table>

Generally, the vendors with highest socioeconomic status are men who are established owners of their own shops (often with employees) who do not collect their own medicines, and sell imported medicines, and the vendors with lowest socioeconomic status are Maasai women who are irregularly stationed along roadsides with tarps or make-shift tables. While the socioeconomic status of a vendor or healer can also influence the perceived quality of medicine, a specialist who has low socioeconomic
status can be well-respected for their healing powers. Consumers with high socioeconomic status do not only purchase medicines from vendors with high socioeconomic status. From their car windows, wealthy urbanites purchase medicines from roadside vendors or healers in mud and thatch huts. Poor people with low socioeconomic status also purchase imported medicines from established shops.

Consumers' decisions to purchase medicines are based on the reputation of the vendor or healer, not on the quality of the plant medicine because the meaning imbued by the context in which the medicine is obtained is more important. Further, most consumers do not ask for know plant medicines by name and so there is little comparison of medicines from different vendors. Modern commercial packaging (bottled and labeled plant medicines) can also signal quality, but not always. Some people prefer traditional preparations for their purity and authenticity.

6.3.1.3 Specialist vendors: Waganga 'healers,' watilabu 'treaters,' watatifitj 'researchers,' watalaamu wa miti shamba 'medicinal plant specialists / herbalists'

In addition to the healers who I classified as healers because of their role (working from home apart from the commercial vending circuit), some vendors also consider themselves to be healers: all of these are Bantu, none is Maasai, and none is of Arabic or Indian ancestry. Even if urban vendors identify as waganga 'healers' (a very broad term), they usually do not identify as waganga wa jadi, a category that is reserved for those who inherited their powers and knowledge or were called by spirits who inform their healing practices. This is especially true in towns where resident and itinerant vendors call themselves watatifitj 'researchers,' daktari, 'doctors,' watalaamu wa miti shamba 'herbalists' and famasist wa mitishamba 'herbal pharmacists.' These self-
appointed titles reflect the various roles that these vendors see themselves playing. Many healers (who do not vend publicly) view commercial vendors as sell-outs who are personally profiting from knowledge given by God or ancestors to help others, or they view them as charlatans who sell plants without really knowing how to use them effectively. In semi-rural and rural areas nearer to source areas public vendors more often self-identify as waganga (healers) as they were healers in their villages previous to being vendors in the market. To contrast, Maasai, regardless of where they vend, never self-identify as waganga. (This is likely due to the word’s Bantu origins and connotation that are distinct from what Maasai call a laibon, as discussed previously.) In rural areas, vendors are often elderly men who are healers-turned-vendors who capitalize on their expertise as younger urban vendors create a demand for the medicines the older, rural healers can supply.

Compared to healers who work privately from home, those who make a business of healing as vendors are relatively disengaged from the cultural traditions and beliefs about healing. They put plant medicines in a more commercial context. Those vendors who identified not as healers but as watalam ‘specialists,’ watafiti ‘researchers,’ mtabibu ‘treaters,’ and famasista ‘pharmacists’ are more into the practice of entrepreneurial herbalism (not ancestor or spirit veneration). Still, even these “researchers” and “herbal pharmacists” who strive to set themselves apart from more traditional roles offer medicines for non-somatic problems like: attracting a spouse, improving business, bringing back a loved one, and protecting a house or a farm. Their roots are in the cultural traditions of plant medicine practice and these cannot be divorced completely from their current practices. People still demand these sorts of medicines, and they are
willing to meet that demand (although people are much more likely to visit a healer than a vendor for those medicines).

In most cases, vendors who do not self-identify as healers do not harvest according to cultural traditions. Most of them said there are no rules or taboos compared to most of the healers who said that there are pre- and proscriptions for harvesting. This will be discussed in more detail in Chapter Ten.

6.3.2 Imported medicine shops - maduka ya dawa za kiarabu

In Tanga, vendors with established permanent shops are a minority in terms of numbers. In terms of status, they are at the upper end of the socioeconomic array of vendors. In Tanga Town there are only a handful of these shops. Less urban areas do not have these specialty shops, but imported medicines are available through rural vendors who buy them in Tanga Town and resell them from their own kiosks or market stalls in rural areas. The shops in Tanga buy most of their supplies from similar, but larger shops with more selection and much more volume in the more urban Mombassa, Kenya.

The customers of these shops are usually healers or the patients of healers who are sent with a list of what to buy and bring to the healer so s/he can prepare the medicine for the appropriate healing ritual or for the patient to use at home. In Tanga Town, there are five specialty shops (as described) with a vast range of offerings, but general stores in rural or semi-urban areas typically offer only a small range of items that are used both as foods and medicines (spices). Although these imported medicine shops are few in number, they sell the widest variety of medicinal products compared to other vendors or to most healers. The most any one vendor of local medicines stocked was 60 plant
medicines, but these imported medicine shops stock more than 100 types of medicinal products.

Arabic/Indian medicinal products are an important part of local ethnomedical systems. Sixty-four percent of healers and vendors interviewed distribute or sell them. (Only 21 of 64 do not distribute them.) Of 23 healers, 21 (91%) use them on their patients in addition to also using locally harvested plant medicines. Of 35 vendors (who sell from markets, kiosk, or roadside), 15 (43%) sell them. In the 112 household interviews that were conducted in rural, and urban, poor and affluent, montane and coastal areas of Tanga region, Arabic/Indian medicines again emerged as an important theme in health care.

Table 6.5. Reported Household Use of Arabic/Indian and Chinese Medicines

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
<th>N</th>
<th>Arabic/Indian Medicines</th>
<th>Chinese Medicines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanga Town, Tanga (coastal)</td>
<td>Urban, affluent</td>
<td>10</td>
<td>60% (6)</td>
<td>20% (2)</td>
</tr>
<tr>
<td></td>
<td>Urban, upper class</td>
<td>12</td>
<td>83% (10)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Urban, mid to lower class</td>
<td>60</td>
<td>77% (46)</td>
<td>18% (11)</td>
</tr>
<tr>
<td>Mlalo, Lushoto (montane)</td>
<td>Rural, middle class*</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Rural, remote, very poor</td>
<td>15</td>
<td>80% (12)</td>
<td>0</td>
</tr>
</tbody>
</table>

* This is the only Christian area and they tend not to use "Arabic medicines" which are associated with the Qur’ān.

Obviously, these products are important to local ethnomedical systems. These specialty shops supply customers, healers, and vendors (who resell them). The market chain for these medicines is different because they are not harvested locally (save for very few exceptions). They are imported and sold from specialty shops in urban areas.
6.3.3 Hospital health workers

As a non-profit organization, TAWG is not a vendor of medicinal plants, but the way it functions and its place in the market chain is similar. TAWG has a large standing order of medicinal plants with Mohammed Kassomo, a healer who buys from a number of harvesters he has trained. He also oversees the processing, packaging, and delivery of the medicines to the hospital where TAWG is based. From there, TAWG distributes two month supply packages to their member clients. Although TAWG is unique in the medicinal plant market chain (no other NGOs distribute plant medicines in Tanga), they deal with huge volumes of material and their infrastructure allows them to distribute it to a much wider base than any one vendor. The demand for these medicines has grown steadily over the years, even since antiretroviral therapies (ARTs) have become available. Since 2005, the government has been providing ARVs (for free or at a reduced-cost) to people with a viral load of 200 or less, but not to all HIV positive people. For ineligible people and for those who are eligible but prefer not to use ARVs, TAWG provides them with plant medicines.

Aside from TAWG, there are other examples of hospital health workers in Tanga distributing plant medicines. In Mlalo (Lushoto District), locally harvested and processed plant medicines were also distributed by hospital health workers to a small number of people living with HIV/AIDS for about six months (late 2003-early 2004), but the program was not sustained due to funding (Personal communication, Dr. Theresea Mauya, Mlalo Hospital Clinical Officer & HIV/AIDS Coordinator August 3, 2006). Throughout Tanzania, including Tanga, “Genesis” is another example. Genesis is a commercial medicine made from dried and ground plants harvested and packaged in
Tanzania (produced by a joint venture between a Tanzanian and a Dane) which is advertised as "100% natural herbs" that treat immune system, hypertension, diabetes, and rheumatism among other problems (www.genesisnvp.com). It is sold only through doctors’ offices and cannot be purchased at local pharmacies or kiosks.

6.4 Healers

Healers’ socioeconomic status ranges from very high to very low. Some healers own cars and homes, make frequent business trips abroad to treat patients, and have mobile phones. Others live in meager settings, rent rooms in mud and thatch structures, and rely on farming for their daily needs. Male healers are more abundant than females (not including traditional birth attendants). In the case of women, the healing profession can provide a way to gain status and power, especially for women who become known for their connections to the spirit world; however male healers are not necessarily afforded more status than other males who are not healers.

Most healers involved in this research identify as either Sambaa or Zigua. They distribute medicinal plants from less public areas such as their homes and traditional clinics. In terms of healer type, Tanga healers are a heterogeneous lot. Participating healers identified the following overlapping categories and typically identified with more than one category:

- **Mganga wa jadi**: healer who inherits powers from a family member
- **Mganga wa asili**: traditional healer
- **Mganga wa majini**: healer who uses ancestral and other spirits
- **Mganga wa vitabu**: healer who uses the Qur’an
- **Mganga wa miti shamba**: herbalist
- **Mganga wa mashetani**: healer who treats evil spirits / bewitchment
- **Mkunga wa asili**: traditional birth attendant
Healers also specialize. For example, some identified their specializations in treating children, diabetes, stroke, HIV related illnesses, problems caused by spirits or ancestors (requiring veneration), astrological alignment, and attracting love, luck, or success.

Healers are not only frequented by the majority of the population (51% of households in this survey), they are also commonplace members of society as kin, neighbors, and friends. Of the 112 households that were surveyed, 33% have traditional healers (of some kind) in their families while only 16% have biomedical health workers (e.g., physician, medical officer, dentist, lab technician) as relatives. The only area that reported not having any healers in their family is the only Christian area. Specialists in this Christian area who know medicinal plants and treat people are not likely to call themselves waganga 'healers,' because they associate the term with tunguri which are used in spirit healing and seen as conflicting with the Christian religion. A preferred term is mtalamu 'specialist.' The fact that no healers emerged in this area is also influenced by the small sample size.

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Healer in family</th>
<th>Health worker in family</th>
<th>Ever visited healer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Montane Village</td>
<td>15</td>
<td>60% (9)</td>
<td>0</td>
<td>60% (9)</td>
</tr>
<tr>
<td>Montane Town*</td>
<td>15</td>
<td>0</td>
<td>20% (3)</td>
<td>20% (3)</td>
</tr>
<tr>
<td>Coastal Urban Low-Mid Class Area</td>
<td>60</td>
<td>30% (20)</td>
<td>15% (9)</td>
<td>52% (31)</td>
</tr>
<tr>
<td>Coastal Urban High-Mid Class Area</td>
<td>12</td>
<td>25% (4)</td>
<td>17% (2)</td>
<td>75% (8)</td>
</tr>
<tr>
<td>Coastal Urban Affluent Area</td>
<td>10</td>
<td>40% (4)</td>
<td>40% (4)</td>
<td>60% (6)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>112</td>
<td>33% (37)</td>
<td>16% (18)</td>
<td>51% (57)</td>
</tr>
</tbody>
</table>

*Christian area
Although there is overlap between the medicines distributed by healers and by vendors, healers fill a unique niche. Even vendors who are also healers cannot treat all things from their kiosk or from the public market space. When the customer’s problem is determined to be spirit- or ancestor-related, rituals must be followed and plant medicines used out of their traditional or ritual context are not appropriate. These rituals are done in private spaces, not in market places.

Going to a healer at some point in your life, whether it was decades ago as a child, last week when you ached with malaria, or last year before your court case, is common and is not limited to specific ethnic, social, or economic groups. Research participants who reported never visiting a healer cited the following reasons: expenses (some healers have a reputation for asking for chickens or goats as payments which are expensive),
differences of *imani* ‘faith/ belief/ conviction,’ (i.e., no belief in healers’ powers to affect the world through spirits), or the belief that healers deal with supernatural only and do not know plants well. One rural Sambaa man explained that he has never been to a healer because, *waganga wa tunguri wanataka hela, hawajui miti zaidi. Hao ni wahuni, hawana dawa maolum.* ‘Healers who use *tunguri* just want money. They don’t know many trees. They are hoodlums. They don’t have any special medicines.’ He continued by talking about his neighbor who is a healer that uses *tunguri* and had worked for years in Nairobi where he became rich but had returned home because he was very sick with a stroke. 

*Ameambiwa asirudi Nairobi, kwa sababu alikuwa mdangalifu. Sasa analipa kwa makasa yake. Mungu amechukua nguvu yake.* ‘He [neighbor] was told not to return to Nairobi because he was a trickster, now he’s paying for his mistakes. God has taken away his strength.’

6.5 Harvesters

6.5.1 Reasons for harvesting

Since most harvesters are primarily subsistence farmers, the farming calendar strongly influences the frequency for and amounts of medicinal plants harvested. In the West Usambara Mountains, there is less farming activity from June to September so harvesters can collect and prepare (dry and pound) more medicines, as long as it is not during Ramadan. On the other hand, many Sambaa diversify their farm locations and also tend farms in the dry lowlands at the base of the mountains, away from their villages. In those areas June to September are busy for planting and harvesting, so harvesters with farms there would also be occupied. Because harvesters prioritize farming, and
typically rely on harvesting to supplement household incomes, some said that when they have enough, they harvest less. When they have pressing needs, they harvest more.

Weather also affects the pattern of work for harvesters. During rainy season, it becomes challenging to dry roots and bark. If roots and barks are not dried immediately they can rot or mold (at worst), or are much more difficult to pound and grind (at best). These patterns of harvest are unique to commercial harvesters, as healers and consumers typically harvest when they have an immediate need for a plant.

While the trend for untrained, unskilled (or perhaps indifferent) commercial gatherers to mine large amounts of plant material is not foreign in Tanga, it is not the only mode of collection I observed. Some healers and vendors have trained their harvesters, and some healers also collect for vendors. These harvesters pride themselves on being distinct from untrained, indifferent gatherers. Further, most commercial harvesters take personal pride in their culturally-based and family-specific knowledge of medicinal plants (which seems to carry more prestige than knowledge about other mundane forest products such as green vegetables, fruits, or fuel wood). These harvesters can become locally valued as specialists by their neighbors. Still, they and their practices are distinct from those who self-identify as healers and acknowledge masharti ‘rules’ and miiko ‘taboos’ for harvesting medicinal plants. Those details will be discussed in the context of local ecological knowledge, beliefs, and behaviors (Chapter Ten).

6.5.2 Seven case studies of how people became commercial harvesters¹

1) Asha was the first member of the team of women harvesters. She was initially recruited by Mzee Ally (a healer/vendor) years ago when she was a young woman. Mzee

¹ All harvesters’ names are pseudonyms.
Ally knew her father who is also a healer and he knew that she lived next to the forest. He was confident that she knew the plants he needed and so he began placing orders with her. He died about seven years ago, but since then his nephew and sons have their own kiosks in Tanga town and they rely on this woman and her team for Usambara forest medicines.

2) Ali is a Zigua man from Handeni District who married a Bondei woman and moved to her home district, Muheza. His father was a healer, strictly an herbalist, not one that used *tunguri* and he learned all about plants from him. Ali used to collect, prepare, and sell *sandal* ‘sandalwood’ (also known as African sandalwood or false sandalwood, *Osyris lanceolata* Hochst. & Steud. Santalaceae) powder door to door in Arabic neighborhoods in Tanga Town. Women use the fragrant powder for cosmetic purposes. Sandalwood increasingly became difficult to find (it is overharvested for export to cosmetic industries) and so when one of the medicinal plant vendors solicited him, he agreed. Ali now regularly harvests plant medicines from the lowlands and coastal area for at least five Sambaa and Maasai vendors. Although he has never been to the Usambara Mountains or harvested any of those montane species, he can identify the prepared medicines by name because he has come to know them by their appearance and smell.

3) Kewa is a Mpangwa (an ethnic group from the Iringa Region of Tanzania), but he was born in Tanga Region and has lived most of his life there. He is a young entrepreneur who has a business making and selling charcoal. In Tanga Town he sells his charcoal around the corner from a busy healer’s clinic. Knowing that Kewa spends a lot of time in the bush as he is waiting for the wood to slowly burn into charcoal (up to two weeks) this healer solicited him to begin collecting medicinal plants. Although Kewa had
no training in plant medicines, the healer is training him to identify them but often has to solicit the assistance of local villagers when he is in the bush to help him find and identify the right trees.

4) **Raji**, a Ngoni (from Ruvuma Region of Tanzania) was born in Tanga Region and lives in a village near the coast about an hour’s bike ride away from Tanga Town. He first met Mohammed Kassomo the healer about eight years ago when he came to Raji’s village to look for young men to help him with his work. Kassomo had been harvesting medicinal trees in the areas around Raji’s village, but knew the orders were too large for him to do all the harvesting himself and still be able to see patients and continue with his own research. Raji helped recruit a team of about 10 other young men from his village. They regularly harvest four different species of plants for Kassomo that he supplies to TAWG.

5) **Ann** is a Maasai, originally from the plains of Lushoto District that became the Mkomazi Game Reserve. She and her family were forced to relocate and now live in an area that is ecologically and culturally distinct from her previous home. Her life has been difficult since they were moved. Many of her livestock have died and so has her husband. She and her daughters and their children now live in a dry coastal area where their herds of cattle and sheep struggle to survive. To help support her family, Anna began collecting medicinal plants around the area where she lives and selling them in Tanga Town, about two hours south by car.

6) **Juma** is a Sambaa, who has lived his whole life (about 75 years) in a village that borders an Usambara forest reserve. He began harvesting plant medicines and bringing them to the vendors at the market to sell about fifty years ago. His father taught
him about medicinal plants, but he was not a healer and neither is Juma. Like many
people in the village, their knowledge of medicinal plants is extensive. He is a
subsistence farmer and used to have farms in the lowlands and on the mountain. He used
to harvest plant medicines from both areas near his farms. Now, he is too old to continue
farming in the lowlands, so he only occasionally harvests ubombo (*Mondia whitei*)
which is always in demand. The women in the village carry it to the market (2 hours
away) for him and return his earnings. In the beginning, Juma remembers there were
only two old men selling medicinal plants in the market, but has seen this grow to about
eight vendors, and he has even noticed some people come from Tanga Town to buy
medicines from them. He believes there are more people selling now than in the past
because *utaalum umeongozeka. Zamani walikuwa wanaleta mizizi, tu. Lakini sasa wana
fundu* ‘expertise/professionalism has advanced. Years ago they just brought roots, but
now they pound them [into powder].’ He says there are more harvesters that bring
medicines to the market to sell now than in the past because *hali imekuwa mbaya sana
 *[living/ cost of living] conditions have become very difficult*.

7) Salehe is a Sambaa who was born in 1952 and raised in Lushoto District. His
great grandfather, grandfather, and father were healers. As he was growing up, he learned
about plants and their uses from them. In the early 1970s two of his relatives who are
medicinal plants specialists moved to Tanga town. They now sell medicines and other
items in Tanga’s main market in Ngamiani. Since Tanga is far from the source of their
plant medicines, they recruited Salehe to harvest and deliver plants to them in Tanga
town. In 1973, he began supplying them and they soon familiarized him with other
vendors in Tanga town who began purchasing from him.

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Initially, many of the vendors he supplied were Sambaa or people he knew from his village. As he became well known, other vendors (Zigua and Maasai) also began to order from him. He supplied about five vendors once or twice a month. In 2002, he saw the opportunity to make a better profit by vending, so he opened a kiosk in town and passed on the collecting responsibility to his younger brother. One of the vendors he supplied (a neighbor from home) provided him with a photocopy of his own typed list of the disease he treats so that Salehe could post it in his new business. About three years later, Salehe began training his older uncle who needed a job. Two years later, Salehe felt his uncle had learned the trade as a vendor, and so he left that kiosk for him to run on his own and opened up another kiosk across from a busy market and mosque in a different part of town. Salehe sells to his own customers but he also supplies itinerant Maasai vendors who need to restock their medicines and do not want to travel back home to do it before they continue on to the next town to sell their medicines.

6.6 How Cultivation Varies by Role

Although commercial medicinal plants are wild harvested and not cultivated, other medicinal plants are cultivated for immediate use at home and at healers’ clinics. People often referred to these as huduma za kwanza ‘first aid.’ These are primarily smaller, fast growing, herbaceous species that also include exotic introductions, and not slow growing, native trees that populate medicinal plant vendors’ stocks. Harvesters do not cultivate the plants they harvest to sell because they grow too slowly. One harvester asked rhetorically, “Why should I plant something that maybe my grandchildren will benefit from? I need money now.”
In semi-structured interviews healers, vendors, harvesters, and consumers were asked if they had ever planted medicinal plants and if so, which ones. These are distinct from popular commercial species. There was no overlap at all. Popular cultivated examples from healers include: *Kivumbasa* /* mzumbasha* (*Ocimum basilicum* O. Laminaceae), *Eza* (*Solanecio angulatus* (Vahl) C. Jeffery Asteraceae), and *kirihan* (*Ocium spp* Laminaceae). Popular examples from consumers in household surveys (n=112) include: *Mzugwa* (*Solenostemon rotundifolius* (Poir.) J.K. Morton Lamiaceae and/or *Plectranthus longipes* vel. sp. aff. Baker Lamiaceae), *Mshashu* (*Conyza pyrrhopappa* subsp. *oblongifolia* (O.Hoffm.) Wild or *C. pyrrhopappa* Sch. Bip. Ex A. Rich Asteraceae), *Eza / Leza* (*S. angulatus* Asteraceae); *Mwarobaini* ‘plant with forty uses’ (*Azadirachta indica* A. Juss. Melliaceae); *Mbono / mnyonyo* ‘castor bean’ (*Ricinus communis* L. Euphorbiaceae). There was a great diversity in responses with only a handful of species that were commonly mentioned by multiple households, as shown in Table 6.7. Twenty-two additional ethnospecies were mentioned by only one household.

<table>
<thead>
<tr>
<th>Swahili Name</th>
<th>Botanical Name</th>
<th>Households</th>
<th>No. (%)</th>
<th>Areas that named it</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mzugwa</em></td>
<td><em>Plectranthus longipes</em></td>
<td>26 (23%)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><em>Mzumbasha</em></td>
<td><em>Ocimum gratissimum</em></td>
<td>18 (16%)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Senna siamea</em> (Lam.) H.S.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Mjohoro</em></td>
<td>Irwin &amp; Barneby Fabaceae</td>
<td>20 (18%)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><em>Mwarobaini</em></td>
<td><em>Azadirachta indica</em></td>
<td>15 (14%)</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

### 6.7 Conclusion

Vendors, healers, and harvesters are the primary roles that direct the flow of medicinal plants to consumers. Although most other researchers have treated these as distinct categories, my research reveals the overlap among categories and the
heterogeneity within them. (This will be explored further in Chapters Nine and Ten.)

People in the medicinal plant market chain are connected to each other by virtue of their business relationships but also because they are relatives or neighbors from “back home.”

The heterogeneity within each role type which influences the flow of medicinal plants from their source to their consumers. The types of medicinal plants important to commercial and domestic arenas differ, a topic that will be explored further in subsequent chapters.
CHAPTER 7. KEY SPECIES IN MEDICINAL PLANT PATHWAYS

7.1 Introduction

Designated priorities for research, conservation, and management should include species of local importance (i.e., due to their ethnomedical, cultural, or economic value) that are also important from a conservation perspective (i.e., due to their uniqueness, ecological role, or threatened status). This chapter describes key species in Tanga and the methods I used to identify them.

The objectives of this chapter are to identify and discuss: 1) Which species are most often traded and most in demand? 2) How confident can we be about the designation of key species identified in the research? 3) Are any of these species at risk of overharvest or currently overharvested? 4) What is their conservation status? 5) What is the relationship between locally valued and internationally valued species?

7.2 Identifying Conservation Priorities for Medicinal Plants in the Trade

Experts in medicinal and aromatic plant research assert that species most susceptible to overharvest are habitat specific, slow growing, and destructively harvested for their bark, roots or the whole plant (Schippman, et al. 2002:8). The International Union for the Conservation of Nature Medicinal Plant Specialists Group developed guidelines that focus on these and other criteria for identifying commercial species that suffer most from harvesting so appropriate conservation measures can be taken. In 1997, they published the “Top 50 Listing” which described guidelines to identify medicinal plant species to focus on for conservation by focusing on biological and socioeconomic factors to consider both international and local perspectives (Cunningham 1997). These
were refined in 2001 (Cunningham 2001:89-90) and are summarized and adapted in Figure 11 according to how they were integrated into my research.

1. Identify species in commercial or highest demand
   Study the largest markets with the widest range of species then work upstream to source areas.

2. Prepare a short-list of species in trade which includes those that are:
   a) Most popular, most expensive, sold in greatest number and or volume
   b) Considered scarce or becoming scarce by market traders or commercial collectors
   c) Destructively harvested (based on plant part harvested)
   d) Slow growing (based on life-form)

3. Identify Species that may require special conservation effort
   e.g., ecological indicator species, keystone species, umbrella species, flagship species

4. Short-list priority traded species further on the basis of commonness or rarity
   Give preference to species with narrow distribution, restricted habitat, and small population sizes.

5. Set priorities on the basis of phylogenetic distinctiveness
   e.g., prioritize species in monotypic family, next in monotypic genus, etc.

6. Prioritize species according to IUCN categories of threat
   Refer to the IUCN Red List.

Figure 11. Six Steps to Identify Conservation Priorities for Medicinal Plants in Trade

Starting with vendors in Tanga Town, I became familiar with the plants and people they rely on for their trade. With the participation of vendors and harvesters, I traced the plants back to their source locations and collected them for botanical identification. The species in highest demand (guideline one) are defined in this research as those inventoried at a frequency of at least 25%. That is, at least seven of 28 vendors
stocked the species which I identify as those in highest demand. (The majority of participating vendors, 20 of 28, were in Tanga Town.)

In order to capture other plants in high demand that were not inventoried, I asked vendors about plants that were out of stock and in need of restocking. The list of out-of-stock plants overlaps with the most inventoried plants. These lists are compared with and supplemented by the plants vendors identified as most important (guideline two). Together these lists are compared and condensed into one list which represents the plants most important from an emic perspective. The overlap I found between plants nominated as popular, plants most often stocked by vendors, and plants nominated as scarce overlaps the quantitative findings from Williams's work in Johannesburg medicinal plant markets. She found that the more traders that sell a plant, the more likely they are to cite it as popular \((r_2=0.853)\) and, to a lesser extent, scarce \((r_2=0.539)\) \(2007b:18\).

This short list is further refined based on additional criteria for guideline two which can signal when plants are becoming scarce. These include: most expensive plants, plants that vendors say are no longer available at all, plants that are destructively harvested, plants that are slow growing. Sections 7.2-7.4 describe how I followed guidelines one and two; section 7.5 describes how I applied the remaining four guidelines to my research.

7.2.1 Ethnospecies vendors named as most important

In semi-structured interviews, vendors were asked to name the plants that are: most important to their work as defined by those that are most in demand and essential to be stocked. Twenty-three of 28 vendors named a total of 116 ethnospecies that met those
criteria. Four of the five vendors that did not name specific plants insisted that *all* plants they sell are the most important, and that they did not sell any that were not essential to stock or in high demand. The fifth vendor preferred to name the most important diseases plants treat, not the names of plants. For vendors who named specific plants (*n*=23), the average number of plants mentioned as most important was 8.0 ±14.0. One vendor named 71 ethnospecies, and he is considered an outlier. When he is removed, the total number of ethnospecies named is 50, with an average of 5.1 ± 2.9 for the 22 vendors who responded.

Of the 116 ethnospecies that were named as most important, there are relatively few (14) that are commonly regarded as such. (Here I determine “common” on the basis of being named by ≥11% (3) of the 28 vendors). In KwaZulu-Natal, South Africa, the proportion of plants that vendors commonly named as important was also relatively small compared to the total number of important plants they named. Of the 70 important species listed by 189 vendors, only eight were named by ≥10% (19) of the vendors (Mander 1998:67). These findings show that although there is a high degree of variability among vendors, plants commonly regarded as important are easy to differentiate from the total pool of plants named as important, which is useful distinction to be aware of in evaluating which plants are locally valuable.

The list of ethnospecies named as the most important by at least three (11%) of the 28 vendors appears on the left in Table 7.1 below. A list of the ethnospecies inventoried with 25% or more of vendors appears on the right. The same vendors participated in both exercises — listing and inventorining. Listing was always done first, and inventorining was done weeks or months later after rapport and trust were established.
7.2.2 Ethnospecies inventoried

I inventoried 251 total ethnospecies in the stocks of 28 vendors. The species in highest demand were identified through conducting complete inventories of the vendors' stocks and then ordering them by frequency of occurrence. Those that occurred with at least 25% of my sample of vendors are defined as those in highest demand. There are twenty, which comprise only a small proportion (8%) of all the ethnospecies inventoried, the majority of which occurred with only one vendor. Taxonomic information is included in Table 7.3.
Table 7.1. Comparing Most Important and Most Inventoried Ethnospecies with Vendors (n= 28)

<table>
<thead>
<tr>
<th>Vendors' Most Important Plants</th>
<th>Most Inventoried Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnospecies</td>
<td>No. who named it</td>
</tr>
<tr>
<td>Mshegeshe</td>
<td>10</td>
</tr>
<tr>
<td>Mjafar/Mlungulungu</td>
<td>8</td>
</tr>
<tr>
<td>Mtundwi</td>
<td>6</td>
</tr>
<tr>
<td>Mkwanga</td>
<td>6</td>
</tr>
<tr>
<td>Mfuleta / Mukutan</td>
<td>6</td>
</tr>
<tr>
<td>Fivi</td>
<td>5</td>
</tr>
<tr>
<td>Mbwakabwaka</td>
<td>5</td>
</tr>
<tr>
<td>Msangaze</td>
<td>5</td>
</tr>
<tr>
<td>Ulenge</td>
<td>4</td>
</tr>
<tr>
<td>Msogonoi</td>
<td>4</td>
</tr>
<tr>
<td>Mwinu</td>
<td>4</td>
</tr>
<tr>
<td>Mkulo</td>
<td>4</td>
</tr>
<tr>
<td>Mdongonyesi</td>
<td>3</td>
</tr>
<tr>
<td>Mchofu</td>
<td>3</td>
</tr>
<tr>
<td>Ubombo</td>
<td></td>
</tr>
<tr>
<td>Sagampa</td>
<td></td>
</tr>
<tr>
<td>Mdaa</td>
<td></td>
</tr>
<tr>
<td>Mkwamba</td>
<td></td>
</tr>
<tr>
<td>Msakwa nguku</td>
<td></td>
</tr>
</tbody>
</table>

Only one of the plants vendors identified as most important (mkwanga) was not also one of the most frequently inventoried. Although its name is similar to mkwamba, one of the most frequently inventoried ethnospecies, follow up interviews with vendors determined them to be different ethnospecies.

The number of ethnospecies stocked varies by the vendors’ ethnicity and mode of vending. Among 28 vendors, the fewest ethnospecies inventoried was five and the most inventoried was 60.
Most Bantu vendors have permanent or semi-permanent kiosks or market stalls where their medicines can be secured and stored at night, while most Maasai vend from small stools or tarps on the street which must be packed up and taken home at the end of each day. Due to their more mobile nature and less permanent vending stations, Maasai are able to stock only about one third of the number of ethnospecies stocked by Bantu groups (Sambaa, Zigua, Bondei, Digo, etc.). The median number of ethnospecies stocked by Maasai was 7.0 ± 2.5. For Sambaa vendors the median was 24.0 ± 14.5 and for Bantu groups other than Sambaa, the average was 30 ± 5.8. (This higher median for non-Sambaa Bantu vendors is due to one outlier who stocked 60 ethnospecies.)
Table 7.2. Median Number of Ethnospecies Inventoried - by Ethnic Group

<table>
<thead>
<tr>
<th>Vendor Ethnic Group (n=28)</th>
<th>Median. No. ethnospecies in stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maasai (n=7)</td>
<td>7.0 (±2.5)</td>
</tr>
<tr>
<td>Bantu (Sambaa &amp; non-Sambaa) (n=21)</td>
<td>23.0 (±14.2)</td>
</tr>
<tr>
<td>Sambaa (n=18)</td>
<td>24.0 (±14.5)</td>
</tr>
<tr>
<td>Non-Sambaa Bantu (n=3)</td>
<td>16.0 (±26.0)</td>
</tr>
<tr>
<td>All (n=28)</td>
<td>20.5 (±14.8)</td>
</tr>
<tr>
<td>All (n=27, outlier removed)</td>
<td>19.0 (±13.1)</td>
</tr>
</tbody>
</table>

7.2.3 Overlapping important and inventoried ethnospecies

Standard botanical collections were made for plants that were both designated as important by vendors and, based on their presence in the market, can also be considered commercially important (Table 7.3). These collections were identified at the NHT and MO to determine the botanical species names for the ethnospecies.

Table 7.3 Species that are both named as important and most in stock with Vendors (13 Ethnospecies / 15 Species)

<table>
<thead>
<tr>
<th>Ethnospecies</th>
<th>Botanical Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fivi</td>
<td><em>Artemisia afr</em> Jacq. ex Willd. Asteraceae</td>
</tr>
<tr>
<td>Mbwakabwaka</td>
<td><em>Deinbollia borbonica</em> Scheff. forma <em>subcordata</em> Verdc. &amp; <em>D. borbonica</em> Scheff. forma <em>glabra</em> Radlk. Sapindaceae</td>
</tr>
<tr>
<td>Mtambaa kuzimu</td>
<td><em>Uvaria acuminata</em> Oliv. Annonaceae</td>
</tr>
<tr>
<td>Mchofu</td>
<td><em>Todalia asiatica</em> (L.) Lam Rutaceae</td>
</tr>
<tr>
<td>Mdongonyesi</td>
<td><em>Albizia anthelmintica</em> Brongn. Fabaceae</td>
</tr>
<tr>
<td>Mfuleta</td>
<td><em>Zanthoxylum chalybeum</em> Engl. var. <em>chalybeum</em> Rutaceae</td>
</tr>
<tr>
<td>Mjafari</td>
<td><em>Ocotia usambarensis</em> Engl. Lauraceae</td>
</tr>
<tr>
<td>Mtangulungu Olufiuki</td>
<td><em>Cassia afrofistula</em> Brenan var. <em>afrofistula</em> &amp; <em>C. abbreviata</em> Oliv. Subsp <em>beareana</em> (Holmes) Brenan Fabaceae</td>
</tr>
<tr>
<td>Mkulo</td>
<td><em>Warburgia stuhlmannii</em> Engl. Canellaceae</td>
</tr>
<tr>
<td>Msangaze</td>
<td><em>Ximenia caffra</em> Sond. var. <em>natalensis</em> Sond. Olacaceae</td>
</tr>
<tr>
<td>Mshegeshe</td>
<td><em>Senna didymobotrya</em> (Fresen.) H.S. Irwin &amp; Barneby Fabaceae</td>
</tr>
<tr>
<td>Msogono</td>
<td><em>Senecto syringifolius</em> O.Hoffm. Asteraceae</td>
</tr>
</tbody>
</table>

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7.2.4 Out-of-stock ethnospecies

When asked about out-of-stock plants, 50% of vendors (14 of 28) reported either "nothing" or "lots" and found it pointless to name specific plants. The other 14 vendors named thirteen ethnospecies; five are also listed as most important and most inventoried (as in the table above); four were also inventoried; and four were new ethnospecies that had neither been inventoried nor named as important. These are in Table 7.4.

Vendors were also asked which species are no longer available at all or are becoming scarce. All vendors agreed that no species is completely unavailable, but they offered examples of trees that are "hard to get" on the basis of limitations on harvesting resulting from protected areas and government permits for commercial species, as well as overharvest due to competing uses. One example is *O. usambarensis*, a timber species that requires a government permit for felling. Although it is distributed throughout southern and eastern Africa, its populations in Tanga are primarily limited to forest reserves. Another example is *Osyris lanceolata* Hochst. & Steud Santalaceae, which is valued locally and abroad for its sandalwood fragrance and has been overharvested for the export cosmetics market. There was not a sense among vendors that any plants are becoming scarce due to their harvest for medicinal use. This contrasts starkly with a study from South Africa where 25% of medicinal plant vendors (n=44) nominated the same 15 ethnospecies as becoming scarce (Cunningham 1993a:22). This reflects a very different situation where medicinal plants are known to be overharvested and demonstrates how urban vendors can be acutely aware of population changes without being in the plants' habitats.
Table 7.4. Reported Out-of-Stock Ethnospecies

Out-of-Stock Ethnospecies Also Listed as Important and Inventoried

<table>
<thead>
<tr>
<th>Ethnospecies</th>
<th>Species</th>
<th>Vendors who cited it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mkulo</td>
<td><em>Ocotea usambarensis</em> Engl. Lauraceae</td>
<td>6 (21%)</td>
</tr>
<tr>
<td></td>
<td><em>Morella salicifolia</em> A. Rich. subsp. kilimandscharica</td>
<td></td>
</tr>
<tr>
<td>Mshegeshe</td>
<td>Engl. Myricaceae</td>
<td>5 (18%)</td>
</tr>
<tr>
<td></td>
<td><em>Cassia afrofistula</em> Brenan var. <em>afrofistula</em> &amp; <em>C. abbreviata</em> Oliv. Subsp beareana* (Holmes) Brenan</td>
<td></td>
</tr>
<tr>
<td>Msangaze</td>
<td>Fabaceae</td>
<td>2 (7%)</td>
</tr>
<tr>
<td></td>
<td><em>Zanthoxylum chalybeum</em> Engl. var. <em>chalybeum</em></td>
<td></td>
</tr>
<tr>
<td>Mlungulungu</td>
<td>Rutaceae</td>
<td>2 (7%)</td>
</tr>
<tr>
<td></td>
<td><em>Vepris uguensis</em> Engl. Rutaceae (may be multiple species) This was only inventoried once and named as most important once.</td>
<td></td>
</tr>
<tr>
<td>Msakwa nguku</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Out-of-Stock and also Inventoried

<table>
<thead>
<tr>
<th>Ethnospecies</th>
<th>Species</th>
<th>Vendors who cited it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gugufa</td>
<td><em>Piper capense</em> L.f. var. capense Piperaeae</td>
<td>2 (7%)</td>
</tr>
<tr>
<td>Mdaula</td>
<td>?</td>
<td>4 (14%)</td>
</tr>
<tr>
<td>Ubombo</td>
<td><em>Mondia whitei</em> (Hook f.) Skeels Asclepiadaceae</td>
<td>3 (11%)</td>
</tr>
<tr>
<td>Msasa mbege</td>
<td><em>Crossopteryx febrifuga</em> (G. Don) Benth Rubiaceae</td>
<td>2 (7%)</td>
</tr>
</tbody>
</table>

Out-of-Stock, Not Listed as Important or Inventoried

<table>
<thead>
<tr>
<th>Ethnospecies</th>
<th>Species</th>
<th>Vendors who cited it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgolmazi</td>
<td>?</td>
<td>2 (7%)</td>
</tr>
<tr>
<td>Mlawa</td>
<td><em>Croton polytrichus</em> Pax Euphorbiaceae</td>
<td>2 (7%)</td>
</tr>
<tr>
<td>Zia/Kinywenywe</td>
<td>?</td>
<td>2 (7%)</td>
</tr>
<tr>
<td>Momboa</td>
<td>? (not inventoried or named as most important)</td>
<td>2 (7%)</td>
</tr>
</tbody>
</table>

Only four ethnospecies that were reported to be out-of-stock were novel (i.e., not previously been mentioned as important or inventoried), and they were only named by two vendors each. Had any previously unmentioned or not inventoried ethnospecies been mentioned as out-of-stock by a significant number of vendors, they would have been further investigated. Since there was no compelling evidence that any important ethnospecies (per the criteria stated) had been missed, we continue with the combined list of species that were listed both as important and inventoried with 25% of the vendors (Table 7.3). From now on, this list will subsequently be referred to as the “short list.”
7.3 Describing Vendors' Stocks

7.3.1 Species richness

Species richness is a measure of the total number of species in a sampled location. In this case it is the total number of ethnospecies inventoried among the Tanga vendors' stocks. The numerical ethnospecies richness among 28 vendors is 251 ethnospecies, which is considered to be high richness. This high richness is represented by many ethnospecies that were inventoried with only one vendor, also known as singletons.

I estimate the degree of overlap in ethnospecies (i.e., same botanical species with different local names) to be low at about 5%. I attribute this low percentage to a number of factors. First, I spent eighteen consecutive months in Tanga and during this time I regularly frequented markets and vendors and became familiar with the appearance of a range of commercial plant medicines. Through informal follow up visits and formal focus group meetings with vendors I investigated ethnospecies names when I suspected there to be overlap. In addition to discussions, I used voucher specimen and photographs of species in question to reconcile these differences. Second, the majority of vendors (64% or 18 of 28 vendors) whose stocks were inventoried are Sambaa. Of the remaining ten vendors who are not Sambaa, seven are Maasai. Although the plant names used by Sambaa and Maasai are different from each other, they are typically consistent within each group. Chapter Six has already established the close relationships among Sambaa and Maasai vendors. An artifact of these close relationships is that the ethnospecies names each group uses are consistent. Even though they come from different ethnic groups (Sambaa versus Maasai) and environments (mountains versus plains) as vendors, many of the Maasai and Sambaa know multiple names of the plants in common that they
both sell. Third, the Tanga Region itself is high in species richness with about 2,000 species (Davis, et al. 1994), which means that there are a large number of plants that can potentially be used medicinally and so it makes sense that there could be a high number of singletons that are actually distinct species and not just different ethnospecies.

I draw attention to the high proportion of singletons in the Tanga vendors’ stocks because it influences the analyses I used to evaluate sampling effort and because it distinguishes Tanga from other medicinal plant markets. Singletons comprise 58% (145) of the total number of ethnospecies inventoried whereas common ethnospecies (i.e., those stocked by 25% or more vendors) comprise only 8% (20) of the total number of inventoried ethnospecies. The average number of singletons among 28 vendors is 6.0 (median 5.5); however, this was strongly influenced by one vendor who represented more than 30% of total singletons with his 49 singletons. When he is removed from the pool of vendors the number of singletons decreases to 100 ethnospecies in the sample represented by 202 ethnospecies, which is still high at half of the total species cited. The average number of singletons for these 27 vendors is 3.3 (median remains 5.5). Because one vendor’s high number of singletons strongly influenced the interpretation of the data, he is considered an outlier.
Of the 251 ethnospecies, one was inventoried with 18 vendors and 145 ethnospecies were inventoried with only one vendor. This dramatic range in frequencies of inventoried ethnospecies, and high ethnospecies richness underscores the extreme heterogeneity of the medicinal plant market in Tanga described in earlier chapters. The uniqueness of Tanga vendors’ stocks is even more evident when compared with other markets.

### Table 7.5. Comparing Rare and Common Ethnospecies in Three Markets

<table>
<thead>
<tr>
<th>Sample</th>
<th>Tanga 28 Vendors</th>
<th>Tanga 27 Vendors</th>
<th>Faraday 100 Vendors</th>
<th>Paramaribo 46 Vendors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnospecies Richness</td>
<td>251</td>
<td>202</td>
<td>349</td>
<td>247 (species, not ethnospp.)</td>
</tr>
<tr>
<td>Singletons (%)</td>
<td>145 (58%)</td>
<td>100 (50%)</td>
<td>84 (24%)</td>
<td>63 (26%)</td>
</tr>
<tr>
<td>Doubletons (%)</td>
<td>28 (11%)</td>
<td>29 (14%)</td>
<td>43 (12%)</td>
<td>32 (13%)</td>
</tr>
<tr>
<td>“Common” (found with ≥ 25% vendors)</td>
<td>20 (8%)</td>
<td>20 (9%)</td>
<td>15 (4%)</td>
<td>12 (5%)</td>
</tr>
</tbody>
</table>

Tanga vendors also exhibit more variety in ethnicity and in modes of vending compared to Faraday where nearly all vendors are Zulu and most are women who work in formal
market stalls (Williams 2004:449), Paramaribo where most vendors are Maroon women who work in formal markets (van Andel, et al. 2007), and even compared to vendors in Tanzania’s capital, Dar es Salaam. A cursory viewing of the medicinal plant market in the Shimoni area of the sprawling Kariakoo Market (Dar es Salaam), revealed much more homogeneity among vendors’ stalls and stocks than seen in Tanga. (Outside of this market, Dar es Salaam vendors exhibit much heterogeneity.) Although no formal interviews or inventories were conducted (Dar es Salaam was not included in this research project), the centralized and standardized stalls of vendors (about 30) and the similarity in the appearance of the medicines sold are all much more homogeneous than the scattered, informal, varied systems of vendors in Tanga.

While Tanga vendors have a higher percentage of unique ethnospecies (singletons) compared to other markets, they also have a higher percentage of “common” ethnospecies. At the same time, Tanga vendors’ stocks exhibit less richness compared to both Faraday and Paramaribo. I attribute this to the smaller number of vendors in Tanga overall, and the less formal and developed nature of the Tanga market system. Another reason that Tanga has a lower richness than Faraday is because Tanga vendors sell local plants from within the Region while Faraday vendors’ medicines come from a much wider geographic area that extends beyond Johannesburg, and relies heavily on KwaZulu-Natal sources.

7.3.2 Significance of rare and common plants in the market

The significant proportion of singletons among Tanga vendors is important to consider in determining key species. Compared to singletons, commonly stocked
ethnospecies are likely harvested with greater intensity to meet market demands, which could mean they are at greater risk. In ecological studies, species that are rarely observed (e.g., singletons) are assumed to be scarce. Contrastingly, singletons in ethnobotanical market surveys often represent those with little commercial value (Williams, et al. 2007:2509) and their scarcity in the market cannot be equated with their scarcity in their source locations. These singletons are likely subjected to low harvesting pressure for the purpose of medicines (although competing uses may cause overharvest). Sometimes, the plant's negligible commercial value is by virtue of its sheer abundance and ease of access in the area leaving people no reason to purchase it. An example is mtura (Swahili) also known as ndulele (Maasai), which was inventoried with only one Maasai vendor. It is a commonly known medicinal plant among the general population throughout and beyond the Tanga Region. The species is *Solanum indicum* L. Solanaceae, which populates disturbed areas and is ubiquitous in Tanga.

In many cases, consumers have specific expectations for which plants or qualities of plants (texture, taste, color) they should be given by a vendor. In this way, unfamiliar medicines that do not meet consumer expectations may be less accepted and in less demand from vendors. This encourages common or familiar plants to be stocked among vendors. Contrastingly, healers’ medicines can meet consumers’ expectations through the meanings they imbibe in the context of their administration. Healers can (and do) use species that are both unfamiliar to their patients and that are common and known by all because the ritual context in which they are administered gives them meaning that meets patients’ expectations.
Perhaps these extremes in higher frequencies of singletons and common species among Tanga vendors are the result of the relatively small sample size, or perhaps they are also a reflection of the uniqueness of the market itself.

The same twenty ethnospecies (8% of all ethnospecies inventoried) were stocked by 25% or more of vendors in Tanga. The percentage of common species in Johannesburg was only 4% (Williams, personal communication July 27, 2007) and 5% in Paramaribo (van Andel, personal communication July 3, 2007) as shown in Table 7.5. Commonly sold plants in the Eastern Cape Province, South Africa also seem to be relatively few, as only one plant was common to six urban medicinal plant markets (Cocks, et al. 2004). These examples contrast with a Mexican market in Ozumba where the vast majority of 234 medicinal plants sold were common among vendors and only about ten (2%) of all plants sold were rare among vendors (Linares and Bye 2007).

Having an idea of the relative abundance of common and rare species in a particular market is relevant to planning research and sampling intensity as well as to developing a picture of how the market's social and biological features compare to other markets.

7.3.3 Evenness

Measures of evenness are based on the ratio of observed diversity to maximum possible diversity. A sample with low evenness will have high dominance of a few species. “When all species are equally abundant, an evenness index would be at a maximum (of 1.0) and decrease towards zero as the relative abundances of the species diverge away from evenness” (Ludwig and Reynolds 1998 cited in Williams et al 2005:2990). The E5 measures of evenness determined the sample exhibit high evenness
and low dominance due to the high number of singletons. The final value is 0.82 which means that evenness is high. This high value is strongly influenced by the high number of singletons in the market, all of which are represented by the same abundance of 1/28.

7.4 Quality Control of Data Collection and Interpretation

Critical evaluation of data collection and analyses enables the validation of findings and assesses their relevance both to the specific research setting and to a broader context. Is my sample of Tanga vendors and ethnospesies adequate? How does Tanga compare to other medicinal plant markets? These questions can be addressed by cross checking findings with other methods and by statistically evaluating the sample size of vendors and inventoried ethnospesies. These techniques strengthen our confidence about the short list of key species by demonstrating that there are not a large number of unaccounted for ethnospesies that I missed in my inventory.

My confidence in the quality of the data is strong because it is the product of long term ethnographic research (i.e., 16 months of focused field work which builds on approximately two years of related fieldwork in the same location), triangulation (cross checking with focus groups, repeat and in-depth interviews with a range of stakeholders, observation and participation in medicinal plant management related activities), and participatory research methods that involve stakeholders in feeding back, validating, and distributing findings.

In addition to adding rigor to the research, the statistical techniques also standardize the data and make it amenable to comparison. Comparing my findings to other medicinal plant markets contributes to our understanding of market trends more
generally. I continue to compare the stocks of Tanga vendors with those of a large well-studied medicinal plant market called Faraday in Johannesburg, South Africa (Williams, et al. 2005; Williams, et al. 2007) and with other markets where the data exists.

7.4.1 Evaluating sample size and comparing data

By the last 10 inventories of vendors’ stocks, I could identify bark and roots for sale and I could anticipate what vendors were going to say before asking. I understood the context of the market system because I had inventoried 70% of vendors. I believed that my sample was representative, but in order to present it objectively, and make my data amenable to comparison I used non-parametric statistics and diversity indices, which are especially useful to ethnobotanical research like mine where very little is known about the numbers and identity of the species sold.

When the distribution of a variable (in my case, the number of ethnospecies inventoried per vendor) is known, it is possible to use parametric statistics to make predictions about how, in repeated samples of equal size, this variable is distributed. In other words, it would have enabled me to estimate a minimum number of ethnospecies to inventory based on what is known about the average number of ethnospecies stocked by vendors. However, because no data exists on the parameters of the distribution of ethnospecies with Tanga vendors, I need to use nonparametric methods. These nonparametric measures assume independent identical sampling from an unknown distribution. Although they are less sensitive than parametric measures, nonparametric measures are robust and widely used in social and biological science research.
Begossi (1996) applied non-parametric measures, specifically Shannon-Wiener indices and rarefaction curves, to estimate richness and evenness, to enable the comparison different sets of ethnobotanical data, and to evaluate sampling effort. Following the techniques she used, and more closely following the way Williams calculated and applied them (Williams, et al. 2005; Williams, et al. 2007), I used EstimateS (Colwell 2001) to evaluate sampling effort. Vendors’ stocks were treated as plots, and the ethnospecies they sell were treated as species in those plots. Comparing the number of ethnospecies actually observed with the numbers that would be expected (based on a number of non-parametric estimators of standard error such as the rarefaction curve) indicates whether or not the sampling effort was adequate, and therefore tells us about the reliability of the short list of key species. I also examine vendors’ stocks of ethnospecies in terms of richness, evenness, and diversity, which are other ways to evaluate sampling effort. These measures also yield data that can objectively and quantitatively be compared to other studies that have calculated diversity. In my case, a list of inventoried ethnospecies that is the product of inadequate sampling would mean that it is likely that additional key species have not yet been identified and that sampling should continue in order to identify potential key species for the short list.

Because all these techniques to assess sampling effort estimate the number of species yet-to-be-collected based on a quantification of rarity, they are strongly influenced by singletons. Thus, the sample of 27 vendors without the outlier who had a disproportionate number of singletons will be the focus of the discussion because it will minimize the skewedness of the high percentage of singletons. Analyses were also conducted with the entire sample of 28 vendors but are not discussed in detail because
they skew the results. Due to greater singletons, the ethnospecies associated with the sample of 28 vendors are more rich and diverse and less even than the ethnospecies associated with the sample of 27 vendors.

7.4.2 Assessing sampling effort by comparing estimated species richness with species accumulation curves

Species accumulation curves plot the total number of species (inventoried ethnospecies) against sampling effort (vendors). The plotted curve approaches asymptote when, with each new sample, fewer and fewer new species are added to the total pool of accumulated species. When additional participants and the plants associated with them do not increase the curve, this is a sign that sampling is sufficient (Begossi 1996:286). A curve that achieves or closely approaches asymptote is interpreted as the result of adequate sampling.

Applying species accumulation curves to ethnobotanical data has proven to be a useful tool for evaluating sampling effort and comparing different sets or subsets of data (Begossi 1996; Hanazaki, et al. 2000; Williams, et al. 2005; Williams, et al. 2007). These can help us understand human-environment interactions by looking at how diverse human populations in different environments use botanical resources, which has implications for planning conservation as well.

Hanazaki and colleagues (2000) used diversity indices (the Simpson and Shannon–Wiener), evenness, and species accumulation curves to assess the plants free listed for different uses by two Caiçara communities. Samples were stratified, which enabled comparisons of plant knowledge and use categories based on gender and age. They found no differences in plant knowledge and uses between the two communities but
found significant differences in knowledge and habitat types for plants utilized by women and men, with women knowing more plants from disturbed, anthropogenic areas and men knowing more forest species from older successional and forested areas. They also found differences in knowledge of medicinal plants based on age, with younger people knowing more in one community and older people knowing more in the other community. They used richness and rarefaction curves to assess adequacy of sample sizes from the two communities and the sub-samples (based on age, gender, use categories) within communities. They also used diversity indices to compare plants from a range of habitats (from disturbed, anthropogenic to old growth forests) based on free lists. Rarefaction curves and Shannon-Wiener indices indicate that, based on respondents’ free lists of species for different plant uses (remedies, food, textiles) and their habitat types, they observed the highest diversity in well-preserved areas, followed by disturbed areas, and finally by old successional areas (Hanazaki, et al. 2006:905).

Williams and coauthors (2005) applied a number of diversity measures and species accumulation curves from inventories of medicinal plant shops (muti shops) and street traders and market vendors in Johannesburg, South Africa to better understand the mechanisms and patterns operating in plant use and trade. With these they constructed cumulative diversity curves to better understand the differences in the relative diversities of the samples. They used these to “evaluate the performance of the indices in relation to samples of different sizes, and trader profiles and to examine the kind of information they provide; make recommendations on measures appropriate for quantifying ethnobotanical data; assess whether the survey sites were adequately sampled, and determine the minimum viable sample size on which a diversity measure should be based for the type
of survey data collected; and lastly, to compare the species diversity of sites within the formal and informal sector, and thereby appraise plant availability within the ethnobotanical trade in the region" (Williams, et al. 2005:2972). In another paper they focus on these indices to evaluate the completeness of medicinal plant inventories as a way to evaluate sampling effort and draw conclusions based on the analyses of the findings from those samples (Williams, et al. 2007).

In addition to evaluating the species accumulation curve alone, sampling effort can also be assessed by comparing the observed species accumulation curve with estimators of species richness. Margalef's index of species richness is recommended for ethnobotanical data, but because it is sensitive to sample size (Williams, et al. 2005:2997) and my sample of 28 vendors is relatively small, I compare my observed species accumulation curve with the first and second order Jackknife, Michaelis-Menten Means, and Bootstrap estimators of species richness. These techniques estimate richness of a hypothetically larger sample by resampling the existing sample and, in the case of Jackknife, iteratively removing successive sampling entities and recalculating the desired statistic, or, in the case of bootstrapping, randomly sampling entities, with replacement after each drawing to generate "bootstrap" samples from which confidence intervals may be constructed based on the repeated recalculation of richness (McGarigal, et al. 2000).

Figure 15 shows the observed ethnospecies richness is 202. The high number of singletons (100) influences the prediction that there are more ethnospecies to be sampled, which is represented by the upward trend of the curves. "The more singletons there are in a sample, the more species are predicted to be present in the sampling 'universe' that remain to be captured during a survey" (Williams, et al. 2007:2508). The curves
continue to climb and have not yet approached asymptote. This indicates that sampling effort should be increased, but this should be considered along side the rates at which new ethnospecies are actually accumulating with each additional vendor and with the goals of the market survey.

![Graph showing ethnospecies richness for 27 vendors](image)

Obs=Observed; Jack1=1st Order Jackknife; Jack2=2nd Order Jackknife; MMMeans= Michaelis-Menten Means; Bootstrap=Bootstrap. The final values appear in parentheses after each curve.

**Figure 15. Observed & Estimated Ethnospecies Richness for 27 Vendors**

By sample 27, the rate of new ethnospecies accumulation is 3.7 per each additional vendor. This is derived by subtracting the species observed by the 26th vendor (197.3) from the sample of 202 observed by the 27th vendor in the sample of 27 vendors. (The rate of new species accumulation for the sample of 28 vendors is 5.18.)
reconnaissance survey of vendors documented only twelve regular vendors I did not inventory (seven in Tanga town, and five in Muheza and Mlalo areas). This means I inventoried 28 of an estimated 40 vendors or 70% sampling intensity. With the addition of 12 vendors it is predicted that 62.16 new ethnospecies may be inventoried, based on the higher rate of new species accumulation for the sample of 28 vendors. Based on data from the sample of 27 vendors, which omits the outlier, 44.4 new ethnospecies are predicted to be inventoried. Based on my ethnography of the area, I think these are a high estimates. Most of the vendors I did not inventory are Sambaa whose kiosks and stands are spin-offs from the stands of their more established relatives who were inventoried. Their knowledge and means of obtaining plants, and the plants they stock overlap considerably.

First Order Jackknife and Michaelis-Menten Means seem to be the best predictors of species richness. Bootstrap predicts an ethnospecies richness of 243 for the 27 vendors, which is less than the 251 I observed with the sample of 28 vendors, so it can be discounted. Second Order Jackknife’s estimate is unlikely, too (at 365) because even if I was able to do a total census of all vendors in Tanga, it’s not likely I would have found over 110 new ethnospecies). In evaluating these estimators of species richness for medicinal plant vendors in South Africa, Williams and coauthors found the first order Jackknife to be the best estimator of species richness (2007:2501), and this appears to be true here as well.

Realistically, the number of ethnospecies that can potentially be inventoried in Tanga medicinal plant markets is much greater that the total number of known species in the Tanga Region. This is because there are multiple ethnospecies names for the same
species due to multiple language groups and areas of specialization of the vendors, and because some species (albeit very few based on my research) are brought from outside the Region. Still, these estimates give us a starting point for understanding how many ethnospecies (and thus, species) are traded. The estimates also enable us to evaluate sampling effort.

Although curves for the species richness estimators are not at asymptote, additional information helps evaluate sampling effort. Considering the time investment I required before reaching a point where I was comfortable requesting to inventory a vendor's stock, and considering the high occurrence of singletons (which are less relevant to conservation concerns where the focus is on commonly harvested and sold plants), it would not have been a wise use of time to inventory additional vendors' stocks.

7.4.3 Assessing sampling effort by comparing species accumulation curves with rarefaction curves

Comparisons of the observed species accumulation curves with the rarefaction curves can be used to assess the homogeneity of the samples, and by extension, sampling effort. Begossi (1996) used species accumulation and rarefaction curves to compare data on the use of plants among ten different populations in different environments ranging from Latin America, Asia-Pacific, and Europe. By comparing the number of informants plotted against the number of species named, she concluded that the low diversity of plants used in Tonga (compared to data from Peru, Mexico, and Brazil) reflects the low diversity of botanical species on the island nation and is not the result of incomplete sampling.
The rarefaction curve is the statistical expectation of a species accumulation curve. It plots the total number of individuals counted with repeated samplings against the total number of species found in those samplings. Each new vendor sampled increases the number of ethnospecies recorded. The more a species accumulation curve lies below the rarefaction curve, the more heterogeneous the samples are. In other words, the more the stocks of the vendors differ from each other, the more the observed species accumulation curve will lie below the rarefaction curve because the rarefaction curve will predict there are more species to be sampled. Because the order in which samples are incorporated into the data set determines the shape of the curve, the sample order was randomized 100 times (by EstimateS) in order to generate a smooth curve that represents the expected species richness for each sample accumulated. If the species accumulation curve (indicated in the graph below as Sobs, or Species Observed, with a solid blue line) and rarefaction curve (indicated by an orange line with diamonds) are approximately the same, as they are in my sample, this is interpreted as relatively homogeneous samples with little variation in the number of species per sample, and is an indicator of sampling sufficiency. The 95% confidence intervals are useful in evaluating whether different data sets exhibit significantly different species richness.

With the sample of 27 Tanga Vendors, 202 ethnospecies were observed in an accumulated pool of almost 600 individual citations and the curve begins to level off after about 400 citations (Figure 16). Asymptote is not reached, but the rate at which new ethnospecies are accumulating is decreasing as additional vendors’ stocks are inventoried, and the curves appear to be approaching asymptote, which are seen as an indicator of sufficient sampling. Williams’ Faraday data showed a similar trend.
"The estimate of species richness is always non-asymptotic; hence, the number of estimated species will increase as the number of individuals (N) increases" (Magurran 2004 cited in Williams, et al. 2007:2497).

**Figure 16. Rarefaction Curves (based on individual citations) for 27 Vendors**

According to the species accumulation curves and species richness estimators, the sampling effort seems adequate. Additional evaluation of sampling effort from evenness and diversity measures helps round out the evaluation.

**7.4.4 Assessing sampling effort by evaluating diversity indices**

Diversity measures take into account two factors: species richness (i.e., the number of species) and species evenness (i.e. how uniformly abundant species are in a
sample) and incorporates them into a single value. Examples are the Shannon-Wiener Index, Simpson's Index, and Fisher's Alpha.

7.4.4.1 Shannon-Wiener Index (Shannon $H'$)

This index measures the order observed within a particular system. In my system, the order is characterized by the number of individuals observed for each ethnospecies in a vendor's stock. Another way to state it is that the index measures the average degree of uncertainty in predicting the identity of species when individuals are chosen at random (Williams et al 2005). The higher the index, the higher the degree of uncertainty in predicting the next randomly chosen species (Williams et al 2005). As species richness increases, $H'$ usually does too. In the graph below, the curve is rapidly approaching asymptote, and $H'$ is not increasing intensely, so uncertainty is decreased and stabilizing. There is no to little increase in diversity with each new vendor after about the 20th vendor. This means that species diversity is not expected to increase much if additional vendors' stocks are sampled. The index of diversity is not decreasing and therefore, sampling can be considered adequate.

The Shannon index is 4.89 for the 27 vendors (Figure 17), and 5.1 for the 28 vendors (not shown here).
Figure 17. Shannon-Wiener Index of Diversity for Stocks of 27 Vendors

7.4.4.2 Simpson’s Index (Simpson’s λ)

Simpson’s index (also called Simpson’s λ) is inversely related to the probability that two individuals picked at random from the sample belong to the same species (Williams et al 2005). Lambda (λ) is usually expressed as a value between zero and one, with values closer to one representing a high probability that both individuals belong to the same species, in which case the diversity of the sample is low. Correspondingly, values closer to zero mean the diversity is high.

Figure 18 shows the final value (at 0.009) is far away from one which means the diversity is high. (Like the Shannon Index, this is also influenced by the high number of singletons.)
Figure 18. Simpson’s Index of Diversity

Since the value at 18 vendors is not different from the value at 27 vendors, this suggests a minimum sample size of about 20 vendors in order to capture the ethnospecies diversity of the Tanga vendors, but this needs to be compared with other measures to improve certainty. This number is an index, not a real measure, which means its real utility is that it can be compared with other samples.

7.4.4.3 Fisher’s Alpha (α)

Generated from a species abundance model, Fisher’s alpha (α) is a constant used to fit the log-series model, which has been judged as a good, if not the best, measure of species diversity (Williams et al 2005: 2989). “Alpha is low when the number of species is low, and therefore smaller samples have low values of α” (Williams et al 2005: 2989). Samples with higher alpha values have comparatively higher species diversity. The value
generated by this index is close to the number of species we expect to be represented by one individual citation, (i.e., singletons) (Williams et al 2005:2989).

![Fisher's Alpha Diversity Index](image)

**Figure 19. Fisher's Alpha Diversity Index**

The top of curve is off the chart, due to the strong influence of singletons in the initial curve. The part not pictured (which I adapted the chart for easier viewing because the numbers go to almost 19000) is unimportant. The final value (110.2) predicts the number of species represented by one individual (i.e., singletons), which is close to the observed 100 singletons for the sample of 27 vendors. At 20 vendors, the value is 109.4, which shows that as additional samples were added diversity did not increase substantially.
7.4.5 Assessing sampling effort

Three diversity indices, the Shannon-Wiener, Simpson’s Lambda, and Fisher’s Alpha, show that additional samples of vendors are not expected to increase diversity significantly. This is illustrated by the asymptotic curve in each of the three graphs for the indices. Comparing the observed species accumulation curve with estimations of species accumulation curves and the rarefaction curve also showed that the sample is approaching asymptote, which is another indicator of sampling adequacy. Based on my own survey of vendors in the area, I know there are only twelve vendors who had yet to be surveyed and many of them are relatives or are spin-off vendors from more established vendors who were inventoried. This strengthens my confidence that my short list captured the most popularly traded ethnospecies, which was the goal of the inventory.

To put things in perspective, Tanga region has almost 2,000 species, and my sample of 251 ethnospecies represents more than 10% of the flora. I think this is a reasonable expectation of the number of commercial medicinal plants in the region. Of course the actual number of species used medicinally is much higher, but not all are commercially traded. Finally, in weighing options of time investment and the acquisition of new data, I believe I sampled more vendors than were adequate to accomplish my goal for the survey which was to identify a short list of the most commonly traded and popular species based on local vendors’ appraisals and the apparency of plants in the market.

7.4.6 Comparing Tanga vendors with other vendors

Tanga vendors have a notably higher proportion of singletons than vendors in Johannesburg, South Africa and in Paramaribo, Suriname, which is a reflection of the
heterogeneous nature of market. Still Tanga and Faraday vendors' stocks exhibit a number of similarities. The patterns in ethnospecies richness are similar between Tanga and Faraday vendors. With the Faraday Vendors, 349 ethnospecies were observed in an accumulated pool of almost 2500 individual citations. The species accumulation curve begins to approach asymptote after about 250 ethnospecies and 1500 individual citations (Williams, et al. 2007:2501). With my data, 202 ethnospecies were observed in an accumulated pool of almost 600 individual citations and the curve begins to level off after about 400 citations.

In terms of diversity, Tanga is comparable to Faraday, but Faraday is more diverse. In Tanga the Shannon index is 4.89 for the 27 vendors, and 5.10 for the 28 vendors. For the Faraday traders it is 5.46 (Williams, et al. 2005:2984). The Simpson’s Lambda for the Faraday Street Traders is 0.0066 which is slightly more diverse than the Tanga sample of 28 at 0.0077. In the Faraday sample the Fishers alpha is 112, which approximates the diversity index for the relatively smaller sample of Tanga vendors at 110. Tanga and Faraday markets also share some important taxa including, Ocotea (O. bullata in Johannesburg and O. usambarensis in Tanga), Warburgia (W. salutaris in Faraday and W. stuhlmannii in Tanga), Zanthoxylum (unspecified species in Faraday, Z. chalybeum in Tanga), and Albizia (A. adianthifolia in Faraday and A. anthelmintica in Tanga). In both markets, bark and roots are the dominant plant parts sold.

7.5 Next Steps in Identifying Key Species

All of the commonly stocked ethnospecies (those that occurred with 25% or more of 28 vendors) were subsequently collected with commercial harvesters from source
locations and identified through standard botanical identification processes. Once species names were confirmed, I considered existing ecological and reproductive data on these species in conjunction with information I had collected on harvesting intensity (based on apparent value in the market) and local perceptions of these species' availability. In addition, associated local ecological knowledge and beliefs about these plants were assessed, and observations of actual harvesting and collection were considered in these assessments as they have the potential to affect management and harvest. These topics will be discussed in subsequent chapters, but I mention them now because the data they yielded are critical for better understanding and having confidence in the statistical findings. I do not recommend applying the statistical techniques without ethnographic detail to contextualize them.

7.5.1 Applying the “Six Steps to Identify Conservation Priorities for Medicinal Plants in the Trade” to my research

1. Identify species in commercial or highest demand
   These are species inventoried with at least 25% of the vendors.

2. Prepare a short-list of species in trade which includes those that are:
   a) most popular and/or most expensive; sold in greatest number and/or volume
   b) considered scarce or becoming scarce by market traders or commercial collectors
   c) destructively harvested (can be assessed based on plant part harvested)
   d) slow growing (separation on the basis of life-form is useful)

The list generated from guideline one was compared with the plants vendors identified as most important (guideline two). The “most expensive” criterion was not instructive in this case, as was described in Chapter Five. Together these lists are compared and condensed into one list which was compared with ethnospesies that were desired but out-of-stock with vendors. Since the out-of-stock list did not add new information to the condensed list of most inventoried and most in demand ethnospesies, it remained
unchanged. Although the list does not take into consideration the volumes of medicinal species in stock with vendors, the data on frequency of occurrence, local perceptions of importance and scarcity are sufficient to derive a short list that represents the plants most important from an emic perspective and even from an outsider conservation perspective. Based on her quantitative findings, Williams concluded that “species that have a high incidence in markets are more likely to be harvested and be present in larger quantities, and are consequently at greater risk of over-harvesting. Therefore, if data on the quantity of plants sold in a market is not collected during an ethnobotanical survey, then the frequency of species occurrences is a reasonable indicator of the relative quantities that would have been present and hence the relative risks” (Williams 2007b:12).

This short list is further refined taking into consideration harvesting and growth patterns. Plants that are destructively harvested and slow growing are identified by considering the part harvested and life form of the plant. The majority (78.6%) of the species in Table 7.6 are trees that are harvested for their bark and roots.

<table>
<thead>
<tr>
<th>Botanical Species</th>
<th>Part Harvested</th>
<th>Life Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artemisia afra</td>
<td>Vegetative</td>
<td>Perennial woody herb</td>
</tr>
<tr>
<td>Deinbollia borbonica</td>
<td>Root</td>
<td>Shrub/ Small tree</td>
</tr>
<tr>
<td>Uvaria acuminata</td>
<td>Root</td>
<td>Shrub / Small tree</td>
</tr>
<tr>
<td>Toddalia asiatica</td>
<td>Root</td>
<td>Climbing shrub</td>
</tr>
<tr>
<td>Albizia anthelmintica</td>
<td>Bark</td>
<td>Tree</td>
</tr>
<tr>
<td>Zanthoxylum chalybeum</td>
<td>Root, Bark</td>
<td>Tree</td>
</tr>
<tr>
<td>Ocotea usambarenisis</td>
<td>Bark</td>
<td>Tree</td>
</tr>
<tr>
<td>Cassia afrofistula &amp; C. abbreviata</td>
<td>Root</td>
<td>Shrub/ Small tree</td>
</tr>
<tr>
<td>Morella salicifolia</td>
<td>Bark, Root</td>
<td>Tree</td>
</tr>
<tr>
<td>Warburgia stuhlmannii</td>
<td>Bark</td>
<td>Tree</td>
</tr>
<tr>
<td>Ximenia caffra</td>
<td>Root</td>
<td>Shrub / Small tree</td>
</tr>
<tr>
<td>Senna didymobotrya</td>
<td>Leaves</td>
<td>Shrub</td>
</tr>
<tr>
<td>Senecio syringifolius</td>
<td>Vegetative</td>
<td>Perennial, climbing herb</td>
</tr>
</tbody>
</table>
Based on the criteria in guideline two, species that are less destructively harvested and less impacted by medicinal plant harvesting activities include *A. afra* and *S. syringifolius*. Both are perennial herbs whose vegetative part (coppice only not roots) is harvested. Since only the leaves of *S. didymobotrya* are harvested it is also considered less destructively harvested. Thus, the refined short list is as follows:

**Table 7.7. Refined Short List that Accounts for Plant Part Harvested and Life form**

<table>
<thead>
<tr>
<th>Botanical Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Deinbollia borbonica</em></td>
</tr>
<tr>
<td><em>Uvaria acuminata</em></td>
</tr>
<tr>
<td><em>Toddalia asiatica</em></td>
</tr>
<tr>
<td><em>Albizia anthelmintica</em></td>
</tr>
<tr>
<td><em>Zanthoxylum chalybeum</em></td>
</tr>
<tr>
<td><em>Ocotea usambarensis</em></td>
</tr>
<tr>
<td><em>Cassia afrofistula &amp; C. abbreviata</em></td>
</tr>
<tr>
<td><em>Morella salicifolia</em></td>
</tr>
<tr>
<td><em>Warburgia stuhlmannii</em></td>
</tr>
<tr>
<td><em>Ximenia caffra</em></td>
</tr>
</tbody>
</table>

3. **Identify Species that may require special conservation effort**
(e.g., ecological indicator species, keystone species, umbrella species, flagship species)

The literature does not identify any of these species as ecological indicator species, keystone species, or umbrella species. Although all of these species were locally identified as important, none of them were distinguished by the diverse study population as quintessentially important to the extent they can be considered flagship species (e.g., Hamilton 2004; Rare Species Conservatory Foundation 2007) or cultural keystone species (e.g., Cristancho and Vining 2004; Garibaldi and Turner 2004). Thus, no one species emerge as exceptional based on the criteria in this guideline. However, the idea of
medicinal plants as a class of cultural keystone species is worth considering, and this will
be discussed in Chapter Eleven.

4. Short-list priority traded species further on the basis of commonness or rarity
(Giving preference to species with narrow distribution, restricted habitat, and small
population sizes)

Rabinowitz and coauthors (1986) described seven forms of rarity, and Pitman and
coauthors (1999) built upon their work, asking three questions in determining rarity: 1)
Does the species have a large or small geographic range? 2) Is the species restricted to a
single habitat type, or is it found in several? and 3) Is the species locally abundant
anywhere or is it scarce everywhere? Three experts in East African Flora with
experience in Tanzania\footnote{They are: Henk Beentje, Editor, Flora of Tropical East Africa and Botanical editor, Systematics and Biodiversity Royal Botanic Gardens, Kew; Anthony B. Cunningham, Botanist and Director of People and Plants International; and Roy Gereau, Assistant Curator, Africa and Madagascar Department of the Missouri Botanic Garden and Director of Tanzania Botanical Research and Conservation Programme.} agreed to assess the commonness or rarity of each species on the
short list, based on those guidelines. Plants ranked one are of least concern and plants
ranked eight are of most concern.

**Key: 7 Forms of Rarity**
1 locally abundant, in several habitats, over a large geographic area
2 locally abundant, in a specific habitat, over a large geographic area
3 constantly sparse, in several habitats, over a large geographic area
4 constantly sparse, in a specific habitat, over a large geographic area
5 locally abundant, in several habitats, over a small geographic area
6 locally abundant, in a specific habitat, over a small geographic area
7 constantly sparse, in several habitats, over a small geographic area
8 constantly sparse, in a specific habitat, over a small geographic area
### Table 7.8. Ranking the Rarity of Short List Species

<table>
<thead>
<tr>
<th>Botanical Species</th>
<th>Expert A</th>
<th>Expert B</th>
<th>Expert C</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artemisia afra</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>Deinbollia borbonica</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Uvaria acuminata</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>Toddalia asiatica</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Albizia anthelmintica</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Zanthoxylum chalybeum</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1.7</td>
</tr>
<tr>
<td>Ocotea usambarensis</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Cassia afrofistula &amp; C. abbreviata</td>
<td>1 &amp; 1</td>
<td>1 &amp; 2</td>
<td>1 &amp; 2</td>
<td>1 &amp; 1.7</td>
</tr>
<tr>
<td>Morella salicifolia</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>Warburgia stuhlmannii</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>7.3</td>
</tr>
<tr>
<td>Ximenia caffra</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>Senna didymobotrya</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Senecio syringifolius</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Only *W. stuhlmannii* was identified as a species of concern that is constantly sparse over a small geographic area. The other species are of little concern from a conservation perspective because their populations are widely distributed and or abundant. This does not take into account local extinction or scarcity, which will be discussed below.

5. Set priorities on the basis of phylogenetic distinctiveness (e.g., prioritizing species in monotypic family, next in monotypic genus, etc.)

*Warburgia* is a small genus with only four species (or three, depending on the authority) and two subspecies. *W. stuhlmannii* is the only phylogenetically distinct species listed.

6. Prioritize species according to IUCN categories of threat

*W. stuhlmannii* is currently listed as vulnerable (IUCN 2006), and is proposed as endangered by the East Africa Plant Red Listing Authority (Roy Gereau, personal communication July 7, 2007). No other species from the short list are on the IUCN Red List.
7.5.2 The Relationship between Local and International Priorities

Priority species can be set on various scales based on a range of perspectives from local to international. These do not always overlap. Although *W. stuhlmannii* is a conservation priority from an international perspective, it alone is not likely to motivate a larger conservation effort locally because it is not widely known, regarded as scarce, or distinguished in terms of its cultural value. Because it is only found in small, fragmented coastal forest remnants, it is not known by many individuals from ethnic groups that make their home in other habitats. It is primarily known by Maasai. Bantu participants involved in the medicinal plant trade know *Warburgia* spp. as one of the Maasai’s most important human and veterinary medicines. It is not a Bantu “traditional” medicine; they did not use it “back home;” and it is not rooted in their culture (through songs, stories, or pre- or proscriptions related to its harvest). For them, its value is commercial—both as a medicine and as a fuel wood. (One Swahili name for the species is *mkaa* ‘charcoal.’) Still, even as the group that knows the plant the best, the Maasai I spoke with have little perception of its scarcity, which is a prerequisite for interest in conservation (Cunningham 1993a:6). Similarly, in Loita, Kenya Maasai also had no perception of a regeneration problem or a threat to the availability of the local flora, including *Warburgia salutaris* which they identified as one of their most important medicines, despite ecological research findings to the contrary (Maundu, et al. 2001). *W. salutaris* and *W. ugandensis* are well known cases of overexploited medicinal plants in other areas of sub-Saharan Africa (Botha, et al. 2004a; Krog, et al. 2004; Maroyi 2000; Maundu, et al. 2001). This illustrates the divergence of priorities and need to share information among stakeholder groups, especially between local residents and researchers.
Local people who have not experienced difficulty in finding *W. stuhlmannii* cannot be expected to know that it is a phylogenetically distinct, threatened, global endemic found only in the highly fragmented and rapidly degrading East African Coastal Forests of Tanzania and Kenya. Still, this does not mean they do not want to know. In the final feedback meetings I held with participants, they were very receptive to the information on the declining state of *W. stuhlmannii* in Tanzania and how related species, *W. salutaris* and *W. ugandensis*, have been overexploited in other areas of sub-Saharan Africa (Botha, et al. 2004a; Krog, et al. 2004; Maroyi 2000; Maundu, et al. 2001).

They were as keen to learn about the circumstances of other popular commercial species that are not considered threatened (e.g., their distribution, uses by different ethnic groups, and cultivation potential). This knowledge seemed to empower participants, and they came to their own conclusions about the links between declining knowledge of medicinal plants that they observe in young people, shrinking habitats that harbor medicinal plants, and declining biodiversity and availability of medicinal plants in their own communities. Some participants responded by initiating an environmental outreach group comprised of healers, vendors, harvesters, and forestry staff (people who do not typically interact). Together they are focusing on documenting and sharing knowledge about the uses and value of medicinal species, cultivating useful plants, learning more about the efficacy of their medicines, and protecting habitats. This happened because they included their own priorities for conservation and outreach. They approached the problem from a broad, not species, perspective.

Research participants' priorities also included ways to improve their own livelihoods, not just the state of the habitats in which they live, even if they do see these
as linked. Local priorities are also at a different scope and time frame than priorities that may be designated by outsiders. It is important for local people to benefit from their energy and time investments in the immediate future and not simply to know that it will benefit “future generations.” One harvester laughed at the idea of cultivating the medicinal tree species that he harvests: “Why should I plant those trees? So my future grandchildren can benefit? I need something [to benefit from] today for my family.”

When local and international priorities for protecting species (or habitats) do overlap, they should be recognized and acted upon as important starting points for engaging local people in conservation efforts. The way these overlap may not be immediately apparent.

These six guidelines for identifying priority species for conservation are useful for structuring research, generating results that consider local and international priorities, and generating results that can be compared in different locations, but their conclusions need to be reflected against the local sociocultural, economic, and ecological context of the particular research setting. These guidelines were conceived of to determine a list of the “Top 50” priorities for medicinal plant conservation. In that case, *W. stuhlmannii* is a fitting addition to a list that covers a much wider region than Tanga. Because *W. stuhlmannii* is not yet locally extinct, it is an excellent example of an opportunity to take preventative action. Ideally, we should not wait until species become red listed before they are deemed worthy of conservation and management action. Clues from local people, including their own priority plants and areas and management goals provide an important link to larger conservation initiatives. Williams's work on identifying medicinal plant species at risk concludes, “taxa identified as 'higher-risk' should be
afforded greater conservation priority, even if the species is not currently Red Listed. Many species within the high risk and conservation priority categories are traded at volumes and levels that are not sustainable and the populations are threatened with fragmentation and quasi-extinction, especially if they exist outside protected areas” (2007b:68).

7.6 Conclusion

In Tanga, the phytomedicines in trade largely consist of roots and bark from native trees. There is little seasonal variation because these products are available year round and keep well once harvested and dried, which means stock supplies can easily be stored and very little must be thrown away due to spoilage. These native plants are wild harvested from the Tanga Region (none are cultivated for commercial purposes), with few exceptions that are harvested from Tanga’s neighboring regions. While exotic species are popular for cultivation and use at home, they are not present in the market.

At the beginning of this chapter, five questions were stated. These have been addressed within the chapter and are summarized here below. 1) Which species are most often traded and most in demand? This was answered with the short list of species which was generated by identifying species inventoried with ≥25% of vendors (Table 7.3). 2) How confident can we be about the designation of key species identified in the research? Based on the findings form non-parametric statistical techniques and the ethnographic research that supports and contextualizes them, the confidence is high. 3) Are any of these species at risk of overharvest or currently overharvested? Currently, commercial harvesting for the timber and cosmetic industries are locally perceived to
threaten *O. usambarensis* and *O. lanceolata*. It does not appear that any species on the short list are being overharvested for medicinal purposes. In a report on the condition of Eastern Arc Mountain Forests (which include the Usambara forests) medicinal plant harvest is ranked the lowest in a listing of the main forest threats in terms of frequency of occurrence and urgency of threat in 26 Eastern Arc Mountain forests (Madoffe and Munishi 2004:28). The highest ranking threats include fire, pole cutting, encroachment, grazing illegal timber harvest, firewood collection, charcoal burning, mining, and hunting (Madoffe and Munishi 2004:28). In conversations I had with forestry officials in Tanga, they agreed that medicinal plant harvest is not currently a threat to any habitats or species. Research from other Eastern Arc Forests in Morogoro, Tanzania is concordant with their perspective. It states that declining populations of some medicinal plants result primarily from demand for their timber and researchers emphasize that any planning for the sustainable use of medicinal plants must also consider other uses for and pressures on those species (Mahonge, et al. 2006).

4) What is their conservation status? Only one species, *W. stuhlmannii*, currently is considered vulnerable and has been proposed as endangered on the IUCN Red List. With the exception of *W. stuhlmannii*, the medicinal plants in the trade are not endangered or threatened. As a narrowly distributed endemic, *W. stuhlmannii*, is even more at risk because of its naturally small population sizes. Still, medicinal plant harvest of *W. stuhlmannii* or any other commercial medicinal plant does not seem to be a threat to these plant populations, rather they are threatened by the same factors that threaten all habitats and species—expanding urban and agricultural areas and a growing demand for low cost wood fuel and timber. 5) What is the relationship between locally valued and internationally valued species? They diverge and are on
different scopes and scales, but there are opportunities for collaboration. International priorities are often habitat specific or species specific over a broad geographic range and timeframe. Local priorities center more on improving livelihoods and well-being in specific areas over shorter timeframes.

Market settings offer fertile ground as starting points to identify important species in the trade as well as to begin to understand the potential ecological consequences of commercial harvest. Lists of key species in the trade can be identified through market surveys, interviews with vendors and harvesters, and inventories of vendors’ stocks. The confidence in these lists can be strengthened by assessing sampling adequacy through statistical methods (such as species accumulation curves and diversity measures) and through feeding back findings to participants for corrections or verification. These ethnographic and analytical methods and the findings they yield are valuable tools for resource managers and conservation planners who must consider both local and external priorities in their programs and activities.

This research is based on the medicinal plant markets of Tanga, Muheza, and Lushoto Districts of Tanga Region. If it were scaled up to a regional level to also include Korogwe, Pangani, Handeni, and Kilindi Districts, I expect the medicinal plants from Handeni and Kilindi Districts would add species not inventoried in this research from dry and coastal forests. Tanga Town, where the commercial medicinal plant market is based, is a multi-cultural mix the market stakeholders are primarily from the Sambaa and Maasai ethnic groups. Handeni and Kilindi are primarily populated by the Zigua people, who do also live in Tanga Town but are not widely involved in the commercial side of medicinal plants, tending to be more involved as healers who work out of the public eye.
The implications for conservation are that, on a larger scale, the dryland and coastal forest species may be more represented. Handeni is already a source of fuelwood for charcoal and has been a source of illegal timber harvesting for export. Although medicinal plants are a less profitable venture, it is possible they are also being sourced from Handeni and Kilindi, but this would require additional research. The Korogwe District includes part of the Usambara Mountains and is also home to Sambaa. I would not expect the plants and vendors from that District to change the findings much from this study, since the environment and the culture are similar to Lushoto District. In fact, I know that Sambaa vendors in Tanga Town also source plants from Korogwe vendors and harvesters, so in a sense, it is represented in the current findings. Pangani District south of Tanga District on the coast may be a source of some medicinal plants for the commercial market, but it is a small and sleepy coastal town and it did not emerge as an important commercial site. Unlike the other districts in Tanga, travel to Pangani is made difficult by poor quality roads (especially in the rainy season) and this is likely a contributing factor to Pangani's lack of involvement in the Regional trade. Pangani plant specialists tend to be healers and not vendors.
CHAPTER 8. KEY LOCATIONS IN MEDICINAL PLANT PATHWAYS

8.1 Introduction

Chapter three introduced the market sites in terms of their cultural, economic, and demographic characteristics and broadly described source areas in terms of land use and ecological characteristics. This chapter details the specific market settings and activities of commercial sites and describes why they are identified as key locations. It also details key source areas for the nine species in the LEK survey and how these vary based on role (harvester, healer, and vendor), land use and habitat.

Ethnobotanical research has highlighted the importance of disturbed, successional, and cultivation areas as the most important sources of medicinal plants. Overwhelmingly, this research is based on South and Central America. My research from Tanga shows that the relationship between disturbed areas and commercial medicinal plants is different and emphasizes the importance of less disturbed and forested areas. A discussion comparing habitat types for medicinal plants in Tanga and elsewhere concludes this chapter.

8.2 Commercial Areas

8.2.1 Urban area - Tanga Town markets and commercial zones

Unlike the circumscribed, organized, and concentrated medicinal plant markets in many areas of the world — the medicinal plant market in Tanga town exists in a more abstract sense due to its unorganized, heterogeneous, and scattered nature. The “market” is dispersed throughout town and is composed of individual entrepreneurs who sell plant medicines from morning to evening daily. Some work within established markets, but
the majority work from free standing kiosks or makeshift roadside stations with small tables or tarps adjacent to markets or in otherwise highly traveled commercial areas (e.g., near the bus stand, on a major road). The medicinal plant market in Tanga is actually best described as pre-commercial, especially when compared to other areas of Western and Southern Africa where large, formal, and organized medicinal plant markets flourish.

Another modality for vending exists in Tanga that emphasizes its ties to local cultural and social networks. One urban vendor sells from the front porch of his house on a busy road. He is well known in town as a healer and harvester and he sells to many other Tanga healers in town who “do not have time” to harvest themselves and to healers who are traveling through Tanga either to treat patients or just to purchase medicines. Too worn from old age, injuries, and surgeries to continue farming, he is there most days “holding court” with other medicinal plant specialists and consumers as they talk politics, exchange stories, and share advice. He is an example of someone who is very much a part of the commercial trade yet he is more than just a vendor --- he is a storehouse of experience, source of advice, and a well-versed historian.

Most urban vendors in Tanga Town are infrequently or sporadically visited by customers. Vendors felt this was a reflection of an oversaturated market and an economically impoverished customer base. It was common for me to sit with Tanga Town vendors at their kiosks or stations for hours without a single transaction but with multiple social interactions happening. There are exceptions, however. The vendors who sell within the context of markets are generally busier due to the sales of items other than medicines (e.g., honey, oil, spices). Other notable exceptions are two cousins who operate separate kiosks where they sell prepared, ready-to-drink medicines.
deceased father/uncle, Mzee Ally, reportedly the first to sell these ready-to-drink medicines in Tanga, trained them. They benefit from his entrepreneurial legacy and the name recognition he established. At their kiosks, customers line up, order, drink their medicines at the counter, and move on. Excerpts from records of two blocks of time spent at one kiosk are instructive.

On July 20, 2005 for one hour and twenty minutes in the afternoon (2:40 to 4:00pm) a constant stream of customers visited his kiosk. I counted 35 customers, primarily young men (18) and old men (12) asking for medicines to treat *muku* ‘exhaustion,’ *homa/malaria* ‘fever/malaria,’ and *chango* ‘stomach problems.’

On January 20, 2006 for one hour in the afternoon (3:53 to 4:53pm) he was visited by 17 customers. Again, most were young men asking for the same medicines (for *muku, homa/malaria,* and *chango*). Two older women customers asked for malaria medicine. One of them had just finished her anti-malarial medications from the hospital but had not felt better and did not want to continue with those *kali* ‘harsh’ medicines, so she decided to use plant medicines. During this hour two harvesters delivered powdered roots of *mtundwi* (*Ximenia caffra* Sond. var. *natalensis* Sond. Olacaceae) and bark of *msasa mbege* (*Crossopteryx febrifuga* (G. Don) Benth Rubiaceae) from Muheza and whole *ubombo* (*Mondia whitei* (Hook f.) Skeels Asclepiadaceae) roots from Lushoto.

**8.2.2 Rural area - Mlalo market**

Since most of the vendors in Tanga Town are Sambaa, and the majority of them come from the area of Mlalo (Lushoto District) it is not surprising that Mlalo is a key commercial and source location for medicinal plants in Tanga. Situated in the West
Usambara Mountains, Mlalo’s largest settlement is about three hours walk to the forest reserve border and the same distance to the plains below. Both are source areas of medicinal plants. Mlalo’s market is a general market where residents buy produce, dried goods; locally produced baskets, pottery, and knives; used and new clothes; prepared snack foods; tobacco; and medicines. It is held twice per week in a central open area of town. There are about 80-90 small-scale producer-vendors, many of whom carry their goods from their remote villages to the market. Vendors display their goods on tarps or small tables or in baskets, depending on their means. Because the market is not a permanent market (it has no structure or stalls) vendors have nowhere to store the items that do not sell, so they only bring what they think they can sell.

There are six to eight plant medicine vendors who sell regularly from one corner of the market. The vendors are all Sambaa men from the Usambara Mountains. Most of them are elderly. They are friends and colleagues with congenial relationships. They refer customers to each other, share medicines with each other, make change for each other, and share snack food while vending. Between market days they store their supplies behind a widowed woman’s house which borders the market. Although she is neither a vendor nor a harvester herself, the space behind her house is the center of all their exchanges. It is where local harvesters (many of whom are women) negotiate with urban middlemen and urban and local vendors. Larger exchanges occur earlier in the morning, sometimes even before the market is completely set up. Bulking and breaking (the accumulation of smaller stocks from multiple harvesters into larger units, or the dividing up of larger stocks into smaller ones) occurs here as well. Bulking is done for large orders from non-local vendors who come to Mlalo from Tanga Town, Dar es Salaam, or
Arusha to buy. Breaking is done on an as-needed basis for local vendors who sell in Mlalo and/or the surrounding area.

The market reaches its height of activity around 10:00am, once people from remote villages have had time to arrive with their wares and populate the area. At this time the medicine vendors are very busy, selling individual doses to local people for home use and larger volumes to healers and vendors who will resell the medicines farther away. Compared to the typical urban vendor in Tanga Town, these vendors are noticeably busier with more customers. I observed one vendor selling to 32 customers in one hour and the other vendors around him seemed equally busy with customers. The market buzzes with activity until approximately 3:00pm when it quiets as people begin the trek back to their villages.

8.2.3 Semi-urban area – Muheza Market

Muheza is not considered a key commercial location because there are so few vendors who regularly sell locally harvested plants. Two of the three of them are supplied with Usambara medicines by their relatives who are vendors in the Mlalo market, which underscores the importance Mlalo as a commercial and source area.

8.3 Preferences for Source Areas by Role

8.3.1 Domestic preferences

During household interviews in five communities, people were asked about areas where they have obtained medicinal plants. Their answers were tallied by community, and the most frequently mentioned sources were noted and ranked from five to one, with
five being the most frequently mentioned and one being the least mentioned. The data is summarized in Figure 20 below.

This graph (Figure 20) gives us an idea of how frequently people harvest their own medicines compared to obtaining them from other people. The home area (consisting of home gardens or disturbed areas nearby residences) was the most frequently reported source of medicinal plants for four of the five communities. While the home area is undoubtedly an important source for consumers, the magnitude of its importance is overemphasized because some participants interpreted “home area” to mean home district, and not just the area surrounding their homes. For the remaining community (the urban, upper-class, coastal households), Bantu vendors (e.g., in kiosks or at tables separate from markets) were the most frequently named source, and the home area was the next most frequently named source. Farm areas (e.g., farm borders and fallow farms) and market vendors (i.e., those located within standard markets) were reported as popular sources only for the rural, montane communities. Not surprisingly, rural communities report sourcing medicines from the forest/bush more often than urban communities. (The forest/bush areas were collapsed into one category because consumers used these terms *msituni* ‘forest’ and *porini* ‘bush’ interchangeably.) The urban households more frequently source plant medicines from (non-market) vendors, healers and relatives. This reflects the resources most available at each site. In urban areas, vendors and healers are abundant. In rural areas, access to medicinal plant habitats is comparatively easy. Rural communities do not frequent (independent) vendors outside of markets because they are so rare. Healers are sources for both rural and urban communities. The two communities that did not frequently report healers as sources of
medicinal plants stand out for two reasons. The rural, montane community is predominantly Christian and the word *mganga* 'healer' was probably interpreted by them as healers who deal with spirits, which would be stigmatized for many respondents. Similarly, the urban affluent community reports not frequenting healers because of the social stigma against healers and their customers as superstitious and irrational and also because they have more resources to visit biomedical specialists.

![Figure 20. Consumers' Five Most Frequently Named Sources for Medicinal Plants](image)

**Figure 20. Consumers' Five Most Frequently Named Sources for Medicinal Plants**

(5 = most frequently named, 1 = least frequently named)

### 8.3.2 Commercial Preferences

The LEK survey conducted with harvesters, vendors, and healers focused on nine commercial medicinal plants and it reveals different sourcing patterns than those reported by consumers. While anthropogenic vegetation around the home and farm are common sources of medicinal plants for consumers, commercial harvesters (and to some degree healers) source plants from broader geographic areas that are farther from their residences. In the Eastern Cape Province of South Africa, healers reported gathering from a greater range of sites (34 different sites), but commercial harvesters and hawkers reported going farther than healers to get plants (Cocks, et al. 2004:483).
Harvesting medicinal plants for Tanga markets happens within the Tanga Region. (Only a couple of participants said they had ever harvested outside of Tanzania, and these were all just across the Kenya border to the north of Tanga.) The areas targeted for commercial harvesting can be identified by a number of characteristics in terms of their species composition, distance from harvester's residence, land use type, and habitat type.

With regard to species composition, commercial harvesters prefer areas with large, dense populations of multiple medicinal species and or multiple harvestable individuals of those species, typically trees. Their goal is to maximize harvest within a minimal time. The same preferences were found by Ghimire and colleagues with commercial harvesters in the buffer zone of a national park in northwestern Nepal (2004). Tanga harvesters prefer larger trees because the bark and roots of smaller individuals yields less; however smaller trees will be harvested if there is no alternative in proximity.

One experienced Mlalo vendor noted that over the years the sizes of roots and thicknesses of bark have declined over time as the largest individuals are no longer available to be harvested. Traveling to multiple places that only have a few harvestable individuals in each place is considered a waste of resources and time. A group of women commercial harvesters described an ideal harvest area as one where many medicinal trees are in close to each other so that after you finish taking all you can from one tree, you can easily begin harvesting from the next closest tree. On multiple occasions, I observed these women ring-bark (i.e., remove bark from the entire perimeter of the tree's bole) from the ground as far up as they can reach or climb, and then move to the next tree. Commercial harvester preferences differ from the criteria that guide most healers, which are
determined by their spirits who lead them. In these cases it is difficult for healers to articulate why an area is preferred or even why a specific plant is preferred.

Other desirable criteria for commercial source areas include public areas that are easy to access (e.g., near a bicycle path or not far from a road). In terms of distance, harvesters generally limit their travel to no more than half a day, with the average being a 3.5 hour trek, one-way. It is rare for harvesters to travel farther than that because of the resources required for the travel, as well as a place to sleep, and food to eat while away.

While commercial harvesters prefer areas where they can harvest with minimal risk of being bothered by land owners or forest guards, healers are less concerned about these constraints. If they are spotted harvesting, they simply explain they are taking medicine for their patients, and because it is only a small amount and they are benefiting society *(tunasaidia jamii)*, the land owner or guard allows them to harvest.

Chapter Six mentioned the importance of kin (blood and fictive) relationships among healers, vendors, and harvesters who work together. Social connections to places also weigh heavily in decisions of where to harvest. Harvesters typically source plants from within their natal areas not from foreign ones. Harvesters and healers who have relocated (to urban areas for employment or other rural areas after marriage) typically go “home” to harvest. The same trend was noted in the Eastern Cape Province of South Africa where urban-based gatherers combine harvesting trips with social visits to their relatives living in source areas (Cocks, et al. 2004:481). Tanga harvesters explained that when they go home, they are considered *wenyeji* ‘locals’ and their rights to harvest are recognized by other locals. I also observed how this is beneficial in cases when forest guards are relatives or friends of commercial harvesters who are regularly allowed to
extract large quantities of roots and or bark even when it is against the rules. At home, harvesters also have relatives and friends who can host and assist them with labor, tools, a place to sleep, and food to eat which minimizes expenses. People do not typically harvest in areas where they are strangers because the resources and rights are not available to them, and they are not familiar with the trees in those areas. *Hawezi kwenda mahali pa kuchimba kama huna mwenyeji.* "You can’t go to a place to harvest if you don’t have a local," summarized one harvester.

Because I am interested in the practical experience of harvesting and not just the theoretical knowledge of medicinal plants, the following discussion focuses on LEK survey participants who not only correctly identified but also had personal experience harvesting these specific plants. Table 8.1 below breaks this down by species.

**Table 8.1. LEK Survey Participants who Identified and Harvested 9 Species**

<table>
<thead>
<tr>
<th>Species</th>
<th>No. who identified it (% of total participants)</th>
<th>No. who harvested it (% of total participants)</th>
<th>% Who harvested of those who identified it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zanthoxylum chalybeum Engl. Var. chalybeum Rutaceae</td>
<td>58 (79%)</td>
<td>50 (68%)</td>
<td>86%</td>
</tr>
<tr>
<td>Albizia anthelmintica Brongn Fabaceae Morella salicifolia A. Rich. subsp. kilimandscharica Engl. Myricaceae</td>
<td>43 (58%)</td>
<td>34 (46%)</td>
<td>79%</td>
</tr>
<tr>
<td>45 (61%)</td>
<td>40 (54%)</td>
<td>89%</td>
<td></td>
</tr>
<tr>
<td>32 (43%)</td>
<td>19 (26%)</td>
<td>59%</td>
<td></td>
</tr>
<tr>
<td>18 (24%)</td>
<td>12 (16%)</td>
<td>67%</td>
<td></td>
</tr>
<tr>
<td>43 (58%)</td>
<td>38 (51%)</td>
<td>88%</td>
<td></td>
</tr>
<tr>
<td>37 (50%)</td>
<td>34 (46%)</td>
<td>92%</td>
<td></td>
</tr>
<tr>
<td>37 (50%)</td>
<td>29 (39%)</td>
<td>78%</td>
<td></td>
</tr>
</tbody>
</table>
In most cases, individuals who identified a plant also have the experience of harvesting it. However, three species, *O. usambarensis*, *W. stuhlmanni*, and *M. salicifolia*, stand out as medicines that were identified by the fewest participants (24%, 43%, 47% of 74 total participants respectively) and also harvested by the fewest proportion of people who identified them (67%, 59%, 66%, respectively). Participants have less experience harvesting these species because of their more limited distribution compared to other species in the survey. *O. usambarensis* and *M. salicifolia* habitats are montane forests, and often the only remaining populations are in forest reserves because they are the only areas off-limits to farming. Outside of forest reserves, the demand for farming land is so great that forests are cleared to prepare land for farming. *W. stuhlmanni* populations are very narrowly distributed as they are found only in coastal forest remnants, a highly degraded and fragmented habitat. Although dense populations of *O. usambarensis* and *M. salicifolia* can be found in forest reserves, *W. stuhlmanni* populations are much more scattered and sparse. It is very rare to find a cluster of them growing in proximity, according to harvesters and to my own observations.

8.4 Land Use Types for Commercial Source Areas

Land use type is one of the key ways that harvesters differentiate areas where they work. It relates to land tenure which is often hard to discuss due to its ambiguous and or sensitive nature, and is therefore directly relevant to discussions of conservation. Healers in Keiyo District, Kenya use land use as a category for differentiating landscape types. They also used topography and vegetation zones as descriptors (Jungerius 1998). Obviously, the implications of harvesting from a government forest reserve that is closed

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to the public are different than harvesting from outside your own front door. Most participants reported harvesting the same plants in multiple land use types.

8.4.1 Descriptions of salient land use types

- **Farms** - farm borders and areas inside active and fallow farms. Commercial medicinal plants in these areas are spontaneous volunteers that are tolerated. They are not cultivated plants.

- **Near Home** – cultivated home gardens, and non-cultivated plants growing spontaneously in proximity to residential areas. As was the case with consumers, this category was interpreted broadly, which means it was over-reported. Participants often responded positively if the plant grows in their natal home area, although in practice commercial harvest does not happen in direct proximity to residential areas.

- **Grazing Area** – non-farmed, non-forested areas that are typically public spaces where ungulates are taken to graze. In some cases also areas where the landowners are absent or ownership is ambiguous. These are managed with fire.

- **Public Area** – land not privately owned or managed. Although 54% of forests in Tanzania are in “General Lands” which are public (Ministry of Natural Resources and Tourism 2004:11), most public areas in this study are not characterized by forest since nearly all forests are managed by the government or private companies.

- **Military Property** – enclosed area for military training that is off-limits to the public. Because it is neither farmed nor grazed, harvesters report that it has larger
trees in greater numbers and a greater diversity of trees compared to those found in adjacent public areas.

- **Plantation Forest** – typically privately-owned areas cultivated for fuel or timber. Fuel lots that are village property and open to village residents are one type of plantation forest, but these are few compared to commercial timber forests.

- **Village Forest** – regulated by local and/or central governments that typically set the parameters for access and use (e.g., fuel wood collecting only on Wednesday and Sunday; no felling of trees without a permit, no grazing in forest, and no fires in forest). These are natural (not cultivated) forests with successional areas and various levels of disturbance. They are typically in “buffer-zone” areas of forest reserves that adjacent villages access for subsistence (fuel, building materials, medicines, fruits/vegetables).

- **Forest Reserve** – government managed forests that local people are restricted from using or entering. These consists of natural and plantation forests and account for 37% of all forests in Tanzania (Ministry of Natural Resources and Tourism 2004:11). Increasingly, these natural forest reserves are transitioning to community-based or joint-forestry management and are patrolled by appointed volunteer village forest guards.

In Figures 21-23, percentages were derived by considering the total number of participants who had the experience of collecting each plant, then dividing the positive responses for each land use category by that number. For example, *O. usambarensis* has been harvested in the forest reserve by 100% (of four) harvesters, 75% (three of four)
healers, and 25% (one of four) vendors; and Z. chalybeum has been harvested in public areas by 100% (of nine) harvesters, 47% (nine of 19) of healers, and 91% (20 of 22) vendors.

The graphs show that restricted-access areas (military property, plantation forests, village forests, and forest reserves) are less utilized for medicinal plant harvesting than more open-access areas (farms, near home, grazing area, public area). Still, this differs by species and by role and does not account for intensity of harvest, an important factor to consider because of its ecological and conservation implications.

The differences in source areas for O. usambarense, M. salicifolia, and W. stuhlmannii are instructive. (Arrows indicate the source area most reported for those species.) O. usambarense and M. salicifolia are only harvested by harvesters in the forest reserve, while healers and vendors also report harvesting it from village forests and plantation forests. Since harvesters most frequently and intensively harvest these species in order to supply vendors and healers, their reliance and impact on the forest reserve is much more substantial. Although these species may be found outside the forest reserve, those populations are scanty (according to all participants and to my own observations). This calls for us to reconsider the emphasis on the importance of disturbed, anthropogenic habitats for medicinal plants, as this case shows that forest reserves are also essential source areas for commercial medicinal plants.
Figure 21. Harvesters' Source Areas for 9 Commercial Plants by Land Use Type

Figure 22. Healers' Source Areas for 9 Commercial Plants by Land Use Type
Figure 23. Vendors' Source Areas for 9 Commercial Plants by Land Use Type

As an endangered species in a shrinking habitat, *W. stuhlmannii* also merits closer inspection. The three harvesters reported harvesting it from grazing areas and public areas, which is an artifact of its degraded habitat. Harvesters had not even considered looking for it in forest reserves, because in their areas reserves do not exist or otherwise are not recognized as reserves. (They may exist only on paper.)

The example of *W. stuhlmannii* underscores the potential role local stakeholders can play with their knowledge of the locations of individuals and populations of this species and in working to boost those populations. Healers (seven) and vendors (nine) reported harvesting *W. stuhlmannii* from a diverse range of land use types: farms, near home, grazing areas, public areas, village forests, and forest reserves. This reflects their infrequent experience of harvesting this species compared to harvesters. Harvesters target specific areas where they know they can obtain adequate supplies to meet the vendors’ and customers’ demands.
8.4.2 A note about farms

Although the graphs (Figures 21-23) show farms are an important source area for locally used medicinal plants, I must emphasize that their existence in farms is not due to cultivation. I observed no evidence or even a heard a mention of any native medicinal plants (not just the nine included in the LEK survey) that are cultivated for local commercial use\(^1\). All of these plants are wild harvested. Similarly, in South Africa an estimated 99% of the 400–550 species (primarily roots, bark, and bulbs) currently sold for use in traditional medicine originate from wild sources (Williams 1996). Research from other areas of Southern Africa follows this trend of wild harvesting (Cunningham 1993c; Keirungi and Fabricius 2005; Krog, et al. 2004; Mander 1998). Most of the commercial medicines in Tanga are slow-growing, native trees which would take decades before they reach harvestable size. The time and land required for such a venture is not an option for harvesters, who are motivated chiefly by immediate returns.

Contrastingly, medicinal plant markets in the New World rely on herbaceous, fast-growing species, which often include exotics. In these areas, a growing demand has inspired small holders to cultivate these species for the market. For example, of the fifteen most popular medicinal plants in Paramaribo, Surinam markets, seven are cultivated and/or domesticated and four of these are non-native (van Andel, et al. 2007:357). Linares and Bye (2007) observed populations of herbaceous medicinal species in Mexico are growing as a result of their increased demand which is met by

\(^1\) \textit{Artemisia annua} L. Asteraceae, a Chinese species, is now cultivated in Tanzania for export so its artemisin can be used in the manufacture of anti-malaria medicaments (Finkel 2007:66). \textit{A. annua} is not used locally. Cultivated species that are used locally include \textit{Azadirachta indica} A. Juss. Meliaceae, from India, \textit{Jatropha curcas} L. Euphorbiaceae from Africa and elsewhere, and \textit{Ricinus communis} L. Euphorbiaceae from Africa. All of these are naturalized throughout tropical areas. Locally, they are cultivated on various levels from small scale farming to commercial farms for cosmetic and health related products such as oils, soaps, candles, and ointments.
commercial cultivation. Shanley and Luz also report how an increasing demand from urban consumers has motivated smallholders in Belém, Brazil to cultivate and sell “fast growing herbaceous species, many of which are naturalized exotics” (2003:577). In the markets of La Paz and El Alto, Bolivia, 35.7% of medicinal plants inventoried are cultivated, 36.4% are exotic, and 48.1% are herbs (Macía, et al. 2005). This is certainly not the case in Tanga where exotic and cultivated plants are scarcely found in market settings at all.

8.5 Habitat Types for Commercial Source Areas

Research conducted in the New World (North, South, and Central America) has characterized medicinal plants as weedy, herbaceous, species that are gathered primarily from anthropogenic environments. This has been documented with non-specialists (mostly women) in dry forests of northeastern Brazil (de Albuquerque, et al. 2005b), healers in Atlantic forests of Bahia, Brazil (Voeks 1996), non-specialists in São Paulo State, Brazil (Hanazaki et al 2006:904), native populations of North America (Stepp and Moerman 2001), non-specialists in the highlands of Chiapas (Stepp 2002); Mixe and Zapotec healers in Mexico (Frei, et al. 2000), and vendors in Mexico (Bye and Linares 1983) and in Suriname (van Andel, et al. 2007:61). It has been documented much less outside the Americas, for example with healers in Borneo, Indonesia (Caniago and Siebert 1998).

This generalization about the importance of disturbed habitats and weedy species to medicinal plants needs to be examined in other areas, such as Africa where the habitats, species, and ethnomedical practices differ. Others have noted the need for such research
in locations other than Central and South America for comparison (Reyes-García, et al. 2006b; Waldstein and Adams 2006:S112). It is of theoretical and applied interest as it relates to the identification of conservation priorities.

While medicinal plants harvested for household use in Tanga are primarily herbaceous species from highly disturbed areas near human settlements, they differ from plants in Tanga’s commercial trade. Commercial plant medicines in Tanga include no popularly cultivated and very few weedy, herbaceous species because there is little commercial demand for those plants. They are the same plants that grow around consumers’ homes, so there is no market for them. Thus, tree species and forest plants have a niche in the market. Many, but not all of these, come from anthropogenic vegetation. Some come from less disturbed forests, including protected forests. The importance of the commercial trade should not be underestimated because it is a growing industry upon which increasing numbers of people rely on both for their livelihoods and for their own health maintenance.

Most of Tanga’s commercial medicinal species are trees collected from lowland, dry areas but high volumes of a few species (*M. salicifolia*, *O. usambarensis*, and *Osyris Lanceolata* Hochst. & Steud Santalaceae) are collected from montane forest reserves. Clearly forests and tree species are an important habitat and source location for some medicinal plants. This demand, also seen in other areas, is not likely to decline as growing numbers of rural people, especially those from forest communities move to urban areas. The familiarity they have in using forest species fuels a demand for their harvest (Shanley and Luz 2003:508).
W. stuhlmannii habitat is only in coastal forest remnants which are increasingly fragmented due to anthropogenic activity such as farming, grazing, and charcoal burning. Greater volumes of W. stuhlmannii may indeed be found in coastal forest reserves, but these did not emerge as important source areas for commercial harvesting—likely because the reserves themselves are very small and very scattered. The low prices paid to harvesters for this bark restrict them from traveling far to harvest from such reserves and transporting the bark to markets. Ironically, the low economic value of this scarce bark protects it from being harvested even more intensely. While the harvest of W. stuhlmannii is primarily due to its value in charcoal making, its value as a medicine could encourage its protection and cultivation by local people.

The preference for habitat type is complex and not easily generalized in Tanga. For example, I met a number of healers who collect from open, dry areas, even though their homes are equidistant to the forest. Harvesters also talked about the importance of plants from “cool” (mountainous) or “hot” (lowland) places, and (depending on the plant) the merits of plants harvested from black, red, sandy, or salty soils. They know that two individual plants of the same species collected from different habitat types can have different potency, which implies they recognize the differences in plant chemistry across an ecological gradient.

8.6 Conclusion

The most important commercial locations in Tanga medicinal plant pathways are in an urban area with dense populations of humans (Tanga Town) and in a rural market near dense populations of medicinal plants (Mlalo). Compared to plants harvested for home use, which often include exotic and cultivated species, commercially harvested
plants are native species that are wild harvested from areas farther from human
settlements and include forests. The most utilized land use types and habitats for
sourcing medicinal plants are open access, savanna and woodland areas that are subjected
to various levels of anthropogenic disturbance (such as farming, grazing, and charcoal
making). However, three tree species that were foci of the LEK survey call us to
reexamine the popular generalization that medicinal plants are abundant, fast growing,
herbaceous species from disturbed environments with little relevance to conservation.
Two are montane forest species, *O. usambarensis* and *M. salicifolia*, which are primarily
sourced from protected forest reserves of limited disturbance, and the third, *W. stuhlmannii*, is a slow-growing endemic from highly fragmented coastal forests which are
in dire need of conservation.

In addition to forest species that have commercial value to harvesters and healers,
other research shows the value of forests to home and ritual use of plants. Some of these
plants can only be found in forest habitats. Household surveys in the West Usambaras
and observations of daily life there revealed that residents rely on trees from the forest,
not just herbaceous species from disturbed areas, for medicinal use. Non-specialist
residents around the East Usambara forests (Woodcock forthcoming), West Usambara
forests (personal communication with village environmental committee at villages around
Shagayo Reserve in Lushoto 2007), and Coastal Forests (personal communication with
Anna Lauo, Tanga Forestry Officer 2006) identified medicinal plants as a priority for
habitat preservation in their village forests which are under or transitioning into joint
forestry management with the government.
In addition, healers from the East Usambaras (Amani Nature Reserve 2004; Ruffo, et al. 1989; Woodcock 2002:64) and West Usambaras (based on this research) who harvest plants for their patients report that some medicinal plants are only collected from forests and not from areas around residences or farms. On average, 34% of medicinal species that East Usambaras healers rely on are from the forests with healers who live in more remote areas near forests sourcing up to 67% of their plants from forests (Ruffo, et al. 1989:195). Forests have also been reported as important sources of medicines for healers in other areas of the Eastern Arc Mountains (the forested mountain chain that includes Usambaras). Midwives (10) and healers (40) from 7 sub-villages in the Uluguru Mountains of Morogoro reported that 37.3% of the plant medicines they use are collected from natural forests (Mahonge, et al. 2006).

Although the medicinal species harvested from forest reserves may not be forest obligates, the reserves function as the last remaining reservoir of these species for local communities. These factors demonstrate the importance of forests and reserves for medicinal plant access and they signal the potential medicinal flora have to motivate forest conservation efforts.

The popular position that medicinal plants are weedy species from disturbed habitats is largely based on research from the Americas and can be seen as a reaction to the much publicized view that preceded it, which portrayed medicinal plants as rare rainforest treasures in need of preservation for use as local people’s medicines, the creation of future pharmaceuticals, and, therefore, incentives for tropical forest conservation. While the point made by research from the New World is valid, I think it has been overemphasized and generalized to areas where it should be reconsidered.
want to bring the importance of medicinal forest and tree species back into the discussion of conservation. I also want to emphasize that different medicinal plants are used in different contexts, based on the user’s role/specialization, biogeography, and the political-economic circumstances that determine stakeholder access to specific source habitats and species.

The most salient differences between my research and the studies I am responding to are a different location; attention to the larger social, economic, and political contexts in which medicinal plants are harvested and used; and an emphasis on the differences among user groups in terms of the species, and habitat and land use types they rely on most and prefer.

My research is based on markets in Tanzania focuses on areas less represented in the literature both in terms of geography and in terms of its commercial setting. In Tanga, commercial plant medicines largely consist of dried roots and bark from wild harvested native trees. Although my findings resonate with other research from sub-Saharan Africa, there has been little voice from Africa in this discussion of “weedy” medicinal plants and their source areas. Place, land tenure, and habitat and land use types are important to any discussion of medicinal plants and conservation.

Considerations of place also draw our attention to the local political and economic context. For example, findings on medicinal plant source areas from the Atlantic Forest in northeastern Brazil encourage us to consider the larger political influences on people’s use of plants from anthropogenic zones over forest reserves. Specialists collected 82.7% of medicinal plants from anthropogenic areas (backyards and small farms), which largely included cultivated and weedy plants, while only 17.3% of their medicinal plants are
collected from inside the forest (Gazzaneo, et al. 2005). The researchers describe how the establishment of the "Usina São José" forest reserve which prohibits medicinal plant collection has meant that local specialists are forced to rely more on weedy, cultivated plants and non-native plants from disturbed habitats. These restrictions have changed their use of different habitats and species. “Despite these restrictions, the medicinal species with the highest use-value by this community was *Pithecellobium cochliocarpum* (Gomez) Macb., a native plant of the Atlantic Forest” (Gazzaneo, et al. 2005).

Clearly, there is a difference between assessing value of habitats based on the quantity of useful or medicinal species found in those areas and assessing value based on what local communities designate are qualitatively the most important to them. There is also a difference between the areas most utilized and the areas most valued or preferred for collection. Measuring the most utilized habitats cannot be substituted for the most preferred habitats for collecting medicinal plants. In Tanga, healers, harvesters, and non-specialist residents in the East and West Usambaras explained that they would prefer to harvest more from forests but are restricted by the forest reserve regulations and so are left to rely on other sources. Restricted access also affects people’s willingness to discuss their use of forest reserves as sources for medicinal plants. Forests would likely emerge as an even more important source for medicinal plants if it were not for people’s limited access to them. Restricted access forces people to rely on nearby, anthropogenic vegetation and weedy species when they may have otherwise preferred forest species. Preferences for disturbed areas have been attributed to convenience (e.g., Frei, et al. 2000), and apparency theory (e.g., Stepp 2002), but the political circumstances that affect access to specific habitats also need to be considered.
Similarly, economic factors also need to be considered when discussing people's preferred source areas for medicinal plant collection. Even outside forest reserves, some trees require the purchase of permits from the government before they can be harvested. Violations are punishable by fines or jail sentences. Harvesters cannot afford such permits, and the returns on the medicines they collect do not make legal collection feasible from an economic perspective.

In addition to the social context of collection, preferences for particular life forms and species are also influenced by plants' reproductive strategies and capacity to regenerate. Trees and shrubs that coppice vigorously after harvest and regenerate new material to be harvested at a later date are attractive as reliable sources of medicines. I have yet to encounter these characteristics in possible explanations for the use of specific plant types over others. Figure 29 in Chapter Ten considers the resprouting tendencies of species from the LEK survey, and this topic is worth further investigation with more species in other areas as well.

In conclusion, the most utilized source areas for medicinal plants reflect the social, cultural, political, economic, and ecological contexts of local harvesters. Although forests did not emerge as the source for most species of commercial phytomedicines, they are nonetheless important as the only sources for specific species in Tanga. In Tanga, medicinal plants have also been identified as priorities for conservation in forests that are jointly managed by villagers and the government. These factors point to the potential value medicinal plants have to conservation planning that integrates both local and national priorities.
CHAPTER 9. TRENDS IN LOCAL ECOLOGICAL KNOWLEDGE RELATED TO NINE MEDICINAL PLANTS

9.1 Introduction

This chapter focuses on Local Ecological Knowledge (LEK). I use multivariate, bivariate, and summary statistics as well as correlation analyses to evaluate how knowledge is distributed among sociodemographic groups. Higher levels of LEK have been associated with level of specialization, as Ghimire and coauthors (2004) demonstrated with Nepalese healers who have more knowledge than commercial collectors, and Joyal demonstrated with harvesters versus non-harvesters of sabal palms (1996:456). Higher levels of LEK have also been associated with lower levels of formal education (Luoga, et al. 2000:337; Voeks and Leony 2004), more years of experience within a specialization (Martin, et al. 2007), increased age (Begossi, et al. 2002:294; Luoga, et al. 2000:337; Monteiro, et al. 2006:177), and longer contact in a given environment (Nyhus et al. 2003 cited in Reyes-García, et al. 2006b). Some researchers have found higher levels of LEK with women (Begossi, et al. 2002:294; Monteiro, et al. 2006:177; Voeks and Leony 2004), while others have found higher levels with men (Joyal 1996:454; Luoga, et al. 2000). Plant knowledge has also been observed to be gendered — based on habitat type (Hanazaki, et al. 2006:904; Kyoshabire 1998), use of plant (Luoga, et al. 2000b), and life form (Caniago and Siebert 1998; Lewis and Elvin-Lewis 1990). Patterns of knowledge are clearly complex and context specific.

Knowing how the knowledge differs among social groups can help identify the most appropriate participants to involve in evaluating the status of specific resources and habitats, and in assessing locally innovated techniques in resource management and conservation planning (Ticktin and Johns 2002b). In this chapter I use my data to explore
the relationships between LEK and social variables (those mentioned above and others) to see what they can tell us about the situation in Tanga and how it compares with trends from other research.

9.1.1 LEK Survey Participants

Table 9.1. Summary Statistics for LEK Survey Participants (n=74)

<table>
<thead>
<tr>
<th>Role</th>
<th>Percent</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvester</td>
<td>26%</td>
<td>19</td>
</tr>
<tr>
<td>Healer</td>
<td>36%</td>
<td>27</td>
</tr>
<tr>
<td>Vendor</td>
<td>38%</td>
<td>28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Healer Status</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-identify as a healer</td>
<td>57%</td>
<td>42</td>
</tr>
<tr>
<td>Does not self-identify as healer</td>
<td>43%</td>
<td>32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Use Tunguri</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>45%</td>
<td>33</td>
</tr>
<tr>
<td>No</td>
<td>55%</td>
<td>41</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sambaa</td>
<td>65%</td>
<td>48</td>
</tr>
<tr>
<td>Zigua</td>
<td>7%</td>
<td>5</td>
</tr>
<tr>
<td>Digo</td>
<td>7%</td>
<td>5</td>
</tr>
<tr>
<td>Bondei</td>
<td>3%</td>
<td>2</td>
</tr>
<tr>
<td>Maasai</td>
<td>8%</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>11%</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent Life at Current District of Residence</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>75-100%</td>
<td>43%</td>
<td>32</td>
</tr>
<tr>
<td>50-74%</td>
<td>23%</td>
<td>17</td>
</tr>
<tr>
<td>25-49%</td>
<td>16%</td>
<td>12</td>
</tr>
<tr>
<td>&lt;24%</td>
<td>18%</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>78%</td>
<td>58</td>
</tr>
<tr>
<td>Female</td>
<td>22%</td>
<td>16</td>
</tr>
</tbody>
</table>
Table 9.1. (Continued) Summary Statistics for LEK Survey Participants (n=74)

**Age in Years**

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Percentage</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-25</td>
<td>4%</td>
<td>3</td>
</tr>
<tr>
<td>26-35</td>
<td>22%</td>
<td>16</td>
</tr>
<tr>
<td>36-45</td>
<td>19%</td>
<td>14</td>
</tr>
<tr>
<td>46-55</td>
<td>20%</td>
<td>15</td>
</tr>
<tr>
<td>56-65</td>
<td>16%</td>
<td>12</td>
</tr>
<tr>
<td>66-75</td>
<td>11%</td>
<td>8</td>
</tr>
<tr>
<td>76+</td>
<td>8%</td>
<td>6</td>
</tr>
</tbody>
</table>

**Formal Education**

<table>
<thead>
<tr>
<th>Education</th>
<th>Percentage</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>16%</td>
<td>12</td>
</tr>
<tr>
<td>Primary</td>
<td>74%</td>
<td>55</td>
</tr>
<tr>
<td>Secondary</td>
<td>5%</td>
<td>4</td>
</tr>
<tr>
<td>College</td>
<td>4%</td>
<td>3</td>
</tr>
</tbody>
</table>

**Years Experience**

<table>
<thead>
<tr>
<th>Experience Range</th>
<th>Percentage</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>20%</td>
<td>15</td>
</tr>
<tr>
<td>6-10</td>
<td>15%</td>
<td>11</td>
</tr>
<tr>
<td>11-15</td>
<td>12%</td>
<td>9</td>
</tr>
<tr>
<td>16-20</td>
<td>12%</td>
<td>9</td>
</tr>
<tr>
<td>21-25</td>
<td>11%</td>
<td>8</td>
</tr>
<tr>
<td>26-35</td>
<td>12%</td>
<td>9</td>
</tr>
<tr>
<td>36+</td>
<td>18%</td>
<td>13</td>
</tr>
</tbody>
</table>

**How Plants are Obtained**

<table>
<thead>
<tr>
<th>How Obtained</th>
<th>Percentage</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>I harvest all myself</td>
<td>49%</td>
<td>36</td>
</tr>
<tr>
<td>I harvest most myself</td>
<td>16%</td>
<td>12</td>
</tr>
<tr>
<td>I harvest about half and about half are supplied by someone else</td>
<td>11%</td>
<td>8</td>
</tr>
<tr>
<td>I am supplied most by someone else</td>
<td>14%</td>
<td>10</td>
</tr>
<tr>
<td>I am supplied all by someone else</td>
<td>11%</td>
<td>8</td>
</tr>
</tbody>
</table>

**Adherence to Cultural Traditions**

<table>
<thead>
<tr>
<th>Adherence</th>
<th>Percentage</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>5%</td>
<td>4</td>
</tr>
<tr>
<td>A bit</td>
<td>62%</td>
<td>46</td>
</tr>
<tr>
<td>A lot</td>
<td>32%</td>
<td>24</td>
</tr>
</tbody>
</table>

These variables will be discussed in the subsequent analyses and were chosen because they are associated with LEK in other research and because my own earlier research indicated their relevancy.
9.1.2 Plants used in LEK survey

The plants in the table below were chosen as the foci for the LEK survey because they emerged from earlier research phases (e.g., interviews, market surveys, inventories) as those that are widely known and harvested relatively intensely. The first six plants listed are among the top 25% sold commercially. The last three are commonly known medicinal plants, although they did not rank among the top 25%. One (*Harrisonia abyssinica* Oliv. Simaroubaceae) is a commercially traded species but the other two (*Aspilia mossambicensis* (Oliv.) Wild Asteraceae and *Steganotaenia araliacea* Hochst. Apiaceae) are more typical of home use. These three were chosen because they are among those used by TAWG, which has generated a consistently strong demand for these plants for more than ten years. This means they are also harvested relatively intensely. In summary, these nine species are important to harvesters, vendors, healers, consumers, and (due to their relatively intense harvest) to resource managers.

<table>
<thead>
<tr>
<th>Species</th>
<th>Family</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Zanthoxylum chalybeum</em> Engl. var. chalybeum</td>
<td>Rutaceae</td>
</tr>
<tr>
<td><em>Albizia anthelmintica</em> Brongn.</td>
<td>Fabaceae</td>
</tr>
<tr>
<td><em>Morella salicifolia</em> A. Rich. subsp. kilimandscharica* Engl.</td>
<td>Myricaceae</td>
</tr>
<tr>
<td><em>Artemisia afra</em> Jacq. ex Wild</td>
<td>Asteraceae</td>
</tr>
<tr>
<td><em>Warburgia stuhlmannii</em> Engl.</td>
<td>Canellaceae</td>
</tr>
<tr>
<td><em>Ocotea usambarensis</em> Engl.</td>
<td>Lauraceae</td>
</tr>
<tr>
<td><em>Harrisonia abyssinica</em> Oliv.</td>
<td>Simaroubaceae</td>
</tr>
<tr>
<td><em>Aspilia mossambicensis</em> (Oliv.) Wild</td>
<td>Asteraceae</td>
</tr>
<tr>
<td><em>Steganotaenia araliacea</em> Hochst.</td>
<td>Apiaceae</td>
</tr>
</tbody>
</table>
9.1.3 Range of LEK scores

The 74 participants exhibited a range of knowledge levels for these nine species. The number of plants identified ranged from zero to nine. Total LEK Scores ranged from 0-95, with an average of 35.0 and a median of 33.5 (±19.8). Six participants scored above 55, and eight scored below 11. Only one participant scored zero (because he did not identify any of the plants). Figure 24 graphs the range of LEK Scores.

![Range of Total LEK Scores](image)

Figure 24. LEK Scores of all 74 Participants

9.1.4 Hypotheses

My underlying hypothesis is that there are relationships between LEK and sociodemographic variables. I use Principal Component Analysis (PCA) to explore relationships among variables, and Spearman Correlations and Analysis of Variance (ANOVA) to test the following hypotheses:
H1 Healers have higher levels of LEK than vendors and harvesters
H2 Vendors have lower levels of LEK than healers and harvesters
H3 LEK is negatively correlated with increasing formal education
H4 LEK is positively correlated with years of experience
H5 LEK is positively correlated with age
H6 LEK is positively correlated with the length of contact in a given environment
H7 LEK is positively correlated with use of tunguri
H8 People who collect their own plants have more LEK than those who are supplied by others
H9 LEK is positively correlated with adherence to cultural lifestyles and traditions
H10 Women have higher LEK levels than men
H11 Culturally based and ecologically based LEK are positively correlated

9.2 Principal Component Analysis Description and Application

Principal components analysis (PCA) is an ordination technique that is used to organize sampling entities (e.g., sites, individuals, species) along a meaningful continuum “based on the interrelationships among a large number of interdependent variables. Specifically, the objective is to condense the information contained in the original variables into a smaller set of dimensions (i.e., principal components), defined as linear combinations of the original variables, that describe maximum variation among individual sampling entities” (McGarigal, et al. 2000:268).

In other words, from a large number of variables PCA identifies a smaller number of variables that can best describe the sources of greatest variation within the sample. PCA is useful in determining which variables most influence variation in the data, describing the strength of the relationships among variables, and revealing whether the observations that comprise the data set can be classified into discrete groups or not. I am particularly interested in whether or not any discrete groups emerge from these analyses based on sociodemographic variables of the LEK survey participants.
9.2.1 Evaluating Adequacy of Sample Size for PCA

McGarigal and coauthors describe four rules for determining if a sample size is adequate for PCA (2000:35). These rules are listed below as A-D. For the equations:

N = sample, P = number of individuals. I inserted my sample size (N=74) and number of variables (P=11) into these equations to evaluate whether or not they are appropriate for PCA.

<table>
<thead>
<tr>
<th>Rule</th>
<th>Equation</th>
<th>My Data</th>
<th>Interpretation of Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule A</td>
<td>$N = 20 + 3P$</td>
<td>$N = 20 + 3(11) = 53$</td>
<td>Yes because $74 &gt; 53$</td>
</tr>
<tr>
<td>Rule B</td>
<td>$N = 4P$</td>
<td>$N = 4(11) = 44$</td>
<td>Yes because $74 &gt; 44$</td>
</tr>
<tr>
<td>Rule C</td>
<td>$N = 10P$</td>
<td>$N = 10(11) = 110$</td>
<td>No because $74 &lt; 110$</td>
</tr>
<tr>
<td>Rule D</td>
<td>$N: P \geq 3:1$</td>
<td>$N: P = 74:11$</td>
<td>Yes because $74:11 \geq 3:1$</td>
</tr>
</tbody>
</table>

With a total of 74 participants, my sample meets the requirements for rules A, B, and D which means it is adequate to use PCA. Because it does not meet the criterion of rule C, I should be more cautious in interpreting my results than if I had a sample size of 110 or more. Still, many researchers apply PCA to sample sizes that meet only minimum ratios, and my sample is exceeds a minimally acceptable size.

First, I applied PCA to my sample of 74 individuals and 11 variables (those shown in Table 9.1) to evaluate which specific variables (sociodemographic and LEK levels) best explain variation in my data, the relationships among specific sociodemographic variables with LEK levels, and whether discrete categories emerge with regard to how specific sociodemographic variables relate to LEK.
### Key to Abbreviated Variables used in PCA One & Two

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description (codes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role</td>
<td>Harvester (0), Healer (1), Vendor (2), or - status assigned by me</td>
</tr>
<tr>
<td>ID Healer</td>
<td>Whether a participant self-identified as a healer (1) or not (0)</td>
</tr>
<tr>
<td>Obtain Plants</td>
<td>Five options from harvesting all yourself (1) to obtaining all from someone else (5)</td>
</tr>
<tr>
<td>Age</td>
<td>Number of years since birth</td>
</tr>
<tr>
<td>Educ</td>
<td>Level of formal education: none (0), primary (1), secondary (2), or post-secondary (3)</td>
</tr>
<tr>
<td>Yrs Exp</td>
<td>Number of years experience with medicinal plants</td>
</tr>
<tr>
<td>Tunguri Use</td>
<td>Whether participant uses tunguri (1) or not (0)</td>
</tr>
<tr>
<td>Cx Trad</td>
<td>Degree to which s/he reports adhering to cultural traditions: not at all (0), a bit (1), or a lot (2)</td>
</tr>
<tr>
<td>Eco</td>
<td>Ecologically-based knowledge score</td>
</tr>
<tr>
<td>Cx</td>
<td>Culturally-based knowledge score</td>
</tr>
<tr>
<td>Total LEK Score</td>
<td>Cumulative score: ecologically-based knowledge + culturally-based knowledge + the number of plants identified</td>
</tr>
<tr>
<td>Gender</td>
<td>Male (1) or Female (0)</td>
</tr>
<tr>
<td>% Life at Current Residence</td>
<td>Years living in current district of residence divided by years of age</td>
</tr>
</tbody>
</table>

### 9.3 PCA ONE: Ten Sociodemographic Variables and Total LEK Scores

#### 9.3.1 Identifying relationships among variables

To evaluate these eleven hypotheses, I begin by looking at the correlation matrix of the ten variables and identify those most correlated with Total LEK Score. Variables most correlated with each other will have values that approach one. Negative correlation coefficients represent inverse relationship, but these should be interpreted differently for categorical data, as will be discussed below. The most important thing to note in the correlation matrix below is that none of the sociodemographic variables (i.e., those in Table 9.3) is highly correlated with Total LEK Score. (Total TEK Score is the aggregate score of the ecologically-based knowledge, culturally-based knowledge, and the number of plants identified.)
Table 9.3. PCA One: Correlation Matrix

<table>
<thead>
<tr>
<th>Role</th>
<th>ID Healer</th>
<th>Obtain Plants</th>
<th>Age</th>
<th>Educ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role</td>
<td>1.0000</td>
<td>0.2605</td>
<td>0.5431</td>
<td>-0.1303</td>
</tr>
<tr>
<td>ID Healer</td>
<td>0.2605</td>
<td>1.0000</td>
<td>0.0094</td>
<td>0.3490</td>
</tr>
<tr>
<td>Obtain Plants</td>
<td>0.5431</td>
<td>0.0094</td>
<td>1.0000</td>
<td>-0.0616</td>
</tr>
<tr>
<td>Age</td>
<td>-0.1303</td>
<td>-0.0221</td>
<td>0.0530</td>
<td>1.0000</td>
</tr>
<tr>
<td>Educ</td>
<td>-0.0221</td>
<td>0.1392</td>
<td>0.0530</td>
<td>0.0914</td>
</tr>
<tr>
<td>Yrs Exp</td>
<td>0.0707</td>
<td>0.3053</td>
<td>0.0468</td>
<td>0.6852</td>
</tr>
<tr>
<td>Tunguri Use</td>
<td>0.0499</td>
<td>0.6733</td>
<td>-0.1863</td>
<td>0.3403</td>
</tr>
<tr>
<td>CxTrad</td>
<td>-0.0088</td>
<td>0.0041</td>
<td>-0.1121</td>
<td>0.1340</td>
</tr>
<tr>
<td>Total LEK Score</td>
<td>0.0177</td>
<td>-0.1628</td>
<td>-0.098</td>
<td>-0.1014</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.1568</td>
<td>-0.1379</td>
<td>-0.3307</td>
<td>0.1584</td>
</tr>
<tr>
<td>% Life at Current Residence</td>
<td>-0.4439</td>
<td>-0.1986</td>
<td>-0.1725</td>
<td>0.4094</td>
</tr>
</tbody>
</table>

Table 9.3. (Continued) PCA One: Correlation Matrix

<table>
<thead>
<tr>
<th>Yrs Exp</th>
<th>Tunguri Use</th>
<th>Cx Trad</th>
<th>Total LEK Score</th>
<th>Gender</th>
<th>% Life at Current Residence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.0707</td>
<td>0.0499</td>
<td>-0.0088</td>
<td>0.0177</td>
<td>-0.1568</td>
<td>-0.4439</td>
</tr>
<tr>
<td>ID Healer</td>
<td>0.3053</td>
<td>0.6733</td>
<td>0.0041</td>
<td>-1628</td>
<td>-0.1379</td>
</tr>
<tr>
<td>Obtain Plants</td>
<td>0.0468</td>
<td>-0.1863</td>
<td>-0.1121</td>
<td>-0.098</td>
<td>-0.3307</td>
</tr>
<tr>
<td>Age</td>
<td>0.6852</td>
<td>0.3403</td>
<td>0.1340</td>
<td>-1.014</td>
<td>0.1584</td>
</tr>
<tr>
<td>Educ</td>
<td>0.0825</td>
<td>0.0395</td>
<td>-0.2240</td>
<td>-1939</td>
<td>-0.1906</td>
</tr>
<tr>
<td>Yrs Exp</td>
<td>1.0000</td>
<td>0.2946</td>
<td>0.0287</td>
<td>0.0687</td>
<td>-0.0608</td>
</tr>
<tr>
<td>Tunguri Use</td>
<td>0.2946</td>
<td>1.0000</td>
<td>0.1853</td>
<td>0.0307</td>
<td>-0.0750</td>
</tr>
<tr>
<td>Cx Trad</td>
<td>0.0287</td>
<td>0.1853</td>
<td>1.0000</td>
<td>0.0517</td>
<td>0.1514</td>
</tr>
<tr>
<td>Total LEK Score</td>
<td>0.0667</td>
<td>0.0307</td>
<td>0.0517</td>
<td>1.0000</td>
<td>-0.1836</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.0608</td>
<td>-0.0750</td>
<td>0.1514</td>
<td>-1836</td>
<td>1.0000</td>
</tr>
<tr>
<td>% Life at Current Residence</td>
<td>0.3606</td>
<td>0.0133</td>
<td>0.1353</td>
<td>0.0828</td>
<td>0.1488</td>
</tr>
</tbody>
</table>

The variables most correlated with Total LEK Score are: Education (-0.1939), Gender (-0.1836), and ID Healer (-0.1628); however, these correlations are all weak and explain only 19%, 18% and 16% of variation in the data, respectively. (For comparison, relatively strong correlations exist between Age and Years of Experience, 0.6852). LEK is negatively correlated with education (H3), but this correlation is not strong. The
negative correlation between LEK and gender represents a correlation between males and higher LEK, since males were coded with one and females with zero. This does not support the hypothesis (H10) above. LEK is also weakly, negatively correlated with healer status, which means that people who did not self-identify as healers were correlated with higher LEK scores. This does not support the hypothesis that healers have the highest levels of LEK (H1). These weak correlations suggest that none of these should be given much consideration, but the statistical significance of the relationships between LEK and education, gender, and healer status will be examined toward the end of this chapter with the Spearman Correlation test.

9.3.2 Identifying Which Variables Best Explain Variation in the Data

Step One

To explore which variables best explain variation in the data (in this case I am interested in variation in LEK scores) look at principal components. Each principal component is represented by an eigenvalue. “The first eigenvalue is the largest. Therefore, the first principal component defines the dimension or gradient with the single height variance (i.e., the maximum variance among entities). The second eigenvalue measures the variance along the second principal component; it represents the largest variance in a dimension orthogonal to (i.e., independent of) the first dimension. Thus, the second component provides the greatest explanation of sample variance after the first has done its best” (McGarigal, et al. 2000:38). The same trend continues with subsequent eigenvalues. Typically only the first three principal components are considered because they correspond with the most variation and dealing with more than three can become
confusing and counter productive to the goal of identifying a subsection of the total variables that are best able to explain variation.

The absolute values of the eigenvalues have no direct interpretive value, but the proportion of variance they represent is of interpretive value. The larger the eigenvalue the greater power it has to explain variation in that component. “Components with small eigenvalues are more likely to describe error variance or represent influences which affect only one or very few of the variables in the system” (McGarigal, et al. 2000:41).

Table 9.4. PCA One Eigenvalues

<table>
<thead>
<tr>
<th>Eigenvalue</th>
<th>Difference</th>
<th>Proportion</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.46171777</td>
<td>0.33447895</td>
<td>0.2238</td>
<td>0.2238</td>
</tr>
<tr>
<td>2.12701496</td>
<td>0.77821815</td>
<td>0.1934</td>
<td>0.4171</td>
</tr>
<tr>
<td>1.34841428</td>
<td>0.1226</td>
<td>0.5398</td>
<td></td>
</tr>
</tbody>
</table>

The most common approach to judge the importance of a principal component is by the latent root criterion, which drops components with eigenvalues less than one from further consideration in the analysis (McGarigal, et al. 2000:41). All three eigenvalues here are more than one and so are considered. Here we see that 54% of variation in data is explained by these three principal components. The first (strongest) component alone has the power to explain 22% of variation in the data.

**Step Two**

The second step in identifying which variables best explain variation in the data is to look at the eigenvectors of the principal components and identifying the largest “loadings” or correlations between the variables and of each principal components.
Evaluating Principal Component Loadings

Significant $> 0.30$ or $<-0.30$
More Important $> 0.40$ or $<-0.40$
Very Significant $> 0.50$ or $<-0.50$


"Variables with higher loadings are considered more important in interpreting each component; they greatly influence the name or label selected to represent a component" (McGarigal, et al. 2000:53). Also important to note is whether a loading is positive or negative. Positive correlations indicate a direct relationship and negative values indicate an inverse relationship. (As with the correlation matrix, nominally ranked variables should be interpreted differently than continuous values.)

Table 9.5. PCA One Eigenvectors

<table>
<thead>
<tr>
<th>Principal Component 1</th>
<th>Principal Component 2</th>
<th>Principal Component 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role</td>
<td>-0.096572</td>
<td>0.516340</td>
</tr>
<tr>
<td>ID Healer</td>
<td>0.370427</td>
<td>0.399607</td>
</tr>
<tr>
<td>Obtain Plants</td>
<td>-0.153042</td>
<td>0.415829</td>
</tr>
<tr>
<td>Age</td>
<td>0.539874</td>
<td>-0.039523</td>
</tr>
<tr>
<td>Educ</td>
<td>0.089082</td>
<td>0.186097</td>
</tr>
<tr>
<td>Yrs Exp</td>
<td>0.481914</td>
<td>0.085850</td>
</tr>
<tr>
<td>Tunguri</td>
<td>0.431811</td>
<td>0.203507</td>
</tr>
<tr>
<td>Cx Trad</td>
<td>0.148298</td>
<td>-0.148877</td>
</tr>
<tr>
<td>Total LEK Score</td>
<td>0.044697</td>
<td>-0.048056</td>
</tr>
<tr>
<td>Gender</td>
<td>0.066702</td>
<td>-0.362660</td>
</tr>
<tr>
<td>% Life at Current</td>
<td>0.285677</td>
<td>-0.048056</td>
</tr>
<tr>
<td>Residence</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Principal Component  Three Highest Significant Loadings
1                      Age, Yrs Exp, Tunguri
2                      Role, Obtain Plants, ID Healer
3                      Cx Trad (negative), % Life at current residence, Tunguri (negative)
The largest loadings for the first principal component are Age (0.539874), Years Experience (0.481914), and Tunguri Use (0.431811). Since we are interested in the relationships between LEK and sociodemographic variables it is worth noting that Total LEK Score has a very small loading (0.044697) in principal component one, as well as for the second and third principal components. None of them is a significant value. In fact, Total LEK Score is the only variable that has no significant loadings for any of the three components, and all of them are far from significant. This means that it was not highly correlated with any of the other variables. In other words the Total LEK Score has negligible power to explain variation in the data with regard to the other sociodemographic variables. In the third principal component we see that Adherence to Cultural Traditions is negatively correlated with Education and the Amount of Time Spent at Current Residence. This means that people who have spent more time in the district they currently live in (i.e., they are long time residents not recent immigrants) reported adhering less to cultural traditions and fewer reported using tunguri; however, this trend is not strong as it explains only 12% of variation in the data as seen in the proportion of the third component. It should not be given much weight in explaining variation in the data. Each of these components is represented in multidimensional space and plotted in order to visualize relationships among variables.

Step Three

After examining the relationships between the individual variables and the principal components (as in step two), the third step in interpreting the principal
components is to “examine the relative positions of the sampling entities in ordination space” (McGarigal, et al. 2000:57). This is done by interpreting the plots.

Plots are graphic representations of the component scores. “Each sampling entity in the data set has a score on each principal component or a location on each principal component axis) that is derived by multiplying the observed values of each variable (in standard form) by the corresponding standardized scoring coefficients (i.e., standardized principal component weights) and summing the products” (McGarigal, et al. 2000:57). Variables in proximity to each other are positively correlated. Each point, marked here by a number, represents an individual participant (1-74). Looking for groupings among the points is instructive for developing or examining hypotheses about what participants have in common. (In this case, I am interested in what they have in common in terms of sociodemographic variables.) The length of the variable’s arrow is related to the strength it has to explain variation in the data (as it corresponds to its loading in the component). Group of points (i.e., individual people in this case) or arrows that are opposite each other are negatively correlated.

In the plot below (Figure 25), “Dimension 1” corresponds to Principal Component One, which is oriented along the y-axis and shows the variables Age, Years Experience, and Tunguri Use at the top. Participants who are related by those variables are found near the apexes of those arrows, and participants who are opposite them, at the bottom of the plot are opposite from those found at the top in terms of those variables (i.e., lower ages, fewer years of experience, and do not use tunguri).
The second principal component is comprised of Role, How You Obtain Plants, and Self-Identification as Healer. These relationships make sense as the role (i.e., harvester, vendor, or healer) is often defined by how plants are obtained (e.g., harvesters harvest all their own while vendors tend to be supplied). Those who self-identify as healers would also naturally have strong correlations with those who I categorized in the healer role. (All individuals I categorized as healers also self-identified as healers.) Because Total LEK Score is not significant in this component, it means that it is not correlated with role.

My underlying hypothesis is that there are relationships between LEK and sociodemographic variables, but the widely dispersed and scattered points in the plot show no distinct groupings among participants, which indicates no relationships among the eleven variables. Further, Total LEK Score is the only variable that is not significant
for any of the three principal components it has the shortest arrow showing its very negligible contribution to explain variation in the data. If there were clusters of points (participants) in the plot, the next step would be to look at the sociodemographic data on those individuals and see what they have in common, but this is not the case.

9.4 PCA TWO: Ten Sociodemographic Variables, Culturally based LEK Levels, Ecologically Based LEK Levels, and Total LEK Levels

This PCA looks at the same sociodemographic variables and Total LEK Scores (which combine culturally based and ecologically based LEK) as in PCA One (Table 9.3). It also includes the individual Culturally based LEK Scores and Ecologically based LEK Scores in order to look at the relationships among the sociocultural variables and the two types of knowledge. This PCA shows a strong correlation between culturally based and ecologically based knowledge. (The significance of this relationship is tested later in this section.) Individuals who could identify a plant typically have both cultural and ecological knowledge about it.

In Figure 26 below, the cluster of the four individuals with the highest scores (72, 66, 60, and 13) have some characteristics in common. Three of the four are Sambaa, the fourth is a Fipa. Three of the four act as healers, the fourth is a vendor. All four are male healers that use tunguri and are between the ages of 51 and 55. The cluster of the four individuals with the lowest scores (16, 73, 10, 45) are also mostly Sambaa, only one is not, he is an Mpangwa. Three are harvesters and one is a vendor. Three are men, one is a woman. None are healers and so none use tunguri. Their ages range from 18 to 78. Although it is tempting to seek out patterns here, none of these sociodemographic trends
(e.g., in role, age, gender) associated with knowledge in these groups is significant, as is shown by the Spearman correlation coefficient tests in section 9.6.

Figure 26. Plot for PCA Two

Table 9.6. PCA TWO: Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Role</th>
<th>ID Healer</th>
<th>Obtain Plants</th>
<th>Age</th>
<th>Edu</th>
<th>Yrs Exp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role</td>
<td>1.0000</td>
<td>0.2605</td>
<td>0.5431</td>
<td>-1.303</td>
<td>-0.0221</td>
<td>0.0707</td>
</tr>
<tr>
<td>ID Healer</td>
<td>0.2605</td>
<td>1.0000</td>
<td>0.0094</td>
<td>0.3490</td>
<td>0.1392</td>
<td>0.3053</td>
</tr>
<tr>
<td>Obtain Plants</td>
<td>0.5431</td>
<td>0.0094</td>
<td>1.0000</td>
<td>-0.0616</td>
<td>0.0530</td>
<td>0.0468</td>
</tr>
<tr>
<td>Age</td>
<td>-1.303</td>
<td>0.3490</td>
<td>-0.0616</td>
<td>1.0000</td>
<td>0.0914</td>
<td>0.6852</td>
</tr>
<tr>
<td>Edu</td>
<td>-0.0221</td>
<td>0.1392</td>
<td>0.0530</td>
<td>0.0914</td>
<td>1.0000</td>
<td>0.0825</td>
</tr>
<tr>
<td>Yrs Exp</td>
<td>0.0707</td>
<td>0.3053</td>
<td>0.0468</td>
<td>0.6852</td>
<td>0.0825</td>
<td>1.0000</td>
</tr>
<tr>
<td>Tunguri</td>
<td>0.0499</td>
<td>0.8733</td>
<td>-0.1863</td>
<td>0.3403</td>
<td>0.0395</td>
<td>0.2946</td>
</tr>
<tr>
<td>Cx Trad</td>
<td>-0.0088</td>
<td>0.0041</td>
<td>-0.1121</td>
<td>0.1340</td>
<td>-0.2240</td>
<td>0.0287</td>
</tr>
<tr>
<td>Gender</td>
<td>-1.568</td>
<td>-1.379</td>
<td>-3.307</td>
<td>0.1584</td>
<td>-1.906</td>
<td>-0.6068</td>
</tr>
<tr>
<td>% Life at Current Residence</td>
<td>-0.4439</td>
<td>-1.986</td>
<td>-1.725</td>
<td>0.4094</td>
<td>-0.0505</td>
<td>0.3606</td>
</tr>
<tr>
<td>Eco</td>
<td>0.0409</td>
<td>-1.416</td>
<td>-0.0057</td>
<td>-1.222</td>
<td>-1.627</td>
<td>0.0239</td>
</tr>
<tr>
<td>Total LEK</td>
<td>0.0177</td>
<td>-1.628</td>
<td>-0.0098</td>
<td>-1.014</td>
<td>-1.939</td>
<td>0.0667</td>
</tr>
<tr>
<td>Cx</td>
<td>0.0491</td>
<td>0.2066</td>
<td>-0.1254</td>
<td>0.0687</td>
<td>0.0671</td>
<td>0.2020</td>
</tr>
</tbody>
</table>
Table 9.6. (Continued) PCA TWO: Correlation Matrix

<table>
<thead>
<tr>
<th>Tunguri</th>
<th>Cx Trad</th>
<th>Gender</th>
<th>% Life at Current Residence</th>
<th>Eco</th>
<th>Total LEK</th>
<th>Cx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role</td>
<td>0.0499</td>
<td>-0.088</td>
<td>-0.1568</td>
<td>-0.4439</td>
<td>0.0409</td>
<td>0.0177</td>
</tr>
<tr>
<td>ID Healer</td>
<td>0.6733</td>
<td>0.0041</td>
<td>-0.1379</td>
<td>-0.1986</td>
<td>-0.1416</td>
<td>-0.1628</td>
</tr>
<tr>
<td>Obt Plants</td>
<td>-0.1863</td>
<td>-0.1121</td>
<td>-0.3307</td>
<td>-0.1725</td>
<td>-0.0057</td>
<td>-0.0098</td>
</tr>
<tr>
<td>Age</td>
<td>0.3403</td>
<td>0.1340</td>
<td>0.1584</td>
<td>0.4094</td>
<td>-0.1222</td>
<td>-0.1014</td>
</tr>
<tr>
<td>Edu</td>
<td>0.0395</td>
<td>-0.2240</td>
<td>-0.1906</td>
<td>-0.0505</td>
<td>-0.1627</td>
<td>-0.1939</td>
</tr>
<tr>
<td>Yrs Exp</td>
<td>0.2946</td>
<td>0.0287</td>
<td>-0.0608</td>
<td>0.3606</td>
<td>0.0239</td>
<td>0.0667</td>
</tr>
<tr>
<td>Tunguri</td>
<td>1.0000</td>
<td>0.1853</td>
<td>-0.0750</td>
<td>0.0133</td>
<td>0.0298</td>
<td>0.0307</td>
</tr>
<tr>
<td>Cx Trad</td>
<td>0.1853</td>
<td>1.0000</td>
<td>0.1514</td>
<td>0.1353</td>
<td>0.0753</td>
<td>0.0517</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.0750</td>
<td>0.1514</td>
<td>1.0000</td>
<td>0.1488</td>
<td>-0.1806</td>
<td>-0.1836</td>
</tr>
<tr>
<td>% Life at Current Residence</td>
<td>0.0133</td>
<td>0.1353</td>
<td>0.1488</td>
<td>1.0000</td>
<td>0.0576</td>
<td>0.0626</td>
</tr>
<tr>
<td>Eco</td>
<td>0.0298</td>
<td>0.0753</td>
<td>-0.1806</td>
<td>0.0576</td>
<td>1.0000</td>
<td>0.9839</td>
</tr>
<tr>
<td>Total LEK</td>
<td>0.0307</td>
<td>0.0517</td>
<td>-0.1836</td>
<td>0.0826</td>
<td>0.9839</td>
<td>1.0000</td>
</tr>
<tr>
<td>Cx</td>
<td>0.2503</td>
<td>-0.0299</td>
<td>-0.1447</td>
<td>0.0560</td>
<td>0.6300</td>
<td>0.6354</td>
</tr>
</tbody>
</table>

As is the case with the first PCA, the Cultural Scores alone (abbreviated as Cx in the table), and the Ecological Scores (abbreviated as Eco in the table) alone are very weakly correlated with all sociodemographic variables. Ecological Scores and Total LEK Scores are very closely correlated with each other, and Cultural Scores are also highly correlated with both. Healers do not have the strongest cultural levels of knowledge about these nine medicinal plants, although other qualitative analyses (discussed later) show they know of more pre- and proscriptions for medicinal plant collection (one of the measures of culturally based LEK levels). Knowledge is distributed among social groups and not focused in one group, as seen by the scattered distribution of points. In the correlation matrix, Years of Experience is weakly correlated with Cultural Scores Alone (0.2020) and even less correlated with Ecological Scores Alone (0.0239) and Total LEK Scores (0.0667). This provides negligible support for the hypothesis that Years of Experience is correlated with LEK (H4). In order to say it these correlations are significant, they would
need to be tested with the Spearman Correlation test, but it is already apparent that they will not be significant.

Table 9.7. PCA Two Eigenvalues

<table>
<thead>
<tr>
<th>Eigenvalue</th>
<th>Difference</th>
<th>Proportion</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.66506620</td>
<td>0.18175478</td>
<td>0.2050</td>
<td>0.2050</td>
</tr>
<tr>
<td>2.48331142</td>
<td>0.34534354</td>
<td>0.1910</td>
<td>0.3960</td>
</tr>
<tr>
<td>2.13796788</td>
<td>0.1645</td>
<td>0.5605</td>
<td></td>
</tr>
</tbody>
</table>

Table 9.8. PCA Two Eigenvectors

<table>
<thead>
<tr>
<th>Role</th>
<th>Principal Component 1</th>
<th>Principal Component 2</th>
<th>Principal Component 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID Healer</td>
<td>0.016973</td>
<td>-0.088492</td>
<td>0.513875</td>
</tr>
<tr>
<td>Obtain Plants</td>
<td>0.157706</td>
<td>0.371845</td>
<td>0.376709</td>
</tr>
<tr>
<td>Age</td>
<td>-0.060155</td>
<td>-0.127109</td>
<td>0.415732</td>
</tr>
<tr>
<td>Edu</td>
<td>-0.047142</td>
<td>0.131493</td>
<td>0.194997</td>
</tr>
<tr>
<td>Yrs Exp</td>
<td>0.271989</td>
<td>0.392077</td>
<td>0.043752</td>
</tr>
<tr>
<td>Tunquri</td>
<td>0.264838</td>
<td>0.356649</td>
<td>0.169310</td>
</tr>
<tr>
<td>Cx Trad</td>
<td>0.088068</td>
<td>0.093660</td>
<td>-0.169079</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.133544</td>
<td>0.124928</td>
<td>-0.355241</td>
</tr>
<tr>
<td>% Life at Current Residence</td>
<td>0.143834</td>
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<tr>
<td>Eco</td>
<td>0.495877</td>
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<td>-0.063495</td>
</tr>
<tr>
<td>Total LEK</td>
<td>0.502749</td>
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<td>-0.078823</td>
</tr>
<tr>
<td>Cx</td>
<td>0.497302</td>
<td>-0.084970</td>
<td>0.046138</td>
</tr>
</tbody>
</table>

Principal Component Significant Loadings

1. Total LEK, Cultural Knowledge, Ecological Knowledge
2. Age, Years experience, Self-identify as a Healer
3. Role, % Life at current residence (negative), Obtain Plants

The first principal component indicates a strong relationship among the ecologically based and culturally based knowledge. (This is tested later in this section using the Spearman correlation coefficient to evaluate whether or not it is significant.) The second
component shows the relationships among age, years of experience, and healers. The third principal component shows a relationship between role and the way plants are obtained. Because the codes for role are Harvester=1, Healer=2, and Vendor=3; and the codes for the way plants are obtained are on a progressive scale from one to five where 1=all plants are harvested by the participant and 5=all plants are obtained from someone else (e.g., they are purchased), this shows a correlation between harvesters who tend to harvest all their own plants and vendors who tend to obtain all their plants from someone else. (This was examined and explained in Chapter Six.) These factors (role and how plants are obtained) have a negative relationship with the amount of time spent in the environment where the participant currently lives which means that harvesters (coded 1) have lived in their current environment for the longest and vendors (coded 3) have lived in their current environment for the shortest times.

9.5 PCA THREE: LEK Scores for Nine Species

Since neither role nor any of the other sociodemographic variables correlate strongly with LEK scores, I took a different approach to look at correlations with knowledge. This PCA shows the relationships among the individual LEK scores for each of the nine species used in the survey to look for patterns in the plants people know and if groups of people or plants cluster together. (The two highest correlations for each species are highlighted below.)
### Key to coded variables used in PCA THREE

<table>
<thead>
<tr>
<th>Abbreviated Variable</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>War</td>
<td>Warburgia stuhlmannii</td>
</tr>
<tr>
<td>Zan</td>
<td>Zanthoxylum chalybeum</td>
</tr>
<tr>
<td>Har</td>
<td>Harrisonia abyssinica</td>
</tr>
<tr>
<td>Alb</td>
<td>Albizia anthelmintica</td>
</tr>
<tr>
<td>Ste</td>
<td>Steganotaenia araliacea</td>
</tr>
<tr>
<td>Asp</td>
<td>Aspilia mossambicensis</td>
</tr>
<tr>
<td>Oco</td>
<td>Ocotea usambarensis</td>
</tr>
<tr>
<td>Mor</td>
<td>Morella salicifolia</td>
</tr>
<tr>
<td>Art</td>
<td>Artemisia afra</td>
</tr>
</tbody>
</table>

#### Table 9.9. PCA Three: Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Zan</th>
<th>Alb</th>
<th>Mor</th>
<th>Art</th>
<th>War</th>
<th>Oco</th>
<th>Har</th>
<th>Asp</th>
<th>Ste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zan</td>
<td>1.0000</td>
<td>0.4121</td>
<td>0.0746</td>
<td>-0.1938</td>
<td>0.3952</td>
<td>0.0834</td>
<td>0.5349</td>
<td>0.1162</td>
<td>0.1247</td>
</tr>
<tr>
<td>Alb</td>
<td>0.4121</td>
<td>1.0000</td>
<td>0.1369</td>
<td>0.0336</td>
<td>0.3714</td>
<td>0.0376</td>
<td>0.4691</td>
<td>0.1324</td>
<td>0.1939</td>
</tr>
<tr>
<td>Mor</td>
<td>0.0746</td>
<td>0.1369</td>
<td>1.0000</td>
<td>0.3931</td>
<td>-0.1302</td>
<td>0.5387</td>
<td>-0.0341</td>
<td>0.3416</td>
<td>0.1996</td>
</tr>
<tr>
<td>Art</td>
<td>-0.1938</td>
<td>0.0336</td>
<td>0.3931</td>
<td>1.0000</td>
<td>-0.1050</td>
<td>0.2966</td>
<td>-0.1809</td>
<td>0.2174</td>
<td>0.2735</td>
</tr>
<tr>
<td>War</td>
<td>0.3952</td>
<td>0.3714</td>
<td>-0.1302</td>
<td>-1.050</td>
<td>1.0000</td>
<td>-0.0192</td>
<td>0.2595</td>
<td>0.0348</td>
<td>-0.0703</td>
</tr>
<tr>
<td>Oco</td>
<td>0.0834</td>
<td>0.0376</td>
<td>0.5387</td>
<td>0.2966</td>
<td>-0.0192</td>
<td>1.0000</td>
<td>0.0332</td>
<td>0.1671</td>
<td>0.1040</td>
</tr>
<tr>
<td>Har</td>
<td>0.5349</td>
<td>0.4691</td>
<td>-0.0341</td>
<td>-1.809</td>
<td>0.2595</td>
<td>0.0332</td>
<td>1.0000</td>
<td>0.3607</td>
<td>0.2655</td>
</tr>
<tr>
<td>Asp</td>
<td>0.1162</td>
<td>0.1324</td>
<td>0.3416</td>
<td>0.2174</td>
<td>0.0348</td>
<td>0.1671</td>
<td>0.3607</td>
<td>1.0000</td>
<td>0.4745</td>
</tr>
<tr>
<td>Ste</td>
<td>0.1247</td>
<td>0.1939</td>
<td>0.1996</td>
<td>0.2735</td>
<td>-0.0703</td>
<td>0.1040</td>
<td>0.2655</td>
<td>0.4745</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

#### Table 9.10. PCA Three Eigenvalues

<table>
<thead>
<tr>
<th>Eigenvalue</th>
<th>Difference</th>
<th>Proportion</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.52106500</td>
<td>0.40488988</td>
<td>0.2801</td>
<td>0.2801</td>
</tr>
<tr>
<td>2.11617512</td>
<td>0.96473106</td>
<td>0.2351</td>
<td>0.5152</td>
</tr>
<tr>
<td>1.15144406</td>
<td>0.1279</td>
<td>0.1279</td>
<td>0.6432</td>
</tr>
</tbody>
</table>

#### Table 9.11. PCA Three Eigenvectors

<table>
<thead>
<tr>
<th></th>
<th>Principal Component 1</th>
<th>Principal Component 2</th>
<th>Principal Component 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zan</td>
<td>0.401041</td>
<td>-0.312063</td>
<td>0.198185</td>
</tr>
<tr>
<td>Alb</td>
<td>0.415855</td>
<td>-0.204236</td>
<td>0.147922</td>
</tr>
<tr>
<td>Mor</td>
<td>0.269305</td>
<td>0.453123</td>
<td>0.318272</td>
</tr>
<tr>
<td>Art</td>
<td>0.119322</td>
<td>0.477283</td>
<td>0.056977</td>
</tr>
<tr>
<td>War</td>
<td>0.240883</td>
<td>-0.353353</td>
<td>0.327930</td>
</tr>
<tr>
<td>Oco</td>
<td>0.224025</td>
<td>0.365648</td>
<td>0.500212</td>
</tr>
<tr>
<td>Har</td>
<td>0.447600</td>
<td>-0.276874</td>
<td>-0.381578</td>
</tr>
<tr>
<td>Asp</td>
<td>0.388635</td>
<td>0.218988</td>
<td>0.401575</td>
</tr>
<tr>
<td>Ste</td>
<td>0.346226</td>
<td>0.211217</td>
<td>0.527810</td>
</tr>
</tbody>
</table>

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Compared to the earlier PCAs that looked at total LEK scores and sociodemographic variables, these first three components explain more variation in the data (64% versus 54% in each of the first two PCAs). The relationship among groups of plants people know explains more variation in the data than the relationships shown correlation matrix of PCA which focused on sociodemographic variables.

The first two principal components explain 52% of the variation in the data, which is strong. (The third principal component is not as important to consider as it explains only 13% of variation in the data.) The points in the plot of this PCA cluster by the plants’ habitats and land use types. Those found in the first principal component (Harrisonia, Albizia, Zanthoxylum) are all found in dry bushlands, wooded grasslands, and evergreen forests up to 1550 masl. This overlaps with findings from focus groups with vendors and healers who participated in an exercise to group together plants that are found in the same habitats in proximity to each other.

The plants in principal component two (A. afr, M. salicifolia, O. usambarensis) are all found in the Usambaras Mountains at elevations of 900-2400 masl, (although Artemisia is also found up to 4000 masl). M. salicifolia and O. usambarensis may be found in direct proximity to each other in the same forest habitat (forest reserve), but A. afr prefers open areas such as heathland and wooded grasslands outside of forests. (In the study area of Tanga Region, their range is primarily in the Usambaras, but these
species are found outside of the Tanga Region as well.) The third principal component shows negative correlations between *O. usambarensis* and *S. araliacea*, as well as *O. usambarensis* and *A. mossambicensis*. This means that people who did not know *O. usambarensis* were likely to know *S. araliacea* and *A. mossambicensis*, two plants that are found in a similar habitat to each other, but very different from *O. usambarensis*, which is only found in high elevations and primarily in protected areas because it is a valued timber species and has been over-harvested in public lands. Plants from similar areas are known by the people from those areas. Plants that grow only in the Usambaras (and not in lowlands or coastal areas) are unlikely to be known by people who are not residents of or do not have ties to the Usambaras.

Expanding slightly from the significant loadings of the first three principal components by looking at the correlation matrix, we see that the relationships among plants people know are based on similarities in land use / tenure and habitat types.

<table>
<thead>
<tr>
<th>Highly Correlated Plants</th>
<th>Land Tenure, Use &amp; Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>H. araliacea</em>, <em>A. anthelmintica</em>, <em>Z. chalybeum</em> (and <em>W. stuhlmannii</em>)</td>
<td>Public/ open scrubland</td>
</tr>
<tr>
<td><em>A. afra</em>, <em>M. salicifolia</em>, <em>O. usambarensis</em></td>
<td>Not cultivated/ fallow farms</td>
</tr>
<tr>
<td><em>S. araliacea</em>, <em>A. mossambicensis</em>, <em>H. abyssinica</em>, <em>A. afra</em></td>
<td>Mountain forest</td>
</tr>
<tr>
<td></td>
<td>Near or inside forest reserve</td>
</tr>
<tr>
<td></td>
<td>Disturbed areas near homes</td>
</tr>
<tr>
<td></td>
<td>Cultivated</td>
</tr>
</tbody>
</table>

The third group of plants above that is correlated (although it did not emerge as one of the first three principal components) consists of species that are most often cultivated (for home use, not commercial purposes): *S. araliacea*, *A. mossambicensis*, and *A. afra*. The
correlation matrix shows their relationships. (S. araliacea is correlated with A. mossambicensis 48% and A. afra 27%; A. mossambicensis and A. afra are correlated 22%.)

Table 9.12. Most Cultivated Species (of the nine from the LEK Survey)

<table>
<thead>
<tr>
<th>Species</th>
<th>Participants Who Have Tried to Grow it</th>
<th>Participants Who Said it is Cultivated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artemisia afra</td>
<td>30%</td>
<td>42%</td>
</tr>
<tr>
<td>Steganotaenia araliacea</td>
<td>23%</td>
<td>43%</td>
</tr>
<tr>
<td>Aspilia mossambicensis</td>
<td>12%</td>
<td>15%</td>
</tr>
</tbody>
</table>

The plot below (Figure 27) represents these first two principal components. (The third principal component explains only 13% of the variation so it is not discussed here in detail.)

As before, each number in the plot represents a person who participated in the survey. Those who knew all or many of the plants (e.g. 72, 60 74, 13) are at the upper limits of the plot, and those who knew none (e.g., 71) or few (e.g., 10, 58, 39,) are at the bottom, opposite the arrows pointing toward the species names. Like the previous PCA, there are no distinct clusters of participants based on role, but there are some grouping tendencies related to ethnicity which is tied to the habitat type where those ethnic groups live.

The plot below (Figure 27) indicates some grouping between Maasai and Sambaa, but the groups are not totally distinctive (i.e. there are no clear spaces between groups, rather we see differences at the peripheries). These ethnic groups live in distinct habitats because knowledge is shared among groups and people are mobile, they maybe more knowledgeable about the plants in their home areas. Maasai typically live in open savannah and plains where W. stuhlmannii, Z. chalybeum, A. anthelmintica and H.
abyssinica are found (all plants used medicinally by them), and Samba live in the Usambara Mountains where O. usambarensis, A. afra, and M. salicifolia are found (all important medicinal plants to them). One of the most important medicinal and dietary plants for the Maasai is W. stuhlmannii so it is not surprising they cluster near it, and the Samba, whose montane home does not include W. stuhlmannii, are opposite it in the plot.

**Figure 27. Plot for PCA Three**
Also interesting is that *Z. chalybeum, A. anthelmintica* and *H. abyssinica* are widely distributed species that are found in both Maasai and Sambaa ranges and they are found between the two ethnic groupings because members from both group identified them. The reason that the groupings based on ethnicity and habitats are not more distinct is because their knowledge is not exclusive, it is shared. People from different ethnic groups interact (especially in Tanga Town). They share knowledge, and buy and sell plants to and from each other — regardless of ethnic group. Although people’s knowledge of the habitat and land use better explains variation in the data compared with sociodemographic variables of participants, it does not show distinctive groups of participants based on who knew which plants.

This procedure was conducted with participants’ ecological knowledge scores, but when the same procedure was conducted with culturally based knowledge scores, the results are very closely related as was the case with the first and second PCAs that looked first at total LEK and then at ecologically-based knowledge and Culturally-based knowledge separately. Here, the first two principal components consist of the same plants in this PCA using the cultural scores. The plots are also similar in terms of the points (participants). The relationship between the patterns seen in ecologically based knowledge and culturally based knowledge is strongly influenced by the number of plants an individual identified. The method for scoring points in this survey is such that it is not possible to be a high scorer in either ecologically based or culturally based knowledge if few plants were identified because no questions are asked of plants not identified, and therefore the opportunities to accumulate points would have also been few. That said, the plot based on the cultural knowledge scores features more healers as top scorers where as
the plot based on ecological knowledge scores has more equal representation among healers, harvesters, and vendors. This reinforces the idea that healers have more culturally based knowledge (e.g., on pre- and proscriptions) than harvesters and vendors. However these differences are not significant as will be shown with non-parametric tests.

On the next page three plots appear, each with the same data but with different labels for the points based on sociocultural characteristics of the participants. Although no distinct groupings of points based on role, self-identification as a healer, or other sociodemographic characteristics can be seen, labeling the points by their healer status, role, and adherence to traditional lifestyle facilitates a way to evaluate patterns in participants' culturally based knowledge.

<table>
<thead>
<tr>
<th>Abbreviated Variable</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cx War</td>
<td>Culturally based Knowledge Scores for Warburgia</td>
</tr>
<tr>
<td>Cx Zan</td>
<td>Culturally based Knowledge Scores for Zanthoxylum</td>
</tr>
<tr>
<td>Cx Har</td>
<td>Culturally based Knowledge Scores for Harrisonia</td>
</tr>
<tr>
<td>Cx Alb</td>
<td>Culturally based Knowledge Scores for Albizia</td>
</tr>
<tr>
<td>Cx Ste</td>
<td>Culturally based Knowledge Scores for Steganiaenla</td>
</tr>
<tr>
<td>Cx Asp</td>
<td>Culturally based Knowledge Scores for Aspilia</td>
</tr>
<tr>
<td>Cx Oco</td>
<td>Culturally based Knowledge Scores for Ocotea</td>
</tr>
<tr>
<td>Cx Mor</td>
<td>Culturally based Knowledge Scores for Morella</td>
</tr>
<tr>
<td>Cx Art</td>
<td>Culturally based Knowledge Scores for Artemisia</td>
</tr>
</tbody>
</table>

Following are three plots of Culturally based LEK Scores of 9 Plants (Dimension 1x2).
Figure 29. Plot of Culturally based LEK Scores with ID Variable as Role
Role: 1=Harvester; 2=Healers; 3=Vendor

Looking at role, we see that healers are both at the top and bottom in terms of their cultural scores for the nine plants, which overlaps with plot A. No clear clusters based on role exist. However, we can see that there are many more low scorers of culturally-based knowledge than there are very high scorers.
Again, looking at the same data by self-identification with a traditional lifestyle and practices, we see that top scorers (at the top of the plot in Figure 30) are those who say they adhere “a bit” (not “a lot” or “not at all”). Many of these are also people who self identify as healers. Interestingly those who said they adhere “a lot” to cultural beliefs and practices are not among the top scorers of culturally-based knowledge. Again, this points to the esoteric and specialized nature of the knowledge, beliefs, and practices related to those who do follow a more traditional lifestyle by regularly doing ancestor veneration ceremonies, for example or by speaking their ethnic language at home, and by knowing cultural traditions, songs, and stories; and, if you are a healer, by using spirit gourds and or following protocols for harvesting and administration of medicines. (Although
participants were asked this question without those specific examples, they emerged in
the context of discussions outside the survey as activities that exemplify traditional life
ways.)

No clear picture emerges from these PCAs, but they do have tendencies which I
test with the Spearman correlation coefficient and non-parametric ANOVAs.

9.6 Testing and Evaluating Hypotheses

My underlying hypothesis that there are relationships between knowledge and
sociodemographic variables is not supported. The trends in the first and second PCAs
show weak support for H3, H4, H6-H9, and strong support for H11. They also show
support for the (unstated) null hypotheses for H1, H2, H5, and H10.

H3-H11 were tested for significance with the Spearman correlation coefficient,
but only H11 (ecologically-based and culturally-based knowledge) is significantly
correlated. The Spearman correlation coefficient showed no significant correlations
between LEK Scores and: formal education, years of experience, age, time spent in the
environment, use of tunguri, how plants are obtained, adherence to cultural lifestyles and
traditions, or gender. The results of are summarized below (Table 9.13).

<table>
<thead>
<tr>
<th>Total LEK Scores &amp; Formal education</th>
<th>Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total LEK Scores &amp; Years of experience</td>
<td>No</td>
</tr>
<tr>
<td>Total LEK Scores &amp; Age</td>
<td>No</td>
</tr>
<tr>
<td>Total LEK Scores &amp; Length of contact in a given environment</td>
<td>No</td>
</tr>
<tr>
<td>Total LEK Scores &amp; Use of tunguri</td>
<td>No</td>
</tr>
<tr>
<td>Total LEK Scores &amp; How plants are obtained</td>
<td>No</td>
</tr>
<tr>
<td>Total LEK Scores &amp; Adherence to cultural lifestyles and traditions</td>
<td>No</td>
</tr>
<tr>
<td>Total LEK Scores &amp; Gender</td>
<td>No</td>
</tr>
<tr>
<td>Culturally based and Ecologically based LEK Scores</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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9.6.1 Supported Hypothesis

H11 Culturally-based LEK and ecologically-based LEK are positively correlated.

A Spearman Correlation was conducted on all 74 participants ecological scores and cultural scores, and the correlation was found to be significant at 59% ($p<0.0001$).

![Graph showing correlation between ecological and cultural knowledge]

$y = 0.411x + 2.0727$

Figure 31. Correlation between Ecological and Cultural Knowledge

This graph in Figure 31 shows the strong relationship between ecologically based and culturally based knowledge, or knowledge that can be gained independently through observation of the environment and experience of harvest, and that which must be learned from another person. Demonstrating this relationship shows that knowledge systems are interconnected networks of people and experience. Local people seem to gain ecological and cultural knowledge simultaneously, which points to the strong relationship between these. This relationship also suggests that separating knowledge into categories (ecological and cultural) reflects a superficial delineation in types of knowledge from an etic perspective. For example I asked participants if there was a method of harvest that encouraged growth of the plant, and categorized this as a culturally based knowledge
question, but it could have also easily been categorized ecologically based knowledge question. It is actually both.

My separation of cultural and ecological knowledge has been influenced by authors like Berkes (1999) who describes “traditional ecological knowledge” as shared systems of knowledge, practice, and beliefs. The original source of differentiating “beliefs” from “knowledge” can probably be traced back to Plato’s dialogue “Theaetetus” which describes knowledge as “justified true belief.” Without tracing the development of this discussion over the past 2000 years, what is important to note is that implicit in this distinction is a judgment on the value of “beliefs” (usually associated with cultural knowledge) and “knowledge” (usually associated with empirically validated scientific knowledge). In this case it is now clear to me that the distinction between culturally based and ecologically based knowledge under “local ecological knowledge” is not useful. Instead, it is more accurate to say that all is culturally based ecological knowledge.

9.6.2 Unsupported hypotheses - differences in knowledge among groups

I used ANOVAs to test the hypotheses that predict higher levels of LEK would be associated with specific roles (H1, H2) and healer status. The data on four measures of knowledge were tested for normality and homogeneity of variance. They are: Number of Plants Identified, Total LEK Scores, Ecological Scores, and Cultural Scores. Only Ecological Scores met the assumptions of an ANOVA and were found to be normally distributed (based on the Normality Probability Plot, and the Shapiro-Wilk, Kolmogorov-Smirnov, Cramer-von Mises, and Anderson-Darling tests) and exhibit homogeneity of
variance (based on the Leven test, \( P = 0.1805 \)). Since none of the other three measures of knowledge met the assumptions of a parametric ANOVA, I used Kruskal Wallis, a non-parametric one-way ANOVA, to test whether the differences in knowledge scores among groups (by role or by healer status) are significant. I ran these on all four measures of knowledge.

I recognize that role categories (harvester, healer, vendor) are not necessarily discrete and therefore are potentially problematic for looking at differences among groups. I have already discussed the overlap among roles (Chapter Five) and, since I assigned individuals to role categories, I recognize that my bias could have affected the results. Therefore, I also tested for significant differences in knowledge between those who self-identify as healers and those who do not. The distinction between these two categories is based on participants' responses (not my own assessments) and the groups are unquestionably distinct. There are no significant differences in Ecological Scores (\( df=1; \) Chi Squared = 2.7913; \( P=0.0948 \)) or any of the other three measures of knowledge for those who self-identify as healers and those who do not. These findings are congruent with the findings from the role categories, except in one case. Only the Plants Identified and the Ecological Score show that there are significant differences among the three different roles. Since the number of Plants Identified does not assess what participants knew about those plants, I only discuss the Ecological Score, which tells us about their knowledge about the plants than simply the ability to identify them.
Table 9.14 Kruskal Wallis Results for Knowledge by Role and Healers Status

<table>
<thead>
<tr>
<th>Role</th>
<th>Plants Identified</th>
<th>Total LEK Score</th>
<th>Ecological Score</th>
<th>Cultural Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Df</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Role</td>
<td>2</td>
<td>12.844 (P=0.0016)*</td>
<td>0.6055 (P=0.738)</td>
<td>6.82 (P=0.0330)*</td>
</tr>
<tr>
<td>Healer</td>
<td>1</td>
<td>1.7312 (P=0.1883)</td>
<td>1.1952 (P=0.2743)</td>
<td>2.7193 (P=0.09)</td>
</tr>
<tr>
<td>Status</td>
<td>1</td>
<td>1.1952 (P=0.2743)</td>
<td>1.1952 (P=0.2743)</td>
<td></td>
</tr>
</tbody>
</table>

* Significant P value

In order to determine which of the three roles exhibited significant differences in their scores, I used the Kruskal Wallis again. I tested for significant differences in the Ecological Scores between healers and harvesters; healers and vendors; and harvesters and vendors. The only significant difference is between the Ecological Scores of healers and vendors (df=1; chi squared=6.096; P=0.0135). Table 9.15 below shows vendors’ average Ecological Scores (18.4 ±7.5) are higher than healers’ average Ecological Scores (13.8 ±11.9); thus we can say that vendors’ Ecological Scores are significantly higher than healers’ Ecological Scores.

Table 9.15 Knowledge Scores by Role

<table>
<thead>
<tr>
<th>Role</th>
<th>N</th>
<th>Plants Identified</th>
<th>Total LEK Score</th>
<th>Ecological Score</th>
<th>Cultural Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvester</td>
<td>19</td>
<td>4.8 (7.0) ±2.0</td>
<td>36.8 (27.0)±36.8</td>
<td>17.9 (19.0) ±9.5</td>
<td>7.4 (8.0) ±4.2</td>
</tr>
<tr>
<td>Healer</td>
<td>28</td>
<td>3.4 (7.0) ±2.4</td>
<td>31.5 (16.5)±25.2</td>
<td>13.8 (10.0)±11.9</td>
<td>10.2 (7.5) ±8.5</td>
</tr>
<tr>
<td>Vendor</td>
<td>27</td>
<td>5.7 (7.0) ±1.9</td>
<td>37.5 (24.0)±15.3</td>
<td>18.4 (17.0)±7.5*</td>
<td>8.5 (7.0) ±5.3</td>
</tr>
</tbody>
</table>

* Significant P value
Figure 32. Average Knowledge Scores by Role (* Significant P value)

Figure 33. Median Knowledge Scores by Role (* Significant P value)
There was a tendency toward a significant difference for the Ecological Scores between harvesters and healers but it was not quite significant (chi squared=0.0011; P=0.0576).

On the basis of these findings, we should reject both the hypotheses that healers have the highest LEK (H1); and that vendors have the lowest LEK (H2).

9.6.3 Revisiting Hypotheses, Summary Outcomes of Findings, and Interpretation

**H1**  
**Healers have the highest total levels of LEK**  
Analyses: Correlation matrices for PCA One and Two do not support this hypothesis and the Kruskal Wallis test shows there are no significant differences among roles.
Interpretation: Healer knowledge is highly variable and does not necessarily include commercially important species.

**H2**  
**Vendors have the lowest levels of LEK**  
Analyses: Correlation matrices for PCA One and Two do not support this hypothesis and the Kruskal Wallis test shows there are no significant differences in total LEK scores among roles. The Kruskal Wallis showed that vendors have significantly higher ecological scores than healers, which supports the null hypothesis.
Interpretation: Vendor knowledge is highly variable. It can include a rich knowledge of commercial species without field experience. The survey measured knowledge of specific commercial species, and thus favored vendors and commercial harvesters who focus on commercial species.

**H3**  
**LEK is negatively correlated with increasing formal education**  
Analyses: Correlation matrices for PCA One and Two show weak support; but these differences are not significant when tested with the Spearman Correlation Coefficient.
Interpretation: Most participants (74%) had the same level of education (primary), which may have made it difficult to assess knowledge differences based on education level. High levels and low to no levels of formal education were seen in both high and low scorers. One’s level of formal education has little to do with their LEK of commercial medicinal plants.

**H4**  
**LEK is positively correlated with years of experience**  
Analyses: Correlation matrices for PCA One and Two show weak support; but this correlation is not significant when tested with the Spearman Correlation Coefficient.
Interpretation: The knowledge of vendors and harvesters with few years of experience is focused on commercial species and these individuals scored well.
H5  **LEK is positively correlated with age**
Analyses: Correlation matrices for PCA One and Two show weak support for the null hypothesis; but these differences are not significant when tested with the Spearman Correlation Coefficient.
Interpretation: The knowledge of vendors and harvesters with few years of experience (due to their young age) is focused on commercial species and these individuals scored well. Young people who may not otherwise be interested in or given access to medicinal plant knowledge are encouraged to acquire it in a market context.

H6  **LEK is positively correlated with length of contact in a given environment**
Analyses: Correlation matrices for PCA One and Two show weak support; but these differences are not significant when tested with the Spearman Correlation Coefficient.
Interpretation: The market facilitates sharing knowledge among groups. Commercial medicinal plant knowledge is more market-based than place-based (as related to source). People who are not from the districts where they currently live, work, and deal with commercial medicinal plants learn about the plants in the context of the market — even though they may lack extensive lived experience in medicinal plant source areas.

H7  **LEK is positively correlated with use of tunguri**
Analyses: Correlation matrices for PCA One and Two show weak support; but these differences are not significant when tested with the Spearman Correlation Coefficient.
Interpretation: The LEK of healers who use tunguri seems to be even more esoteric and less shared than knowledge among healers who do not use tunguri. Because of the harvesting rituals they observe, healers who use tunguri tend to harvest their own plants and are less interested in commercial plants.

H8  **People who harvest their own plants have more LEK than those who are supplied by others.**
Analyses: Correlation matrices for PCA One and Two show weak support. (The matrices show this as a negative correlation, but this is the result of coding “I harvest all my own plants” as a one and “All my plants are provided by others” as a five. Thus, the negative correlation shows a negative relationship between higher scores and those who are provided their plants by others, thereby supporting the hypothesis.) These differences are not significant when tested with the Spearman Correlation Coefficient.
Interpretation: Vendors who do not harvest can be adept at identifying commercial medicinal plants. Some can recognize plant parts and medicine preparations by sight and smell, even if they cannot identify the plant in situ. Equal points were given for identifying roots/bark and for the
voucher specimens. This gave people with no "field" experience equal opportunities to acquire points as those with extensive field experience, although people with more field experience should have known more ecological details of the plants.

**H9**

**LEK is correlated with stronger adherence to cultural lifestyles and traditions**

**Analyses:** Correlation matrices for PCA One and Two show weak support; but these differences are not significant when tested with the Spearman Correlation Coefficient.

**Interpretation:** Few participants consider themselves to strongly adhere to cultural lifestyles and traditions. Most participants (62%) said they adhere "a bit." Within that group, the knowledge varied greatly.

**H10**

**Women have higher LEK levels than men**

**Analyses:** Correlation matrices for PCA One and Two support the null hypothesis; but these differences are not significant when tested with the Spearman Correlation Coefficient.

**Interpretation:** Compared to men, women are less likely to be vendors so their knowledge of commercial plants is limited. Women healers' knowledge is esoteric, just as it is with all healers. Gendered knowledge is not detected in this survey, although I suspect it exists and will discuss later in the chapter.

**H11**

**Culturally based LEK and ecologically based LEK are positively correlated**

**Analyses:** The correlation matrix for PCA Two shows strong support; and this correlation is significant when tested with the Spearman Correlation Coefficient.

**Interpretation:** The delineation between ecological and cultural knowledge of medicinal plants is superficial and reflects my own bias. Local people learn about plants in their eco-cultural contexts.

### 9.7 Discussion

In this study, higher levels of knowledge are not correlated with specific sociodemographic characteristics, including those usually associated with LEK (e.g., age, specialization, length of time spent in environment, gender). This trend is related to two factors. First, the differences among groups in terms of their role is not highly differentiated, as it is in other research that looked at differences in knowledge between quite distinct social groups in terms of ethnicity and level of specialization (e.g., Ghimire 313
Second, I did not include non-specialists in the LEK survey. Household interviews with lay people explored knowledge and harvesting strategies but did not elicit data specifically about the nine species from the LEK survey which I could have quantitatively compared with healers, harvesters, and vendors. I suspect that if they had been included in the LEK survey, the knowledge of non-specialist consumers (lay people) generally would have been less than all specialists groups (healers, harvesters, and vendors), as found by Ghimire and coauthors (2004). Based on my ethnography of the areas, I also suspect that within the group of non-specialists the rural, montane communities would have exhibited more knowledge than the urban, coastal communities.

While there were no distinct groupings based on sociodemographic characteristics as predicted by the overriding hypothesis, there were differences in Ecological Knowledge based on role. The non-parametric ANOVA found vendors to have significantly higher scores than healers in Ecological Knowledge, but this was not the case with the Number of Plants Identified, Culturally-based Knowledge, or Total LEK Scores. Even though ecologically based and culturally based knowledge are significantly and positively correlated, there was no significant difference in the vendors’ Cultural Scores as there was with their Ecological Scores. Taken together, these quantitative findings and the qualitative findings that support them (discussed in other chapters) tell us that knowledge is complex and heterogeneous.

9.7.1 What do the findings tell us? Or why are there no observable differences in knowledge?

Responses were scored so participants’ knowledge of nine species could be compared, not to define who has knowledge and who does not. Ultimately, we cannot
assume those with low scores actually have little knowledge overall. We can say they did not identify and or have little knowledge about the nine species in this survey. Compared to vendors and harvesters, which are roles that developed relatively recently, healers have the most culturally instituted and longstanding knowledge of medicinal plants. Although many healers scored low, I observed that they have extensive and rich knowledge about a wide range of plants and the rituals and knowledge associated with their harvest, preparation, and administration. At the same time, the secretive nature of healers' work means that it is not widely shared outside kin groups or mentor-apprentice relationships. Further, depending on the type of healer, knowledge may center on spirit-based or psychological healing and not on phytotherapy (as in Ghimire et. al 2004), which also influences their level of knowledge about medicinal plants. This contributes to the esoteric nature of culturally-based healer knowledge, which could not easily be measured by this survey because it is based on nine commercial plants. (More culturally-based knowledge is explored and discussed in Chapter Ten.)

Although healers are often assumed to have the most knowledge about medicinal plants, vendors with little personal experience harvesting scored high. Overall, healers may be able to identify more medicinal plants, and they may have more harvesting experience and more environmental experience (and therefore they likely have more ecologically based knowledge associated with those plants), but their knowledge of the nine species in this survey is on par with that of the other participants. I expected people with more experience living and harvesting in the areas where these plants are found would be associated with more knowledge, but the findings did not show this correlation. Although healers who work outside of the commercial realm may have more years of
experience harvesting, their expertise differs from that of commercial vendors and harvesters who work to meet a public demand. Because the survey assessed knowledge of nine plants that are important to the commercial trade, some healers with decades of experience and very detailed knowledge about many plants (that do not include commercial plants) were at a disadvantage in the survey. Ghimire et. al (2004) also found that commercial harvesters had the most knowledge of commercially traded plants, compared to specialist healers and non-specialists.

Although healers' levels of knowledge were not distinguished from other groups, they are typically assumed to be the experts on medicinal plants, vendors and harvesters are not. Forestry staff (from government agencies and non-governmental agencies) in Tanga who are working toward joint forestry management have invited the participation of healers to learn about local concerns, practices, and priorities. I observed that they preferentially recruit healers who are locally regarded as the most powerful, who are older, who have more experience, and who appear to adhere more to cultural traditions. These are commonly preferred criteria for forestry staff, researchers, and health workers who want to interact with "authentic" plant medicine specialists. While these foresters should be acknowledged for their culturally appropriate initiatives, they should also extend their invitation to a wider range of stakeholders from the medicinal plant trade in their meetings and decision making processes.

This research shows healers, and people who are older, with more experience, that are seen as more traditional are not necessarily the most knowledgeable about widely harvested species—which are the species that should be a focus for conservation and natural resource management. Forestry personnel need to recognize that healers are only
one group of stakeholders, and probably not the ones who make the most impact on the environment from harvesting. Commercial harvesters (and by extension, the vendors they supply) harvest greater quantities and with greater species specificity than healers, which means their impact on the environment is greater—all the more reason they should be involved in management forestry policies and programs. Further, I have already established that commercial species tend to be trees, some of which are primarily harvested from forest reserves or forest remnants, while plants harvested by healers and consumers for home use include a wider range of life forms such as herbs and lianas from more disturbed areas. Another reason to involve vendors and harvesters in resource management is that they seem to rely on less disturbed areas and slower growing life forms than healers, but this should be tested in future research.

Although many vendors have considerable knowledge of plants with medicinal uses, the relationships they have with forestry staff are much more tenuous than the relationships healers have with forestry staff. Healers are confident in their right to harvest, by virtue of cultural precedents and by virtue of their work which is often seen as a benevolent service to society. Despite the close connections and overlap between vendors and healers, vendors and harvesters are often viewed by forestry staff, resource managers, and biomedical health workers as environmentally destructive, self-interested, charlatans. Vendors and commercial harvesters avoid interacting with forestry staff because they see it as a risk to their livelihoods. They fear being caught doing something illegal, but because it is not always clear what is illegal in terms of harvesting rights, they simply to avoid forestry staff altogether.
9.7.2 Gendered knowledge

Other research highlights the gendered nature of plant knowledge with regard to life form and habitat. In the Morogoro Region of Tanzania, men’s knowledge was found to be significantly greater than women’s knowledge only for the tree species used for charcoal production, but not for plants with other uses (Luoga, et al. 2000b). In Indonesia (Caniago and Siebert 1998) and the Amazon (Lewis and Elvin-Lewis 1990), women were frequently more knowledgeable than men about herbaceous and non-forest plants. In studies from Brazil (Hanazaki, et al. 2006) and Uganda (Kyoshabire 1998), men knew more about medicinal plants from well preserved forests and old successional stages of forest habitats than women; and women preferred more recently disturbed areas, younger successional stages, and home gardens for harvesting medicinal plants. Hanazaki and coauthors attribute this to the lower mobility of women whose knowledge is restricted to the domestic environment whereas men’s economic activities take them out of the domestic sphere and so they are exposed more to forest and other habitats (Hanazaki, et al. 2006:904). This may also be the case in Tanga, but the differences in scores between men and women were not significant. Since women are not typically vendors in Tanga, their knowledge of the commercial species in this survey was not as extensive as men’s knowledge. However, other methods including interviews, informal discussions, and direct observation revealed that women’s knowledge is extensive, especially with regard to non-commercial, herbaceous plants for treating women and children.
Market forces on knowledge

While past research has noted trends toward gendered and specialist knowledge, this research shows that commercial markets influence knowledge as well. Market forces have influenced knowledge transmission among groups who otherwise may have had more limited knowledge of medicinal species. The market is also a locus for the transmission of traditionally-based knowledge, but the motivations for and the pathways of that transmission are different from those that happen back home in the village.

I observed that women harvesters who live near forests and supply vendors and healers are knowledgeable about commercial arborescent medicinal species from forests, which are habitats that are more associated with men. Sambaa vendors and harvesters know about plants from low lying dryer areas typically associated with the Maasai. Valley dwellers involved in the trade can recognize commercial plant medicines that originate from montane forests they have never visited. Even people who lacked hands-on experience with live trees in situ were able to identify them in the market by the distinctive fragrances of their bark, roots, and leaves. Participants looked for the black pepper scent of *W. stuhlmannii* (which is also known as *pilibili mwito* ‘wild pepper’) bark, the sneeze-inducing reaction one gets from sniffing *M. salicifolia* roots and bark, and the rich, spicy-cinnamon like smell that emanates from *O. usambarensis* bark as their clues for identification—clues they have learned in the market.

Another example of the market’s influence on knowledge is the transmission of knowledge to young people. Contrary to expectations, age was not found to be significantly correlated with knowledge in this survey. Instead I found that young people are vendors and harvesters and the market has stimulated their interest in traditional
knowledge of medicinal plants. Similarly, in Mexico, age and formal education levels were also found to have no significant effect on LEK of sabal palm harvesters (Joyal 1996:455), which may also be due to their market value. Young people are often said to have disdain for traditional knowledge, especially as related to medicinal plants, because they link it with to rural, impoverished lifestyles and perceive it as an impediment to modern, urban living. Examples are the Dusun of northern Borneo as described by Vocks and Leony (2004) and the Waluguru of Morogoro, Tanzania as described by Mahonge and coauthors (2006). Contrastingly, some young men in Tanga, Sambaa and Maasai in particular, have pursued learning about medicinal plants for the opposite purpose – to make their livelihoods outside of rural settings. I observed young people who are involved in the trade to support their urban lifestyles and to earn money to purchase school uniforms and bean seeds to plant in their farm plots. Of course, in the bigger picture, the number of youth who side with Dusun and the Waluguru may completely overwhelm the number of entrepreneurial youth in Tanga. Still, this trend should be noted and explored further.

What is perhaps more important than noting trends in various levels of knowledge among social groups is to recognize the heterogeneous nature of knowledge and the influences on knowledge development, transmission, and acquisition. Ghimire and coauthors (2004) discuss variation in knowledge and practices related to medicinal plants within and among cultures. "Heterogeneity in levels of knowledge and in practices both within and between groups corresponds to differences in level of specialization in relation to medicinal plants, to socio-cultural and institutional contexts, and to extra-local influences" [emphasis added]. They argue that "understanding the heterogeneity of"
knowledge and practice is crucial to design management practices that build on the intricate links between knowledge, practices, and institutional context” (Ghimire, et al. 2004). This is important from a theoretical perspective, as we continue to formulate ideas about what LEK is and how it evolves. It is also essential for resource managers and planners to not only consider healers’ perspectives and practices but also to involve commercial vendors, harvesters, young people, and women in order to capture the range of perspectives, knowledge, and practices within and among groups. Examples exist from locations around South Africa where traditional healers involved in the trade (Botha, et al. 2004b:39; Crouch and Edwards 2004) and harvesters (Geldenhuys 2004:113) have organized to plan for continued access to medicinal plants through establishing medicinal plant nurseries and conducting sustainable bark harvesting studies.

Clearly, natural resource managers need to know the sociocultural and demographic characteristics of relevant stakeholders and the range of locally important species (Botha, et al. 2004b:43). The question then, is: do these stakeholders have an interest in being involved in conservation and resource management? My sense is that, at present, they do not see a threat to their livelihoods and therefore have expressed no profound interest. However, in my research I found these participants to be open and interested to learn more about medicinal plants. With more information about the potential consequences of unchecked and unregulated harvesting, and with the encouragement to become involved, natural resource management and livelihoods could be improved. The time in Tanzania is especially ripe for such interaction. Medicinal plant harvest has yet to make a detrimental impact as it has in other areas (e.g., Southern
Africa); joint forestry management is becoming more widespread; and poverty reduction is a priority in the National Forest Policy (United Republic of Tanzania 2001).

9.8 Conclusion

The results from the multivariate analyses suggest that variation in LEK across the participants was less than it was for the other variables (e.g., ethnicity, how plants are obtained, formal education). Contrary to trends found elsewhere, in this research the level of specialization, years of experience, gender, and age are not correlated with LEK. This is attributed to the greater differences of knowledge within than among social groups, an artifact of the heterogeneity within the social groups involved in the study. Findings show that LEK is place-based. People tend to know about plants that grow in their home areas. Recall that Maasai had little knowledge of montane forest plants, which is not surprising as they typically do not enter those habitats because their herds keep them on the plains. Sambaa were much more adept at recognizing montane forest plants than other groups because the plants come from the Usambaras where the Sambaa make their home. At the same time, it is evident that the market has influenced knowledge exchange among groups, which suggests that patterns in knowledge are affected by market demands and changing livelihoods. The market is a driving force behind the distribution of knowledge among groups that would not otherwise have had the environmental or cultural experience that would have familiarized them with the medicinal plants.

The market is an increasingly important locus of place-based knowledge. It stimulates new forms of knowledge transfer and innovative ways to prepare and use
traditional medicinal plants. While market economies and culture change are often named as the culprits causing a loss of local knowledge, here we see a case when local plant knowledge is passed on because of its value to the market. This knowledge is based on traditional knowledge and uses of plants, although of course it is evolving, just as traditional knowledge evolves everywhere. New roles in conveying this knowledge, specifically those of vendor and commercial harvester, are gaining importance while traditional roles (healers) perhaps are becoming less central to this process of knowledge transmission.

Results also show a highly significant relationship between cultural and ecological knowledge which underscores the importance of understanding and integrating what managers may see as irrelevant culturally-based knowledge and practices into official management.

The process of separating the LEK that seems useful to scientists and resource managers from the LEK that seems esoteric and culturally based is problematic as it potentially eliminates the components that are responsible for the usefulness of the knowledge and practices (Agrawal 2002:292; Etkin 2002). Another problem with separating the “useless” from the “useful” knowledge is that the people who possess that knowledge become unimportant to the application of it. Instead, the focus on the knowledge draws attention and resources away from the local or indigenous people (Agrawal 2002:292). Finally, we should remember that knowledge is heterogeneous among and within groups. Planning resource management by involving representative stakeholders means drawing widely from the general population and not just from one kind of specialist.
CHAPTER 10. LOCAL ECOLOGICAL KNOWLEDGE AND PRACTICES AND THEIR ECOLOGICAL IMPLICATIONS

10.1 Introduction

This research considers LEK as a system of shared knowledge, beliefs, and practices. At the same time, I acknowledge that even within LEK systems, there is variation due to culture, age, gender, livelihood, locale, transmission of knowledge across ethnic boundaries and between “traditional” knowledge and bioscientific knowledge, and due to innovation and adaptation. Following Davis and Wagner (2003) and Johns and coauthors (1990), the shared knowledge and beliefs discussed here are those which were mentioned by a minimum of three people on separate occasions. This chapter discusses knowledge about the relationship between characteristics of plants and the potency of plant medicines, pre- and proscriptions for harvest, the ways they are (and are not) institutionalized and reinforced, and potential ecological impacts of those practices. The chapter concludes with a discussion of how an understanding of LEK relates to resource management strategies and practices.

10.2 What Determines the Potency of a Medicine?

“Efficacy is brought about in a context of belief and expectation and through social communication and interaction. It has a processual nature and is initiated by preparatory activities like prescribing, buying, collecting, and preparing the medicine. Therefore, the therapeutic effect of a medicine cannot be reduced to its chemical substance. Its “total drug effect” depends also on nonchemical attributes of the drug such as its
color, name, and provenance; on properties of the recipient and prescriber; and on the situations in which the medicine is delivered and consumed” (van der Geest, et al. 1996:167).

In Tanga, I observed that for people who harvest, the perceived potency of a medicine is linked to its environmental, developmental, and symbolic characteristics. Most of the LEK survey participants believe the potency and efficacy of a plant medicine is tied to its environment and the part used. (Efficacy, as I refer to it, is from an emic perspective, not from a pharmacological perspective.) Healers also identified the habit of a plant which mimics the desired action of the medicine as another important characteristic signaling potency. For example, struggling business owners use medicines made from sea weeds and corals that are gathered when the tide is coming in so that customers will come into their shops. A parasitic plant robs its host tree of life and so it is used to steal the life of the tumor living in a human body. For the Iroquois, plants with hook-like structures that are sticky have “ensnaring/capturing qualities” and are used to cure cold sores, venereal diseases, and diarrhea — all of which are perceived as running or escaping things. Plants with these qualities are also seen as effective for returning an unfaithful lover and enticing or “hooking” buyers (Moerman 2007:458).

Before a plant is even used, healers in Tanga also consider adherence to harvesting pre- and proscriptions (detailed later in this chapter) as determinants of a plants’ efficacy. If these practices are not followed by the harvester, the medicine is not expected to work because it will not have the power of the healer or his/her associated spirits. Healers in other areas also understand their actions to affect the efficacy of the medicines they use. Yoruba healers sing to their medicines to make them effective and in
Burundi healers claim that their personal power, not a power inherent in the plants, makes the medicines work (van der Geest, et al. 1996:167).

A plant’s power to heal is also indicated by its overall appearance, specifically its size and vigor, as well as its organoleptic qualities (Etkin 2006:35-36; Ghimire, et al. 2004; Gollin 2001; Shepard 2004). In Tanga, stronger, more pungent tastes and smells are preferred, which can also indicate biochemical qualities. The vibrant color of bark and roots (especially inner bark and roots) also indicate a plant’s strength to local practitioners.

For each of the nine species participants identified in the LEK survey, they were asked if there are special places to harvest where the plants have more strength than if they were collected elsewhere. I expected healers to talk about *sehemu ya mizimuni* ‘places inhabited by ancestral spirits’ (typically these are at the shore, in caves, in forests, at a cliff’s edge) or other places in the landscape such as crossroads or near a termite mound (often the sites where rituals are conducted) that are given symbolic importance. I predicted that areas that are linked to powerful spirits would correspondingly be the sources of powerful medicines, especially for healers whose practices are guided by spirits. Instead, participants primarily discussed ecological aspects of the habitats where each species is found. When asked directly if plants harvested from places inhabited by ancestral spirits or at a crossroads, for example, are stronger than those harvested elsewhere people, healers included, routinely said “no.”

Consumers have different indicators of efficacy. Some indicators are linked to how the medicine affects them, but these effects are not limited to a resolution of symptoms. Among Hausa, after a medicine (plant or pharmaceutical) is used, signs of
“disease egress” such as vomiting, diarrhea, and sweating are interpreted as evidence that the medicine is effective (Etkin 1992). In Tanga, these signs of egress are also interpreted as the work of effective medicines.

In terms of quality of a plant medicine, it is important to emphasize that consumers do not typically set out to buy plant “x,” rather they set out in search for expertise from person “x” who will provide them with the right medicine to treat their problem. Since the perceived quality is related to the expectation of efficacy, it is also relevant to the discussion here.

Ethnicity of the vendor or healer does play into expectations of quality. For example, because kambako, a condition associated with sinus blockage, is associated with eating meat and Maasai are known for their diet which is high in meat, Maasai are considered the experts in treating kambako. Consumers described how they specifically sought out Maasai vendors when they had a problem with sinus blockage. Similarly, the Digo, people from Pemba (islands just off the Tanga coast that are part of Zanzibar), and people with Arabic ancestry (including Swahili people) are known for their adeptness at treating problems caused by spirits, so they are specifically sought out for those problems.

The aesthetics of the medicine also can factor into its perceived quality. For some consumers, commercially prepared and packaged powdered plant medicines and capsules that are kept in new bottles with printed labels are seen as of higher quality than small-scale produced medicines sold in reused bottles with hand written labels or wrapped pieces of newspaper. For others, the authenticity of a “traditional” appearance (e.g., distributed by a healer, wrapped in a banana leaf, directed to use with a ritual) and the
absence of a biomedical context signal the medicines’ potency. Obviously, expectations and perceptions of quality are highly variable for consumers and harvesters.

10.2.1 Habitat

Medicinal plants that grow in a number of habitat types are understood to differ in potency. Usually, descriptions of preferred harvest areas overlap characteristics of the respondents’ home areas, be it bondeini ‘valley lowlands,’ milimani ‘in the mountains,’ sehemu penye joto ‘hot places’ (usually lowlands or arid areas) or sehemu za baridi ‘cool places’ (usually wetter, more elevated areas). In this case, the grass is not greener on the other side. LEK Survey participants from a wide range of areas felt that the plants from their home area were stronger than the plants from other areas. Whereas these harvesters, healers, and vendors with personal experience of collecting commercial plant medicines invoke “home” as a place with strong medicines, consumers were noted as perceiving exotic medicines as more potent than familiar ones from home, as reported in Chapter Five (5.2 Ethnomedical Systems).

The quality of the soil is also noted as important by harvesters. Usually, ardhi ya chumvi ‘salty soil’ (in coastal areas) is believed to produce weak plants and ardhi ya mbolea, ya mweusi ‘fertile, black soil’ is preferred by both coastal dwellers and others. A number of respondents pointed to the areas that are agriculturally rich (in Tanga these are montane areas) as indicators of the quality of the environment and soil. They argued that if an area produces a bounty of nutritious fruits and vegetables, it should also produce strong plant medicines. Contrastingly, one healer who I have worked with extensively lives in a coastal area but is from a village in the Usambara Mountains. He generally
prefers harsh, arid environments for harvesting medicinal plants, which is a departure from the trend noted in the survey but overlaps findings from Nepal, where plants from harsh, rocky, dry habitats were considered to have greater potency and medicinal efficacy (Ghimire, et al. 2004).


### Table 10.1. Habitats Associated with More Efficacious Medicinal Plants

<table>
<thead>
<tr>
<th>Species</th>
<th>Description of Preferred Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Albizia anthelmintica</em> Brongn Fabaceae</td>
<td>Dark, mineral rich, fertile soil; Lowlands, Mountains</td>
</tr>
<tr>
<td><em>Artemisia afra</em> Jacq.ex Willd Asteraceae</td>
<td>Cool mountains (highly salient response)</td>
</tr>
<tr>
<td><em>Aspilia mossambicensis</em> (Oliv.) Wild Asteraceae</td>
<td>Valley, rocky places, dark, fertile soil</td>
</tr>
<tr>
<td><em>Harrisonia abyssinica</em> Oliv. Simaroubaceae</td>
<td>Mixed habitats that include thickets, scrub, bush (little redundancy)</td>
</tr>
<tr>
<td><em>Ocotea usambarensis</em> Engl. Lauraceae</td>
<td>Cool mountains, fertile soil (highly salient responses)</td>
</tr>
<tr>
<td><em>Steganotaenia araliacea</em> Hochst. Apiaceae</td>
<td>Mixed habitats in lowland and montane areas (little redundancy)</td>
</tr>
<tr>
<td><em>Warburgia stuhlmannii</em> Engl. Canellaceae</td>
<td>Sandy, clay soils (few responses, but they were in agreement)</td>
</tr>
<tr>
<td><em>Zanthoxylum chalybeum</em> Engl. var. chalybeum Rutaceae</td>
<td>Mountains, valley, lowlands, cool and hot places, all types of soils-black, clay, sandy (little redundancy)</td>
</tr>
</tbody>
</table>
Specialists in Uganda associate stronger medicines with older plants (Kyoshabire 1998:49) and habitats with older stages of succession (Kyoshabire 1998:50). Wild harvested are considered to be stronger than cultivated medicines in Uganda (Kyoshabire 1998:52) and in Botswana (Cunningham 1993a:28). These trends also exist in Tanga, but they are not the most cogent for explaining potency.

10.2.2 Plant Parts

No plant parts are taboo to harvest, but the part considered to be most effective differs by plant; this affects what is commercially valuable and what is harvested. Many participants reported that if a plant’s leaves are medicinal, the entire plant will also have medicinal qualities, at various potency levels. For some plants only the roots or bark have medicinal properties. Commercial medicines include few above-ground vegetative parts and primarily consist of bark and roots, which are said to be more potent than aerial parts. This local knowledge is consistent with findings from 15 years of data collected from tropical forests in six countries where roots and below-ground plant materials were significantly more bioactive than above-ground materials (Balunas, et al. 2006).

For some medicinal trees the leaves, bark, and roots are all considered to be medicinal by healers in Tanga. But for other trees — harvesters and healers agree that only certain parts can be used medicinally (e.g., roots or bark or leaves, but not all three). The accessibility of different plant parts also affects their harvest. I found that healers and male commercial harvesters most often harvest roots whereas women commercial harvesters are more likely to take bark from those same species because, according to them, it is easier to harvest and does not require digging. For example, mshegeshe (M.
salicifolia) roots and bark are acceptable as medicines; but the women harvesters take bark exclusively saying that the roots are too difficult to dig out. Male harvesters of mshegeshe take roots and bark. I also met women harvesters who do dig roots of other species and did not describe a preference for bark harvest because of its accessibility, so this preference for bark over roots should be taken as an influence but not an absolute pattern among women. Healers who use tunguri use leaves more often than healers who do not use tunguri. Among traditional healers and midwives in the Uluguru Mountains of Morogoro, Tanzania, leaves have also been noted as the plant part most often used in their medicines (31.7%), followed by roots (29.6%) and barks (20.7%) (Mahonge, et al. 2006).

In the western Himalayas of Nepal, different plant parts are harvested at different times of the year, according to local perceptions of changing nutrient levels with the changing of the seasons and the lifecycle of the food plants. For example people use seeds during December to January, shoots during February to April, flowers during May to August, and roots during September to November” (Rokaya, et al. 2001:17). In a Tibetan community located inside a national park in northwestern Nepal, medicinal plant collectors observe similar harvesting regimes, based on perceptions of potency linked to lifecycle stages. Spring is preferred for collecting tree bark, winter for collecting rhizomes because these plant parts are considered to be most efficacious at those times (Ghimire, et al. 2004).

In Tanga, many participants said the rainy season was preferable for medicinal plant collection because the hot and dry season causes plants to wilt and lose their strength. It also causes the ground to be so hard it is extremely difficult to dig for roots.
A few also talked about harvesting at night, early morning, or evening when there is no harsh sun to wilt the plant and deplete its strength.

10.2.3  Method of Harvest

When plants are harvested specifically for patients with "Swahili" diseases (i.e. spirit or witchcraft induced illnesses) or by those whose practice is influenced by spirits, the method of harvested determines the plants' efficacy. A break from the culturally based rules and rituals for harvesting diminishes plants' power to heal. These pre- and proscriptions are explained below.

10.3  *Masharti na Milko ya Kimila* 'Cultural Rules and Taboos' for Harvesting Medicines

Pre- and proscriptions (which include taboos) can be species-specific and vary by role (healer, harvester, collector, vendor) and ethnicity. Unlike the ecologically-based knowledge on preferred habitat conditions for medicinal plant collection, these are culturally based beliefs that influence harvest practices. Healers, especially those who use *tunguri*, are most knowledgeable and adhere most to pre- and proscriptions, compared to either vendors or harvesters.

Colding and Folke (2001) identify six types of pre- and proscriptions that guide human contact with the environment. Here, I list them and present examples from local practices and perspectives in Tanga.
10.3.1 Segment taboos regulate resource withdrawal by prohibiting certain people from using specific species

Healers talked about the need for a person *kukamilika* 'to be complete' which refers to being married and trained in healing before harvesting. Unmarried, untrained people are restricted from harvesting. Menstruating and pregnant women are also restricted from collecting because they are considered vulnerable and polluting, a taboo that also exists in Southern Africa (Cunningham 1993a:5). No commercial harvesters or lay collectors described segment taboos that they follow, although a few were aware that healers observe the ones just mentioned.

10.3.2 Temporal taboos regulate access to resources in time

Temporal taboos have been documented in Swaziland and South Africa for specific medicinal species' roots which are forbidden to be collected during the summer months. Harvesters collect those roots in winter months (after seed has set) or else lightening and storms will occur (Cunningham 1993a:7). In Tanga temporal taboos for collecting medicinal plants based on season were not identified. However, because Tanga is primarily Islamic, harvest patterns relate directly to restrictions on work in accordance with Islamic teachings. Many Muslim-owned businesses have shortened hours or close completely in observance of the holy month of Ramadan and during prescribed daily prayer times. Similarly, many healers whose work is related to spirits also come to a halt during Ramadan. Ancestor worship ceremonies and spirit exorcisms are not practiced during that time. Some healers also observe restrictions on plant collections during prayer times. As a result, plant collection for these healers as well as for harvesters who supply healers and vendors also decreases during the month of
Ramadan (which was October 2005 during the research period). The confluence of Ramadan, obligate fasting (and even drinking water for strict observers), and the hottest time of the year likely also contributes to decreased harvesting activity during this time. Temperatures can reach over 100°F and humidity is high on the coast. Healers and vendors used this time to take stock of their medicines—throwing away old ones and noting what needs to be replenished. Muslim vendors and harvesters do not typically follow the same strict restrictions that healers follow.

In Tanga, the timing of commercial harvesting is primarily influenced by the farming calendar, not taboos. During planting and harvesting seasons for crops, medicine harvesting becomes less of a priority, but never stops completely. In Nepal, commercial harvesters who, like Tanga harvesters, collect medicinal plants to supplement their herding and agricultural activities are similarly influenced by the farming calendar (Ghimire et al. 2004).

In summary, less activity by healers and vendors during Ramadan means fewer demands on harvesters, so their work decreases during Ramadan as well as during planting and harvesting times in Tanga.

10.3.3 Method taboos regulate techniques of harvest

Many healers talked about specific protocols to follow when harvesting medicinal plants. This is common elsewhere, for example with amchi in Nepal who harvest after performing specific rituals and according to cultural and religious calendars (Ghimire et al. 2004). Below are examples of masharti ya kuchimbia dawa ‘rules for harvesting medicines’ or utaratibu wa waganga kuchukua dawa ‘procedures for healers to procure
medicines.’ These are general pre- and proscriptions that apply to multiple species by multiple Bantu groups. (Maasai never talked about any taboos for harvesting).

- Approach the tree naked
- Approach the tree crawling
- Wear a black/white/red kaniki ‘wrap of fabric worn over clothes’
- Prohibition on talking to anyone when going to and coming from harvesting
- Harvest with eyes closed or harvest behind your back (not facing plant)
- Prohibition on sharp or large tools
- Prohibition on all tools, roots must be pulled out with your teeth
- Take bark or leaves or roots from the sunrise or sunset sides only
- Take only the pieces of bark that have fallen with the inside facing up (after being cut with a machete)
- Leave ritual offerings of unga ‘flour,’ mtama ‘sorghum,’ mashanga ‘beads,’ pesa ‘money,’ pombe ‘beer/alcohol,’ chumvi ‘salt,’ udi ‘incense,’ or kuku ‘chicken’ at the site of harvest. These offerings are part of tambiko ‘rituals to appease the spirits’ which can also include prayer, asking permission from the tree itself, and explaining why you need to harvest – for whom and for what reason. Some healers talked about conducting ritual offerings on a yearly basis, not at every harvest event.

These are culturally based practices, but actually they are cross-cultural in that they extend across ethnic borders and are more characteristic of “Bantu healer culture.” Some of them have also been documented in other areas of Africa. For example, the prohibition on using sharp tools for harvesting (Cunningham 1993a:5).
Table 10.2. Milko and Masharti 'Taboos and Rules' for Harvesting Nine Species

<table>
<thead>
<tr>
<th>Plant</th>
<th>No. who Identified plant</th>
<th>% who said rules exist for its harvest</th>
<th>% who follow rules</th>
<th>% who self identify as healer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z. chalybeum</td>
<td>58</td>
<td>36%</td>
<td>28%</td>
<td>24%</td>
</tr>
<tr>
<td>M. salicifolia</td>
<td>25</td>
<td>20%</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td>S. araliacea</td>
<td>37</td>
<td>16%</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td>A. anthelmintica</td>
<td>43</td>
<td>16%</td>
<td>14%</td>
<td>12%</td>
</tr>
<tr>
<td>O. usambarensis</td>
<td>17</td>
<td>12%</td>
<td>0%</td>
<td>6%</td>
</tr>
<tr>
<td>A. afra</td>
<td>45</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>H. abyssinica</td>
<td>43</td>
<td>7%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>A. mossambicensis</td>
<td>37</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>W. stuhlmannii</td>
<td>33</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
</tbody>
</table>

The species in Table 10.2 are organized in order of decreasing frequency of taboos and rules mentioned for their harvest. Most of the people who know and follow taboos and rules for harvesting medicinal plants are healers. Pre- and proscriptions are most often observed for Z. chalybeum (28%), M. salicifolia (16%), and S. araliacea (16%), and least observed for O. usambarensis (0%) and W. stuhlmannii (3%). It is not surprising that the most widely distributed species (Z. chalybeum, M. salicifolia, and S. araliacea) are those that pre- and proscriptions are most observed for, and the more narrowly distributed species that have smaller local populations (O. usambarensis and W. stuhlmannii) have the fewest recognized cultural restrictions on their harvest. This overlaps with larger versus smaller human populations who come into contact with this widely distributed versus narrowly distributed plant populations. From a conservation perspective, this is a paradox because resource managers would favor restrictions on the species that are more at risk of overharvest by virtue of their small populations and limited distribution, but the reverse is true.
As discussed in Chapter Five, section 5.2, *Z. chalybeum* is associated with God and the Qur’ān. It is not surprising that it is subjected to the most taboos and rules. Taboos are also associated with *M. salicifolia*, which is widespread throughout the Usambaras and beyond, and *S. araliacea* which is a tree often planted near the home for protection against snakes and bad spirits. A lack of pre- and proscriptions for harvesting medicines does not mean the plant is unimportant culturally. For example, *O. usambarensis* has many connections to *mizumu* ‘ancestral spirits’ for Sambaa. Four harvesters talked about traditional songs that mention it as the “tree where all the ancestors dwell,” and they talked about the importance of ingesting its medicine as a way to connect with ancestors. Two Maasai vendors talked about songs that refer to *W. stuhlmannii*, yet very few participants mentioned pre- or proscriptions for the harvest of either *O. usambarensis* (two people) or *W. stuhlmannii* (one person). Although *O. usambarensis* is not scarce, its status as a government protected timber species is well known. Cutting or felling a tree without a permit can result in a fine and or imprisonment, which means its access is restricted for harvesters. *W. stuhlmannii* is scarce and has been proposed as an endangered species, but participants do not perceive it as scarce.

There is a general consensus among healers, harvesters, and vendors that culturally based, traditional harvesting practices are sustainable, but these assumptions need to be tested. Participants claimed that if traditional harvesting practices are followed, *huwezi kuchimba mti mpaka umalizia* ‘it is not possible to harvest until you finish the plant.’ It is simply not allowed by the philosophy of traditional harvesting which dictates, for example: if you find five roots, take only two or three and if you are
harvesting bark, take from only one side of the tree. Yet, in discussing pre- and proscriptions this did not emerge as a strong principal, perhaps because it is too obvious to mention. Healers and harvesters also discussed the practical (not culturally based) motivation to harvest a tree in such a way that does not kill it, so it will be available for future harvests.

Lay people and commercial collectors are much less influenced or knowledgeable than healers about taboos for method of harvest. Those that are aware of them are not compelled to follow them because they are considered to be exclusively in the realm of healers. Because such vendors and their harvesters have broken ties with or do not relate to traditional harvesting practices, they may be interested in more sustainable alternative practices that differ from traditional ones followed by healers, for example harvesting bark or leaves instead of roots. Geldenhuys (2004:106) suggests that they may help to break constraining traditions by accepting alternative practices and products. The importance of involving other stakeholders beyond healers was also discussed in Chapter Nine, for the reason that harvesters and vendors are also highly knowledgeable about commercial species.

10.3.4 Life history taboos regulate withdrawal of vulnerable life history stages of species

No specific taboos about life history were discussed. In general terms, healers, commercial harvesters, and lay people perceive immature trees as unharvestable material because their strength as medicines has not yet developed and because harvest will kill the tree. This was discussed in terms of tree size, not age. Medicine from *M. salicifolia*, noted one vendor, was more fragrant in the past when larger trees were harvested. Now
the smell is weaker because the larger trees are fewer and smaller trees are harvested. Harvesters of *M. salicifolia* reported that small trees or very old trees do not have the right color of inner bark. They said deep red is an indicator of potency that vendors look for and will not buy light colored, bland-smelling *M. salicifolia* medicine.

10.3.5 Specific-species taboos

For non-specialists, taboo plants can be specific to *okoo* ‘lineage,’ and *kabila* ‘ethnic group.’ For healers, they are also directly tied to the beliefs and wishes of one’s mentor healer, the healer whose power they inherited, and/or the spirits who advise them. As a result, there is no consensus on which species are taboo to harvest, even for healers from the same ethnic group. In Mlalo, a Sambaa healer explained that his *okoo* is forbidden to harvest *Mbuyu (Adansonia digitata) L. Bombacaceae*), but he is allowed to purchase it or receive it as a gift from other non-family members. None of the other Sambaa healers present in that discussion are forbidden to harvest it.

Another related guideline (not taboo) for healers emerged in separately conducted open-ended interviews. Three healers in Tanga Town described how every year a different plant is named president. The plant president is preferred as a first line of treatment for all diseases and all patients for that year. It is automatically the preferred constituent in any medicine. Healers did not reveal secret information on how the president is selected, which plants were past presidents, or which plant was the current president, but they do circulate the information among their fellow healers. The practice of having a rotating plant president may distribute harvesting pressure so no one species
is over-harvested for extended periods but it may also mean that that one species will be more intensely harvested during its year.

Species-specific taboos observed by the general population are more agreed upon than taboo species for medicinal plant specialists in Tanga. In Miombo woodlands (characterized by a type of African savanna dominated by Brachystegia and Julbernardia genera of the Caesalpinioideae family) around the Kitulanghalo forest reserve in the Morogoro Region of Tanzania, interviews with healers (4), charcoal burners (8), village headmen (3), craftsmen (5), and household interviews with villagers revealed that particular species (Boscia salicifolia, Suregada zanzibariensis, Ehretia amoeana, Deinbollia borbonica, Allophylus rubifolius) are not used for construction because of cultural taboos (Luoga, et al. 2000:337), and that Turraea stuhlmanii, Grewia bicolor, Erythrina abyssinica, Maytenus senegalensis, and Ehretia amoeana are not harvested for fuel or construction because they are considered sacred, associated with ritual beliefs, and there is no market for their timber (Luoga, et al. 2000:331). Although Sclerocarya birrea subsp. caffra, is also traditionally taboo to harvest because of its association with ancestral sacrifices, it is now harvested due to commercialization of its wood for timber and handicrafts (Luoga, et al. 2000:331).

Ficus species (of the Moraceae family) are recognized around the world — in Brazil (Rashford 2007), India (Brodt 2001), China (Xu, et al. 2005), Thailand (Pruess 1979), and Uganda (Kakudidi 2004), among other places — for their connections to the sacred and spiritual and are often spared rather than cut down. For many Sambaa in Tanga, Mvumo (Ficus spp.) is taboo for building material, fuelwood, or other uses because of its connection to ancestors. Healers harvest it for medicines and it is also used
in *tabmbiko* 'ancestor veneration ceremonies.' The village environmental committee for Mpanga Forest (part of Shagayo National forest Reserve in Lushoto District) set a rule that inside the boundaries of their forest, there is a prohibition on cutting trees that are used for *tambiko*. This means that in the multiple-use zone where fuelwood and construction materials are allowed to be taken, specific trees: *mvumo* *Ficus* spp., *mkuyu* *Ficus* spp., and *mkamfa* (*O. usambarensis*) are prohibited from being harvested except for special purposes such as medicines (but not commercial medicines) and *tambiko*.

10.3.6 Habitat taboos restrict access and use of specific resources in time and space

Participants tended to discuss land use types that are taboo rather than habitat types. In the case of Kamai forest (which is privately owned by a healer and traditionally protected), the owner prohibits people from taking any trees or even deadwood from the areas dedicated to ancestor worship rituals because he wants to ensure they have all the plants and fuelwood needed for the annual *tambiko*. Comparatively, his forest is a very small area and his policies are not the norm. The effects of his management are not widespread. Beyond these examples, I did not find it common for people to talk about sacred forests where harvesting is taboo. Such forests are well known in neighboring Kenya where they are referred to as *Kayas* and exists as islands of refuge (Wilson 1993:244). Other sacred forests have been identified in central Tanzania (Mgumia and Oba 2003) but they are less studied.

Gravesites are well noted for their protected status and harvesting there is often taboo worldwide. In Amani (East Usambaras), healers said that *tambiko* areas and gravesites are taboo for harvesting. In Morogoro, Tanzania, *maziara* 'burial places' were
also found to be off limits for harvesting, although the restrictions had become relaxed in more recent years (Luoga, et al. 2000). A more extreme example of the relaxing of such a taboo is in Tanga Town itself, where on multiple occasions, I witnessed urban residents grazing livestock (cows and goats) in graveyards without objections from passersby.

Participants agreed that as long as one asks permission from *mizimu* 'ancestors' and *wazee* 'elders,' harvesting is allowed, even from areas or plants that otherwise would be restricted. I observed a *tambiko* ceremony in the West Usambara mountains in an area described as *mpangoni, sehemu ya mizimuni* 'cave where the ancestor spirits dwell' but medicinal plants, fuelwood, and wild vegetables are harvested freely from that area, not only throughout the year, but also during the *tambiko* ceremony I observed. Perhaps the area appeared protected from farming and other disturbances simply because the rock structures that defined it are not conducive for farming. Farms surrounded the *tambiko* space on all sides.

10.4 Institutionalization and (Re)enforcement of Rules and Taboos

One hypothesis investigated in this research is that there are sociopolitical and religious institutions that (re)enforce the pre- and proscriptions for plant collecting. Local institutions that control access to resources have been considered an important component of successful local resource management (Berkes, et al. 2000; Ghimire, et al. 2004; Ticktin, et al. 2002). They can also provide support to larger state-sponsored resource management programs. The degree to which these institutions actually function has been examined less than their theoretical value. I identified three types of institutions that relate to resource management: religious, traditional, and political institutions.
10.4.1 Religious institutions

Although participants did not discuss any Christian or Islamic institutions that explicitly guide human-environment interactions in general or the harvest of medicinal plants in particular, for Muslims, prayer time and Ramadan have been adopted as either taboo or liminal periods when work comes to a halt (as discussed earlier).

10.4.2 Traditional institutions

Traditional ancestor worship and the ceremonies and procedures associated with it do influence human-environment interactions and the harvest of medicinal plants. Healers, the central facilitators of ancestor worship ceremonies, were historically and even today are often spiritual and political leaders. Today, they are among those who are more aware of, and adhere more to traditional beliefs and practices. Because their work, healing through plant medicines and spirits, is based in cultural traditions, their perspectives are distinct from other people who harvest and distribute plant medicines but do not identify themselves as healers.

Healers explained that it is not necessary to follow masharti makali 'strict laws/rules' every time a plant medicine is harvested, but they do need to follow them for hard cases where a person has been using plant medicine, but has not gotten better (because the spirit side of the disease has not been addressed). These include cases of people who are kichaa 'crazy' due to mizimu 'ancestor spirits' and magonjwa ya Kiswahili 'Swahili diseases' that are related to spirits or witchcraft. Healers tended to agree that pre-and proscriptions are dependent on the patient's problem and not the tree harvested, which means that the taboos are not really species-specific. The variation
among healers' practices, their training, their medicines, and their beliefs is significant. Therefore, uncovering patterned beliefs and practices is difficult. This is further hindered by the secretive nature of healers' knowledge. Understandably, they are hesitant to share information on treatments (even with each other), but they do not even share information on the specifics of the taboos and masharti for harvesting.

An exchange between two Mlalo healers illustrates this:


Everyone has his/her own tree that s/he identifies as a particular treatment. Everyone has his/her own tree that s/he knows for treating specific things. Now, all of us can’t know only one tree and we can’t know all trees. Every person has his/her trees s/he knows. Now, this thing requires social refinement! [It is sensitive information that should not be shared.]


Yes! Let’s say a person works in Dar es Salaam, he has an herbal dispensary. He sells plant medicines, but he has something else that protects him there, something cultural. He has this because he can get problems, so when a certain problem comes, he does his thing. He has his own protection. This is called spiritual something, that’s how it is. Therefore, every one has his own specific thing. Another will tell you s/he doesn’t eat specific things, but they have their own reasons. Even if it is just meat. He’ll tell you I just don’t eat chicken, that’s all. So, they have their reasons. Even since long ago, it has been this way. This is what it means to live by respecting each other. It means that every person can’t know the secret of his friend. I don’t know that gentleman’s secret there. He doesn’t know the next guy’s. That is internal. It’s top-secret.
The esoteric, personal, and secretive nature of these taboos and practices means that they are not widely shared among specialist or ethnic groups. The effect may be that they confer a more general protection on resource use and management instead of specific areas or species, or the effect may be that protection is diluted. The possible protective effects of such practices need to be tested.

As has already been acknowledged in this chapter and in Chapter Two (Section 2.5), traditional institutions that functioned to regulate resource use have been compromised due to socioeconomic pressures. This has affected the harvest of taboo species, sacred areas, and the power of elder’s recommendations. The power of existing institutions needs to be assessed in terms of their ecological impact. A living memory of their existence is not enough to impact the environment.

10.4.3 Political institutions

The policies and understandings of the national union of traditional healers and birth attendants in Tanzania (CHAWA TIATA) contrast with those of the forestry officers, forest guards, and village environmental committees. CHAWATIATA, whose leadership and active membership consist primarily of healers who use tunguri, does nothing to institute or enforce taboos or traditional rules of harvest. As an organization with few financial or institutional resources, it has no power to do so. The memberships they grant have no stipulations on methods of harvest. The organization seems to exist to validate the work of its members, to confer protection on them against claims of illegitimacy or witchcraft if they arise, and to work to gain recognition and resources from government and non-government organizations. A lack of communication between
CHAWATIATA and the Ministry of Natural Resources and Tourism has resulted in CHAWATIATA members believing that membership in the union (8,000 TSh / $8 to join, 200TSh / $0.20 monthly dues), and the photo identification card it provides, allow them the right to harvest medicines anywhere. Anyone can be a member of the organization: healers of any type, birth attendants, researchers, and harvesters—including commercial harvesters. While the organization pays lip service to the need to conserve medicinal plants, and is ---in some ways--- against the commercial harvest of medicinal plants, even commercial harvesters can be and are members. Thus, the harvesters and the organization believe these members have the legal right to harvest and as a result, the organization encourages more commercial harvesting. Officially, the Ministry does not agree with this stance of CHAWATIATA. In most cases its staff members are not even aware that CHAWATIATA members have this belief. However, because communication is poor from the national to the village levels of forestry and environmental committees, I learned that even local village forest guards and environmental committee members are satisfied with CHAWATIATA’s claims and do not question the rights of the members to harvest. The effect is that commercial and specialist harvesting are condoned but not regulated.

10.4.4 Consequences for not following pre- and proscriptions

Overwhelmingly, people said that the consequences for not following the *miiko* ‘taboos’ and *miila* ‘cultural traditions’ are that the medicine will not be efficacious. Not all who reported this believe it, however. A couple said that it was disrespectful not to follow them but they were unsure of the consequences because they had always followed
them. These taboos lose power if the consequences for not following them are not recognized.

One harvester who knew of taboos but does not follow them explained, *sina kilenge* ‘I don’t have a traditional clinic.’ In other words, because he is not a specialist, the cultural rules and taboos do not apply to him; they are for *watalamu wenyewe tunguri sana sana* ‘specialist healers who use many tunguri [and deal with spirits].’ He explained that wearing black, going naked, and sacrificing a chicken are only done for things like *kupatanisha watu, ndele, au mambo ya Kiswahili* ‘to bring quarreling people together, love medicine, or Swahili things.’ Although he said he does not collect plants for those purposes, he explained that if the rules are not followed by people who are harvesting medicines for those types of problems, the medicines will not work. *Lakini dawa zao ni miti hii hii* ‘but, their [healers’] medicines are these same trees [that I harvest and sell to vendors] *hakuna tofauti* ‘there is no difference.’ He insisted that medicines for treating stomach problems, and normal diseases (i.e., not “Swahili problems”) do not require pre- or proscriptions even if the medicines come from the same trees that do treat “Swahili problems.” This overlaps with what healers discussed as well.

Although LEK is embedded in local institutions that serve to protect and regulate resources, harvest takes place in the context of a struggle for land and livelihoods, declining power of elders and their traditions, and younger generations who see their grandparents’ traditions as old-fashioned and unnecessary. A system of knowledge and practices that was integrated into daily life and once may have functioned to conserve resources now exists under different terms and the ecological effects are also subject to change.
Although changing ecological, social, and political contexts may render local institutions less powerful in managing resources than in the past, these institutions are often flexible and adaptive. For example, in Nepal, the development of a Traditional Health Care Center and of Community Forest User Groups show how local institutions may be reformulated in new local contexts where global and local views and needs are addressed simultaneously (Aumeeruddy-Thomas and Lama, in press, cited in Ghimire, et al. 2004). The Health Care Center and Forest User Groups did not exist traditionally, but they are based on traditional institutions that have been reconfigured to meet local health needs and larger conservation priorities.

10.5 The Ecological Context of Harvest and its Implications for Conservation

The potential ecological consequences of culturally based practices are relevant to larger, state-based conservation and management. These cultural rules and taboos are signs of humility, prevention of pollution, and respect for God and ancestors, but they can also function to limit access to harvest and amounts of plants harvested. The degree to which they are practiced and actually limit harvest requires additional research. It is important to emphasize that the people who adhere most to this knowledge and practice are not commercial harvesters, but healers. Further, it does not follow that knowledge of a pre- or proscription means it is observed. The potential ecological impacts of these beliefs and their practices must be considered with the understanding that healers harvest smaller volumes and a greater variety of species compared to commercial harvesters who harvest large volumes of fewer species.
Table 10.3 below summarizes pre- and proscriptions and their potential ecological consequences.

**Table 10.3. Pre/Proscriptions for Medicinal Plant Harvest and Potential Conservation Implications**

<table>
<thead>
<tr>
<th>Pre- or Proscription</th>
<th>Potential Conservation Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmarried, untrained people are restricted from collecting as are menstruating or pregnant women</td>
<td>Limits number of potential harvesters and potentially the intensity of harvest</td>
</tr>
<tr>
<td>Harvesting (and spirit rituals) are restricted during Ramadan and prayer time</td>
<td>Limits harvesting time and potentially the intensity of harvest</td>
</tr>
<tr>
<td>Approach tree and harvest it naked</td>
<td>Discourages harvesting in groups or for extended periods of time</td>
</tr>
<tr>
<td>Approach the tree crawling</td>
<td>Discourages harvesting often</td>
</tr>
<tr>
<td>Harvest with eyes closed or behind your back</td>
<td>Limits the amount one can harvest</td>
</tr>
<tr>
<td>Pull a root out with your teeth (no tools allowed)</td>
<td>Limits the amount one can harvest</td>
</tr>
<tr>
<td>No sharp tools allowed</td>
<td>Limits the amount one can harvest</td>
</tr>
<tr>
<td>Harvest from sunrise or sunset sides only</td>
<td>Limits the amount one can harvest</td>
</tr>
<tr>
<td>Take only harvested pieces of bark that have fallen up, leave those that have fallen face down after cutting from trunk</td>
<td>Bark left at base of tree contributes nutrients into soil</td>
</tr>
<tr>
<td>Make ritual offerings of money or items of monetary or symbolic value at the harvest site</td>
<td>Discourages harvesting often because of the associated cost</td>
</tr>
<tr>
<td>Specific taxa are taboo based on lineage or ethnic group</td>
<td>Confers protection for specific species in specific areas where those families and ethnic groups live</td>
</tr>
<tr>
<td>Annually selected “tree president”</td>
<td>Shifts harvesting pressure on a different ethnospecies annually, and increases pressure on a given ethnospecies during the year</td>
</tr>
<tr>
<td>Pray and / or ask permission from the tree to harvest it</td>
<td>Discourages harvesting wastefully</td>
</tr>
</tbody>
</table>

LEK survey participants were asked about ways to harvest a plant to make it grow back stronger, or ways to harvest that inflict minimal damage on the plant. Their
responses demonstrated ecological knowledge; however some of their insights, though logical, contrast with ecological research findings on the effects of harvest. Harvesting behaviors are complex and the ecological outcomes are not always what one would expect. This underscores the need to conduct ecological experiments before anything can decisively be stated about the effects of local harvest practices. For example, Ticktin’s ecological experiments that compared different harvest regimes had surprising results. She found that bromeliad harvesters who only took a percentage of rammet leaves had less sustainable harvest populations than harvesters who removed the entire rammet because those harvesters also transplanted individuals (Ticktin 2002c). Harvesting practices based in tradition are also dynamic and research needs to be in step with these adapted practices. For example, in Hawai‘i (USA) the traditional collection of hula ‘garland’ plants has been adapted by some specialists to also include the weeding of invasive alien species. Findings from an ecological experiment that examined these practices indicate the potential benefits of reduced groundcover of alien species and increased cover of native plants used in hula (Ticktin, et al. 2006). Table 10.4 below lists examples of harvesting strategies described by participants that have undoubtedly been influenced both by traditional practices and by adaptations and innovations with those practices.
### Table 10.4 Local Harvest Techniques to Promote the Life of the Plant

<table>
<thead>
<tr>
<th>Plant</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>A. anthelmintica</em>, <em>Z. chalybeum</em></td>
<td>Limit bark harvest – no ring barking, take only a portion not all, take from one side, take only outer bark (not inner bark)</td>
</tr>
<tr>
<td><em>A. afra</em>, <em>A. mossambicensis</em></td>
<td>Do not cut all stems / branches, leave some so the plant will regenerate</td>
</tr>
<tr>
<td><em>H. abyssinica</em></td>
<td>Limit root harvest - take only a portion not all, take from one side, take distal tips of roots only</td>
</tr>
<tr>
<td></td>
<td>It resprouts after cutting, so there is no problem in harvesting</td>
</tr>
<tr>
<td><em>M. salicifolia</em></td>
<td>Limit root harvest - take only a portion not all, take from one side, take distal tips of roots (not the part proximal to the trunk); Take young roots, and if it is 5 years or older you can take bark</td>
</tr>
<tr>
<td></td>
<td>Cut between the roots so it will coppice / resprout strongly</td>
</tr>
<tr>
<td></td>
<td>Limit branch harvest - take from one side only, take low branches only</td>
</tr>
<tr>
<td><em>O. usambarensis</em></td>
<td>Limit bark harvest – no ring barking, take only a portion not all, take from one side, take only outer bark (not inner bark)</td>
</tr>
<tr>
<td></td>
<td>Only cut mature tree, if it is small do not cut it</td>
</tr>
<tr>
<td><em>S. araliacea</em></td>
<td>Limit roots - take only a portion not all, take from one side, take distal tips of roots (not the part proximal to the trunk); Take leaves only</td>
</tr>
<tr>
<td></td>
<td>Limit branch harvest – take only high ones or from one side only</td>
</tr>
<tr>
<td><em>W. stuhlmannii</em></td>
<td>Do not take roots (only bark)</td>
</tr>
<tr>
<td></td>
<td>Cover roots after digging</td>
</tr>
</tbody>
</table>

Research on medicinal bark harvesting in South Africa found that "*Ocotea bullata* readily developed coppice shoots at the base of the stem or around the debarked wound...Coppice shoots on protected stumps, or in a position out of reach of antelope grew very rapidly, between 3.0 and 4.5 m height in 18 months in two cases" (Geldenhuys 2004:109). Based on inventory results, the complete harvest of one of every four *O. bullata* trees by stripping it of all its bark for medicine, its bole for timber, and its branch
wood for carvings would result in a much smaller impact on the forest than multiple harvest regimes that target specific parts of the tree and leave it standing. By harvesters covering cut stumps with branches from the cut tree, developing coppice shoots could be protected from browsers and encourage further growth (Geldenhuys 2004:111).

Applying these findings to Tanga may mean that some species such as *W. stuhlmannii* and *O. usambarensis*, which are slow growing large trees, can be more productively harvested by cutting them down completely and removing their bark entirely, rather than slowly killing them by debarking over a long period of time. These trees coppice or resprout vigorously. If their new growth (post harvest) can be protected from browsers, in the long term it may result in healthier populations than slow bark removal which can kill the trees.

Most of the species from the LEK survey have both seeds and the ability to coppice, but each one regenerates more from one method or the other. The ecological implications of their regeneration and reproduction are relevant to how they are harvested and should be considered when sustainable harvest is being researched and promoted.

Figure 34. Continuum of Seeders and Resprouters
(Arranged with assistance from Dr. A.B. Cunningham)
Promoting the harvest of the entire tree over limited bark harvest obviously requires collaboration among harvesters as well as communication between harvesters and resource managers in designing appropriate resource management guidelines (Geldenhuys 2004). These groups do not typically communicate. Before promoting this sort of whole-tree harvesting, research into the amounts and frequencies of harvest in each area and with each species is also required.

10.6 Discussion

The shift in harvesting from specialists who are trained in traditional knowledge and practices and serve a small local population to commercial collectors who are economically motivated and serve a large urban population has been identified as a risk to sustainable harvesting (Cunningham 1993a). Ghimire and coauthors (2004) found the harvesting strategies of commercial collectors and Tibetan amchi (healers) to be very distinct. The commercial collectors from the National Park buffer zone are chiefly motivated by market demands and they “employed a destructive harvesting approach, despite their good ethnoecological knowledge about species collected,” while the amchi in the National Park “harvested with an approach that aims at sustaining the regeneration of plant populations” and is regulated by religious and cultural practices and beliefs (Ghimire, et al. 2004).

In theory, the strategies of commercial harvesters and healers in Tanga follow this trend. Most healers proudly distinguish their harvesting practices from those of commercial harvesters by selectively harvesting limited amounts of roots and bark,
harvesting only from trees that do not already show signs of being harvested, and taking smaller amounts from multiple trees instead of taking all one tree has to give. They emphasize how their practices differ from those of commercial collectors who are just interested in taking as much as they can as fast as they can. Commercial harvesters discussed their preferences for large, dense populations of harvestable trees to expedite efficient harvest of large volumes of bark and roots. Ghimire and coauthors (2004) noted the same strategies with commercial harvesters in Nepal. Further research is needed to compare differences by actually observing many more healer harvesting events in Tanga, which was not possible during this research period.

Although participants, healers in particular, know about and claim to adhere to pre- and proscriptions for harvesting, it is difficult to discern the degree to which they are followed and the actual ecological consequences of their various harvest practices. The received wisdom that “traditional” harvesting done by indigenous people or by specialists is automatically sustainable, needs to be evaluated through observation and experiments based on different harvest regimes and styles of management (e.g., Geldenhuys 2004; Ghimire, et al. 2005; Ticktin and Johns 2002b; Ticktin, et al. 2006). Traditions change, the ecological context in which traditional harvesting occurs changes, and traditional practices vary widely, even within groups. What once may have been sustainable practices may no longer be. Traditional practices may also be adapted to meet changing social and ecological circumstances.

Researchers need to recognize the disconnect between knowledge and practice, or the differences in “active and passive knowledge” (Ghimire, et al. 2004). Based on limited observations of harvest by participants who claimed to follow pre- and
proscriptions that articulate an ethos of respect for resources and sustainable harvest, my experience is that actual harvesting behaviors diverge from this ethos. That is, the pre- and proscriptions should be followed in an ideal situation, but their application is highly context specific and in practice they are not adhered to strictly or often. For example, two healers led me on a field expedition so I could collect plants for botanical identification purposes. Both are vendors in the market and they are also locally regarded as respected elders who are keepers of traditions. Through multiple interactions with them over the year, I knew that they both use *tunguri* and have decades of experience in healing and the associated spirit based rituals, and that they were knowledgeable about pre- and proscriptions for harvesting. I rented a vehicle for an afternoon to expedite a field collection of market plants that grow in a range of habitats. While I collected vouchers, they collected plants for their own purposes. I observed them quickly collecting as many leaves and plant parts as they could. They did this to take advantage of the car that had been hired for the day--- a car that would facilitate the efficient transport of their medicines. These plants were beyond the area that these aged men would normally travel to collect on their own, and would have had pay harvesters to collect for them if the car was not available to them. It was revealing to see how healers who had discussed the importance of *masharti* ‘rules,’ seemed to disregard them completely. This day also reminded me how important it is for researchers to recognize how their presence impacts the behaviors of people and the characteristics of the environment in which they work. There is some disconnect between theory and practice, and local harvest techniques vary depending on the context. Ghimire and coauthors (2004) observed that commercial collectors who had extensive experience harvesting and
knowledge of plant lifecycles and reproduction did not have different harvest techniques than those without such knowledge. Clearly knowledge, cultural or ecological, does not dictate behavior.

This is why knowledge needs to be considered along with practices, not as a short-cut to understanding practices. Meaning and knowledge are encoded in practices and these may not emerge in interviews and discussions that take place apart from harvesting events. In addition, the strictest taboos that go unobserved confer no ecological benefits. Although this research focused on commercial harvesters because of my interest in high-volume harvesting, I intended to observe a range of harvesting practices from commercial to ritual contexts. There were many opportunities for me to observe commercial harvesters at work, because they are at work much more frequently than healers. Unfortunately, it was difficult for me to have the opportunity to observe healers at work harvesting. Even in cases when I accompanied healers into the field to collect plants, the context was not typical for them. I was present and observing; we were not collecting for a specific patient but rather collecting as an educational experience. This certainly affected the harvesting practices of healers who did not follow the taboos they spoke of. It demonstrated the disconnect between harvesting theory and practice and it underscored the extreme variability in harvest techniques — even by the same person.

According to Agrawal, “strict bookish applications” of “useful” knowledge risk becoming useless themselves because they do not include the “many, small, almost imperceptible variations that a constantly changing context creates. Thus workers on factory floors, operators of old pieces of machinery, doctors and surgeons, contract
farmers, and many other workers constantly make small adjustments and changes in applying specified procedures for a task. It is these small and minute adjustments, gained through experience and impossible to enunciate as a matter of principle, that make the difference between success and failure of a task being pursued by a practitioner" (Agrawal 2002:292).

This helps explain why it was difficult for participants to articulate medicinal plant management practices and ethos. It also explains why reducing the harvest and management of medicinal species into sound bites on pre-proscriptions can seem so disconnected from the harvest behaviors of healers and harvesters I observed. This is why it will be essential in future research to learn what Alcorn referred to as "scripts." In her research on Huastec and Bora tropical agroecosystems, she describes a script as "an internalized plan. Its basic structure is a series of routine steps, to a decision tree, but at some points it does contain alternative subroutines, decision nodes, and room for experimentation" (Alcorn 1989:65). These medicinal plant management and harvesting scripts can only be understood by researchers through in depth observation of these practices over time. LEK is hard to comprehend and is obscured by our own biases. Resource managers who learn to understand and follow scripts may be able to more accurately apply that knowledge to conserving resources (1989).

10.7 Conclusion

Future research on medicinal plant management and on general resource management and conservation must recognize the underlying diversity in not only who stakeholders are (i.e., not just healers, but also harvesters, vendors, and everyday
consumers), but the intracultural and intragroup variation in knowledge and practices within groups of stakeholders (Cassagrande 2004; Ghimire, et al. 2004; Lawrence, et al. 2005). “An implicit assumption underlying community-based conservation is that stakeholders can negotiate management goals because they share some basic perceptions of the resources in question” Cassagrande 2004:190). This assumption needs to be examined. As this research shows, it is not true. Understanding the heterogeneity of knowledge has implications, then, for resource management planning.

In thinking about conservation strategies, Cassagrande, warns us against treating knowledge as synonymous with use and cultural importance, and he encourages conservation planners to “consider behavior within a changing economic context” (2004:199). The fact that a species is highly culturally significant (e.g., associated with ancestral spirits or healing) may be a sufficient motivating factor for a large-scale conservation effort of that species or the habitat in which it grows. But it may not. I found that species that are important from a cultural perspective (i.e., associated with ancestors or have multiple uses) are not necessarily valued more or harvested differently than other species. In large part, I believe this is because people see no threat to continued availability of those plants and because harvest takes place in a market context where the immediate focus is on sustaining livelihoods not upholding traditions.

We must be careful in our research and question assumptions about the relationships among cultural importance, knowledge, use, and behaviors. These have sometimes been treated as synonymous, but other researcher has shown different results. Cassagrade highlighted the nonparallel relationship between knowledge and cultural importance of medicinal plants in Mexico (2004). Hanazaki and coauthors (2006:907)
observed a non-linear relationship between knowledge and use of plants among rural people in São Paulo State, Brazil. Similarly, Ghimire (2004) and coauthors emphasize the difference between active and passive knowledge of medicinal plants and their connections to harvest and management behaviors around a National Park in Nepal. The findings from Tanga support their assertions. I also observed how cultural importance, knowledge, use, and management of medicinal plants are not necessarily parallel. We cannot assume that a plant which is culturally significant will be managed differently or that the most known plants are the most used plants. Clearly, integrating local knowledge and practices into conservation strategies must be done carefully and cannot be based on assumptions.

There is a need to focus not just on knowledge, but also on the context in which that knowledge exists. Agrawal (2002) emphasized the importance of understanding the institutions and practices sustained by different forms of knowledge. This study supports others that have demonstrated that LEK is not a static, homogeneous system of knowledge and practices. Rather it is a heterogeneous, plastic, and evolving entity that is based on traditions but responds to the changing cultural, economic, and ecological context in which it exists. Understanding the larger context for LEK is essential for designing medicinal plant and other natural resource management strategies.
CHAPTER 11. SYNOPSIS, SUGGESTIONS FOR FUTURE RESEARCH, AND SIGNIFICANCE

11.1 Introduction

The links between human health and environmental health are widely appreciated and understood in general terms. Specific influences on this relationship are less obvious and understood, but are gaining attention. Recent research has linked increasing medicinal plant (and other NTFP) harvest and habitat degradation to rising rates of chronic diseases (including HIV), growing urban centers, and the struggle to support rural people’s livelihoods. These same concerns were brought to my attention by Tanga healers who reported increasing difficulty sourcing their plants over the years. This dissertation has investigated how Tanga can contribute to our understanding of these issues in a broader context. As pharmacologic agents, cultural artifacts, trade goods, and components of complex ecosystems, medicinal plants are (to borrow language from Lévi-Strauss) good to think with in exploring human-nature relations.

This chapter synthesizes the conceptual, methodological and empirical findings from research in the Tanga Region and discusses the implications of these findings in relation to local ethnomedical systems, livelihoods, conservation and resource management beyond the study region. The implications of approaching medicinal plants from a broad perspective are discussed in relation to methods that engage with the multiple stakeholders inherent to health and conservation issues. Informed by the research findings from Tanga, this final chapter revisits and responds to the research questions from Chapter One, discusses limitations of the research, makes
recommendations for future research, and reviews the theoretical significance and practical applications of the work.

11.2 Synopsis

This dissertation has explored the central question: What mediates medicinal plant management and how does it relate to larger conservation concerns in Tanga, Tanzania? It has considered whether addressing the conservation needs of locally important plants and places can promote larger conservation goals of an area. To answer these questions, it considers biological and social factors in its examination of the knowledge, procurement, and use of medicinal plants within their ecological contexts. It has also described in detail methods that were used to identify key species and source areas, which has important implications for comparing the findings to international priorities. These methods also have applications for other places where medicinal plants and conservation are important issues.

In Tanga I explored the context of medicinal plant procurement, management and use; local ecological knowledge about medicinal plants; and the relationship of local natural resource management to larger conservation goals in order to answer five research questions.
11.2.1 Responses to Research Questions

1) What is the context (sociocultural, ethnomedical, economic, and environmental) in which medicinal plants are procured, distributed, used, and managed?

Chapters Three through Eight and Ten addressed this broad question. Such complex relationships require an interdisciplinary approach such as the one adopted for this research. In summary, medicinal plants are multidimensional and not bound by any one social or biological feature.

Sociocultural Context: The most popular commercial medicinal plants are based in traditional knowledge and experiences that have been handed down over generations. Their origins are linked to ethnic groups from specific areas, but they are used by a broad base of consumers that cross ethnic and socioeconomic status lines.

Ethnomedical Context: The relationship between HIV and increasing demands for medicinal plants was explored in this research; however, it was difficult to assess the degree to which local vendors and healers are responding to HIV/AIDS. This seems to occur most early in the disease before the individual has come to terms with it (and may associate it with witchcraft), later in the management of the disease with the treatment of opportunistic infections, and in cases when people prefer not to use ARVs. TAWG clients certainly have increased over the years. From 2003 to 2006, enrollment has increased five fold, up to 75-85 new patients each month. Annually, 2,100 clients each receive about 23 kg (a total of 48.3 tonnes) of plant medicines, derived from an estimated 190 tonnes of raw material. Compared to commercial plant medicines, the plants harvested for TAWG clients are better known in terms of their quantities, sources, and species.

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Medicinal plant vendors sell medicines for both minor and chronic problems. Examples are *chango* (a range of gastro-intestinal and reproductive problems), *mchango* (febrile convulsions in children), *upungufu wa ngavu* (loss of sexual strength), *uchovu* (physical exhaustion), *kambako* (sinus or allergy problems), *magonjwa wa watoto* (children’s diseases), *kisukari* (diabetes), *magonjwa ya zinzaa* (sexually transmitted infections), and *UKIMWI* (HIV/AIDS). Supernatural or witchcraft induced problems, *magonjwa wa Kiswahili*, are also sold by some vendors, but are more within the realm of healers.

Economic context: Findings are contrary to some accepted beliefs about the prices of medicinal plants. For example, plant medicines are not always more affordable than pharmaceuticals; and the relationship between supply and demand, whereby higher prices reflect scarcity or popularity, is not direct. A much more complex set of issues influences price. These include social relationships between the vendor and the consumer and perceptions of efficacy of the medicine.

In terms of livelihoods, the major motivation for commercial harvesters is to supplement their livelihoods as subsistence farmers. Few urban vendors and healers are able to make a sufficient living with medicinal plants. For most vendors and healers, income from medicinal plants supplements other livelihood activities including farming, small businesses (vending produce or household goods, etc), or it is an income source for elderly men who have “retired” from other activities such as farming.

Environmental context: Medicinal plant habitats, species, and plant parts used vary in commercial and domestic contexts. (This is also addressed below in questions four and five.) In Tanga markets, roots and bark from trees (not leafy material from herbaceous species) are most prominently featured. This is interesting to consider in the
context of apparency theory which predicts slow reproducing, slow growing plants tend not to invest in chemical defenses in their leaves. Perhaps bark and roots from the larger life forms (i.e., large shrubs and trees) harvested in Tanga have bioactive metabolites, and therefore are more likely to have medicinal applications; perhaps the year-round availability of roots and bark compared to leaves in arid areas is the answer; or perhaps culturally based sensibilities are more responsible for the strong reliance on roots and bark. The explanation is complex and includes multiple factors.

Of the 20 most sold and most popular commercial species, 17 are widely distributed in terms of elevation and habitat type and are found in areas that range from highly anthropogenic to relatively undisturbed. One of the key commercial species, Warburgia stuhlmannii Engl. Canellaceae, has been proposed as endangered because of its small distribution in a limited and degraded habitat in Coastal Forests. Two key commercial species, Ocotea usambarensis Engl. Lauraceae and Morella salicifolia A. Rich. subsp. kilimandscharica Engl. Myricaceae are only harvested in montane forests, primarily reserves.

2) What are the key roles, species, and sources for the medicinal plant trade?

The key roles in the trade are harvesters, vendors, healers, and consumers, but there is a high degree of overlap and plasticity among these roles. Middlemen play an insignificant role in Tanga. Most material goes directly from harvesters to vendors or is harvested by the vendor him/herself. This research has elucidated the role of harvesters, their identity and influences on their work, which provide crucial links in understanding the market chain, an element that has been lacking in other studies.
The key plant medicines are non-cultivated, locally harvested, native, primarily tree species that are harvested for their bark and roots. Of 251 ethnospecies that were inventoried among 28 vendors’ stocks, 20 were identified as key species on the basis of their 25% prevalence rate among vendors’ stocks and on the basis of vendors nominating them as important and popular. Many of these have competing uses as fuelwood, timber, and cosmetics.

Findings also highlight the dynamic nature of harvest patterns and valued species. They demonstrate how the most valued species are not static, or dictated by tradition. Harvest patterns respond to availability, time of year (Ramadan and farming affect times of harvest and demand) and demand, which is influenced by urban vendors’ entrepreneurial practices.

Important commercial areas are focused in Tanga Town’s urban center and in Mlalo which is proximate to rural source areas. Source areas for medicinal plants in the trade span a number of habitat, land use, and land tenure types. They are chosen on the basis of their access rights (public spaces such as abandoned or untended farms or grazing areas are preferred), species composition, habitat type (depending on the species), and local perceptions of the quality of those individual plants and their characteristics of efficacy. The selection of and preference for source areas is highly influenced by social factors (natal residence, familiarity with a place, presence of support group in harvesting place, and the acknowledgement of harvest rights). Montane forests, including forest reserves with relatively little disturbance, are the only sources for three commercial medicines (O. usambarensis, M. salicifolia, Osyris lanceolata Hochst. & Steud Santalaceae). Coastal Forest remnants which are highly fragmented and degraded are the
last stands of *W. stuhlmannii*. This underscores the relevance of medicinal plants to forest management and conservation.

Commercial medicines differ from the plants which are primarily harvested for home use which tend to be smaller life forms (herbaceous species) from disturbed, highly anthropogenic areas and cultivated species (including exotics). Commercial plants found in the context of farms are spontaneous volunteers and are not cultivated.

Commercially harvested medicinal plants are not only harvested locally, they are primarily for local use within the Tanga Region. On a few occasions, I observed their purchase for transport to other urban centers in Dar es Salaam or Arusha. I learned of few anecdotal mentions of export to other countries, which included bioprospecting ventures to Europe and North America, and sale to small medicine shops (*maduka ya kiarabu*) in Mombassa and to entrepreneurs in the Arabian Peninsula.

3) What are local ecological knowledge and behaviors related to the management of botanical medicines?

Knowledge was explored generally with all participants through interviews, focus groups, and participation and observation of daily life with particular attention to medicinal plant use and management. Experiences with and uses of medicines were explored specifically with consumers through household surveys. A focused LEK survey with harvesters, vendors, and healers assessed culturally and ecologically based knowledge on nine widely harvested and sold medicinal species. While the LEK survey analyses show no significant differences in knowledge among social groups (on the basis of role, gender, experience, etc.), qualitative data indicates that people who self-identify as healers had more culturally based knowledge of and claimed to adhere more to pre-
and proscriptions for harvesting medicinal plants. Culturally based and ecologically based knowledge are significantly correlated, but knowledge and behavior are not necessarily consistent with each other. This is evident based on comparisons of harvesting practices by healers (limited occasions) and commercial harvesters (multiple occasions), with their knowledge of medicinal plant ecology and their descriptions of harvesting philosophies and techniques. Knowledge of a plant's growth cycle or cultivation potential did not correlate with particular harvesting practices or cultivation attempts. Similarly, awareness of culturally based harvesting taboos did not parallel adherence to those behaviors and practices. Further, among participants generally there is little local knowledge of growth rates, reproduction, or interactions with other species (pollinators or feeders) compared to knowledge of plants' habitats and uses. Knowledge transmission about commercial plants is affected by market demands and motivated by opportunities to supplement livelihoods.

4) What are actual and potential consequences of these management practices?

The harvest of medicinal plants for domestic use at home or by healers is not considered to be a threat either to medicinal plants or to their habitats. Researchers believe that commercial harvest has a much greater effect on specific medicinal plant populations and on their habitats generally (e.g., Cunningham 1991; Hamilton 2004). Based on local impressions (of harvesters, vendors, healers and forestry staff) in Tanga and on my own assessments, the commercial harvest of medicinal plants is not presently a threat to their persistence, but further research is needed to confirm this on a species by species basis. The harvest of bark and roots, the most often collected and sold plant
parts, has a much greater negative effect on trees than the collection of their leaves or fruits. I observed destructive commercial collection practices that include ring-barking and tap-root harvesting. From an ecological perspective, those individual plants are not expected to survive. Species with competing uses (e.g., *O. usambarensis*, *W. stuhlmannii*) are at more risk because they are subjected to multiple harvesting pressures for timber and charcoal making. As is the case with all plants, the availability of medicinal plants is affected by habitat conversion to agricultural and grazing areas, as well as urban expansion seen everywhere with growing human populations.

Although the harvest of medicinal plants in Tanga is not widely recognized as a threat now, it has the potential to be a threat. On the one hand, I observed a trend for local stakeholders (harvesters, healers, vendors, consumers) not to recognize the scarcity of any particular species, but on the other hand, to notice declining tree sizes, and longer distances to travel to suitable source areas. One reason why there is little perception of scarcity could be related to the slow growth rates of these species such as *W. stuhlmannii* and *O. usambarensis*. This means that it will take local people longer to see the effects of harvest and dwindling populations.

There are other signs that these plant populations are being affected. Some local stakeholders (primarily healers) have remarked that medicinal plant habitats and populations continue to shrink. Also, the demand for these commercial species seems to be growing and they continue to be wild harvested without cultivation to supplement supplies, which implies their future availability will be limited.
5) How can an understanding of local knowledge and practices impact resource management and conservation?

Knowing who the stakeholders are, how knowledge is distributed and reproduced, and the context in which practices are enacted are important for planning natural resource management, especially if it is to involve the community. Findings demonstrate that knowledge is heterogeneous within and among groups. Resource managers need to acknowledge this variation instead of trying to apply the one size fits all model or reducing it to “healers do this and harvesters do that.” Resource managers also need to recognize that knowledge and practice, or in the words of Ghimire and colleagues (2004) “active and passive knowledge” are not synonymous. Where local institutions are engaged in resource management, they should be recognized and built upon as is the case with the village committee in the West Usambaras and the healer owned forest in Mlalo. Where these institutions are innovating new models, as in the case of TAWG’s forest farm (described below in 11.4.2), they should be supported and studied to see what lessons can be learned for other areas. Also, knowing which areas, habitats, and species are most relied on and most preferred can help identify specific starting points for collaborative management. (These areas are not necessarily the same.)

Approaching conservation from a broader perspective that includes international priorities is fine, as long as it is contextualized in a local perspective and also includes local priorities. Chapter Seven described how, as a valued species, *W. stuhlmannii* could be one component of an approach to conservation and management, as long as it happens alongside local priorities that put people at the center. Local priorities for conservation typically do not center on species or habitats that are disconnected from life ways. Local
priorities include improving livelihoods and well being which depend on these species
and habitats. Improving livelihoods and well being means attending to more than just
one species. Consequently, resource management should not focus on one or two species
alone. Traditional healing requires a range of medicinal products for holistic treatment,
and bark from some species is required in larger quantities than from other species. This
needs be considered in developing a working relationship with bark harvesters and in the
guidelines for sustainable bark harvesting" (Geldenhuys 2004:111). Applying this
recommendation to Tanga would mean include *W. stuhlmannii* as one species among
others that are important to the trade as well as working with stakeholders to identify
priorities that are appropriate foci for local and international interests.

In summary, medicinal plant management, whether it is from a traditional / local
perspective or from a conservation / outside perspective — or a hybrid of the two—is
influenced by a number of cultural, socioeconomic, and ecological factors as well as
external influences that affect those factors and management itself, as is depicted in the
model below (Figure 35).
Figure 35. Conceptual Model of Medicinal Plant Management

11.2.2 Limitations

The sensitive nature of medicinal plant knowledge is a limitation of this research. Although measures were taken to establish rapport with participants, some were hesitant to talk about plants by name and location for fear of conflict (with forestry or health workers), or being exploited, which related to previous researchers who have come through Tanga and have not been open about the work they were doing, did not share
findings with participants, or otherwise did not follow up at all. Three healers who have interacted with a number of international medicinal plant researchers over the past ten years chose to limit their participation in my research. In two other cases, the participation of vendors was limited because of language barriers. I had no Sambaa translator and their Swahili was minimal.

Another limitation is the inability to directly compare consumer and specialist knowledge because of the different methods I used to collect data. I assumed that consumers had less knowledge than healers, harvesters, and vendors, but I cannot state this definitively. I would have been able say more about the distribution of LEK if I would have included non-specialists (consumers) in the LEK survey. The household survey explored similar issues of most used plants, most harvested habitats, and other means of sourcing plant medicines, but it did not explore the same nine species and therefore the findings are not directly comparable. In theory, this certainly could be done in future field research as the LEK survey method is standardized and repeatable. This inconsistency in data collection methods reflects my own bias that the specialist roles were distinct categories from each other and from consumers.

Another impediment to comparing data is the lack of observations of ritual healer harvesting practices, or real healer harvesting events (as opposed to performed harvesting for the benefit of the research). This limited my ability to directly compare the practices of commercial harvesters and healers. Actual observations of healers collecting for their patients would be possible in the future by living with or in direct proximity to healers who agreed to participate in research which would enable the researcher to aware of and observe spontaneous collection events. A handful of healers involved in this research
were interested in me accompanying them on ritual harvesting events, but the logistics were difficult to arrange because they were not planned with enough advanced notice for me to arrange being there. Unlike interviews and meetings which can be scheduled, these events happen spontaneously when a patient’s need arises, and only once a number of factors (e.g., religious, logistical, and financial) align.

If I had sampled more Maasai vendors, I could have compared subgroups of Maasai and Sambas vendors. The large time investment required by my research protocols which were designed to achieve an acceptable level of comfort before involving research participants in advanced stages of the research meant that more Maasai were not included in inventories. I prioritized in-depth information from fewer individuals versus larger quantities of information from more individuals I could not know well or could not be sure understood my research and its objectives well.

11.3 Recommendations for Future Research

Through this research I came to understand the importance of the trade across the Indian Ocean in plant material used as medicines. In future research I would like to explore this further, tracing back dawa za kiarabu to their sources in India and the Arabian Peninsula and tracing any plant materials that leave Tanga and are exported. This was very difficult to assess since no government export records exist for medicinal plants alone. They are grouped together along with plants for perfumery, pharmacy or insecticidal/ fungicidal purposes. Further, the undocumented trade of many goods is commonplace. These are often transported by dhow, traditional sailing ships that have followed the monsoon winds back and forth across the Indian Ocean. I suspect that they
facilitate the transport and trade of medicinal plant material although it needs to be explored further.

The population of the West Usambaras continues to grow and develop and these changes should be followed with regard to their effect on the management of medicinal plants. At the time I left Tanzania, the government had just begun to build roads up to remote montane towns (source areas for medicinal plants) that have previously been accessible only by foot. This certainly will change the forest use patterns and the way that materials are transported out of the forest. I predict this will facilitate the movement of even more medicinal plants out of the area. It will also be interesting to see how joint forestry management (JFM) between villages and the central government unfolds. At the time I left, a number of villages had already formed environmental committees which had written bi-laws describing the management of their village sections of the forest reserves but the central government had yet to sign off on these so they were not yet fully functional. When I left, Coastal Forests were much farther behind Usambara Forests in terms of being designated and in terms of participating with local villagers in joint forestry management.

Maasai vendors and itinerant vendors (many of whom are also Maasai) are important components of the medicinal plant trade but their involvement in this research was not extensive. Their cultural, socio-political, economic, and environmental realities are unique from those of Bantu vendors. They should be the focus of future studies which would enable researchers to develop the rapport and relationships necessary to better understand their role in the trade and the people, plants, and places that are key to
their involvement in it. I have observed that both Maasai and itinerant vendors have increased in Tanga over the past ten years and I suspect that this trend will continue.

Future research should also explore in detail the actual ecological consequences of harvest regimes as they are practiced by a range of harvesters. Ticktin and coauthors (2002c) compared different harvest regimes of bromeliad ramets in different forest types over time. Simulations of harvested and unharvested populations yielded significantly different estimates of maximum sustainable harvest limits, indicating that methods for calculating maximum harvest limits that assume linear responses to harvest may lead to erroneous conclusions. Active participation in the research process enabled local harvesters to accept as valid the harvest limits determined in this study, to switch to using a more sustainable harvest regime, and to pass a local law prohibiting the destruction of their remaining primary forest because of its potential as \textit{A. magdalenae} habitat.

In South Africa, Geldenhuys (2004) conducted a study of four tree species whose bark have commercial value for medicinal use. The effects of bark removal over time were compared with the effects of complete removal of the tree. They concluded that for some species, including \textit{Ocotea bullata}, it is more sustainable to cut down the entire tree, remove all bark, and protect the stump so coppices can be established and new growth promoted. As with the Mexico study, researchers worked with actual harvesters, which was important for both simulating actual harvest practices and also for involving stakeholders in understanding and adopting the findings of the study so that appropriate management guidelines could be established for sustainable harvesting that is also beneficial commercially to harvesters.
Both of these studies demonstrate the need to observe real harvest, and involve actual harvesters and other stakeholders in participatory research. These can lead to the adoption of appropriate management which takes into consideration ecological, cultural, and livelihood concerns. I recommend future research use these studies as guidelines and explore the effects of *W. stuhlmannii* bark harvest, comparing various techniques already in practice by a range of harvesters. The findings could have applications to establishing sustainable bark harvest of *W. stuhlmannii* and to larger participatory management efforts that integrate harvesters and forestry officers. Future research could also build on the *O. bullata* studies by apply their findings to Tanga’s *O. usambarensis* populations and harvesters.

In the Uluguru Mountains of Morogoro (Tanzania), healers agreed and seemed interested in training on sustainable harvesting techniques to improve medicinal plant conservation (Mahonge, et al. 2006). Healers, vendors, and harvesters involved in my research in Tanga Town and in the Usambaras also expressed interest in working with forestry officers and researchers to learn about harvesting. Interactions between forestry staff, researchers, and local stakeholders are potentially fruitful.

11.4 Significance

This dissertation explores the role of medicinal plants in conservation and resource management and has argued that medicinal plants must be examined in their broader sociocultural, economic, and ecological context. It contributes to medical and environmental anthropologies by documenting previously unrecorded local ecological knowledge and adding to our understanding of the links between human health and the
biophysical environment. It also has applications both to the local research community and to a broader context.

11.4.1 Dismantling accepted truths about medicinal plants

The findings from this research on medicinal plant source areas encourage us to reexamine the generalization that medicinal plants come from disturbed, anthropogenic environments. Much of the work that supports this contention is from the New World—North America (Moerman 1998; Stepp and Moerman 2001), South America (de Albuquerque and de Lucena 2005; Hanazaki, et al. 2006; Monteiro, et al. 2006; van Andel, et al. 2007; Voeks 2004) and Central America (Bye and Linares 1983; Frei, et al. 2000; Stepp 2002). That research has described forest habitats as unimportant to medicinal plants. The corollary idea expressed in such research is that medicinal plant habitats are not relevant to conservation. My work refocuses attention toward a new perspective with information from a commercial market in East Africa. It illustrates that preferences for plant part, life form, and habitats for sourcing medicinal plants differ by social groups and that forest habitats do need to be considered in discussions of medicinal plant habitats. While leafy material from fast-growing herbaceous species --- including exotic and cultivated plants--- is common in medicines for home use, commercial plant medicines in Tanga diverge from this trend. Overwhelmingly, they consist of the bark and roots from native trees which are wild harvested, not cultivated. Two plants are primarily (if not only) sourced from forest reserves in the Usambara Mountains and a third has become threatened due to its shrinking and highly fragmented habitat in Coastal Forests. The demand for locally harvested plant medicines in Africa is expected to
increase (Barany, et al. 2005; Cunningham 1993a; Dold and Cocks 2002; Hamilton and Hamilton 2006:258). This trend also applies to Tanga where the trend for an increase in local people’s reliance on forest-based plant medicines which occurs vis-à-vis the commercial sale of medicinal plants underscores the need to consider their relationship to and potential role in conservation.

The findings from my research are in line with research from Mexico which questions the assumed link between salient medicinal plants and disturbed habitats (Cassagrande 2001:261), research from Brazil which questions the assumption that the most utilized environment is also the most preferred environment for collection (Gazzaneo, et al. 2005), and other research from Africa which highlights the importance of woody plants (not herbaceous ones) and forests to local pharmacopoeias (Cocks, et al. 2004; Earthskine 2004). I found that some salient plants come from less disturbed habitats, that the most preferred collection areas are not necessarily the most utilized ones, and that woody plants comprise a significant proportion of local pharmacopoeias.

The findings from my research also cause us to question accepted truths about the distribution of LEK. The LEK of commercial medicinal plants does not follow trends noted elsewhere from studies that focused on home-based and/or healer knowledge and use of plants. Those studies predict more knowledge is held by older, more experienced specialists who have less formal education. Instead, we see that knowledge is distributed differently in a market context where people other than healers who are younger with less experience and higher levels of formal education also have high levels of LEK. These findings bring the market into the picture as a central locus for knowledge acquisition,
transmission, and innovation. It also points to the importance of the market for identifying important species to consider for conservation planning.

By uncovering unexpected trends in LEK, this dissertation highlights variation in knowledge not only among but also within social groups. Its findings support the position of Ghimire and coauthors (2004), Agrawal (2002), and Lawrence and coauthors (2005) which argues that the heterogeneous nature of LEK must be recognized if it is to be useful to resource management planning. This dissertation reiterates their point which is particularly germane to conservation planners and resource managers who are increasingly becoming aware of the potential applications of LEK. Chapter One referred to the value of predicting who understands local ecological knowledge and behaviors for identifying “individuals who can work with scientists, bureaucrats, and the local-community to develop effective conservation measures” (Joyal 1996). This dissertation expands this idea by emphasizing the need to recognize not just who has knowledge, but how it varies within groups, how it relates to behavior, and what the institutions are that give it meaning, (re)enforce it, and transmit it. This dissertation has tried to emphasize the need to approach resource management with the understanding that local knowledge and practices are dynamic and context-specific (based on historical, ecological, social and economic factors). It has also stressed the need to recognize that knowledge and behavior are not necessarily parallel and that understanding the institutions that support LEK and influence resource management need to be understood in order to effectively incorporate LEK into management and conservation.
11.4.2 Reconsidering the role of medicinal plants in curing conservation ills

Chapter One introduced three paradigms related to medicinal plant management and general conservation. They are of theoretical interest and have practical applications to management approaches. Drawing on findings from the case study in Tanga, I revisit their potential utility to conservation and resource management.

Cultural keystone species are defined as those that are central to the healthy functioning of human communities, shape cultural identity, have fundamental roles in diet, materials, medicine, and/or spiritual practices. Examples are the western red-cedar (*Thuja plicata*) for Northwest Coast cultures of North America, and sago palm (*Metroxylon sagu*) in eastern Indonesia (Garibaldi and Turner 2004). Cultural keystone species are context specific, dynamic, and are based on community needs and availability; difficult to replace with other available native species; have a strong intensity of use as well as a multiplicity of uses; are represented in narratives and ceremonies; and their use is persistence in relation to cultural change (Garibaldi and Turner 2004).

Examples of flagship species in Africa are the mountain gorilla (*Gorilla gorilla beringei*) in Eastern and Central Africa (Hamilton 2004), and the bongo antelope (*Boocercus eurycerus isaaci*) of East Africa (Rare Species Conservatory Foundation 2007). Like cultural keystone species, flagship species are designated as such because of their ability to foster broad protection for whole ecosystems and therefore benefit multiple plants and animals. "Effective flagship species not only characterize diverse ecosystems, but also connect cultural, political and social value systems to nature. The human component is crucial, since collectively we must shoulder the responsibility of preserving what remains of nature" (Rare Species Conservatory Foundation 2007). They
should captivate interests from outside to generate sufficient support and resources and have local support to enable them to sponsor conservation of habitats and ecological services generally.

No one species in Tanga meets the criteria that apply to the concepts of cultural keystone species (Garibaldi and Turner 2004) or flagship species (e.g., Hamilton 2004; Rare Species Conservatory Foundation 2007). Although some medicinal plants meet some of these criteria for some people, they are highly context specific and variable. Choosing a species from the marketplace which incorporates multiple cultural traditions is difficult for Tanga. No one species emerged as the embodiment of these cultural icons for any one ethnic group or for the market as a group.

In part, this results from the culturally heterogeneous nature of Tanga, but more importantly, even within ethnic groups I noted a lack of agreement on which plant(s) are most important to a particular culture or best represent an area. Identifying a plant medicine that is much more important than others is difficult. Do you value Tylenol, Tums, or Neosporin the most? It is hard to choose one, but easier to say that continued access to all first aid medications are important. These concepts better apply to medicinal plants as a class of plants generally, or maybe a group of specifically chosen medicinal plants that are tailored to and designated by each local community in proximity to a potential conservation area or habitat.

*W. stuhlmannii* is the only commercial medicinal plant from this research that has been proposed as endangered. Importantly, harvesting it for medicinal purposes does not seem to be the primary threat to it, rather the same factors that threaten all habitats and species---expanding urban and agricultural areas and a growing demand for low cost
wood fuel and timber—are the most important factors. While *W. stuhlmannii* may be compelling as a flagship species because of its endangered status, it does not meet the other criteria of being so important to local culture that it could leverage local support for conserving their larger habitats and ecosystems.

Still, both the concepts of cultural keystone species and flagship species lend themselves to approaching conservation or fostering of ecological and human health from a bio-cultural perspective, and are useful even if not obviously applicable to one species. The most potential for applying these concepts is to forests in the Usambaras, where local people have already identified medicinal plants and their habitats as conservation priorities for their village forests, and in Coastal Forests which are less defined and more degraded but are the only habitat for *W. stuhlmannii*.

The third concept introduced in Chapter One is that medicinal plants are a microcosm of conservation. This study provided additional support for this idea as local stakeholders identified habitat loss due to the expansion of urban, agricultural, and grazing areas, and competing uses (specifically fuel wood and timber) as reasons for decreasing availability of medicinal plants. These are the same threats to plants and habitats generally, so addressing them for the sake of medicinal plants also has the potential to inspire conservation more broadly. This is in keeping with the cultural keystone and flagship species concepts. As a group of plants, medicinal plants can be the basis for motivating general conservation.

Restrictions on the harvest of commercial species or salient medicinal plants must be done with care. Resource managers should understand that the plants harvested in rural areas for home use are among those that are also sold commercially. This means
that the harvesting impact of those rural plants is heightened by harvesting for both commercial and domestic use, which makes them attractive candidates for conservation. On the other hand, it also means that any conservation measures taken for commercial species could also affect rural home users who rely on the plants for everyday health needs, not just people involved in the trade who rely on the plants to supplement their livelihoods.

Components of each of these three paradigms — cultural keystone species, flagship species, and microcosm of conservation — are found in the following emerging and longstanding examples in Tanga. In 2006, TAWG acted on the opportunity to purchase and develop a forest-farm. With guidance from the coastal forestry officer and the endorsement of the village who owned the land, TAWG acquired 100 acres for habitat conservation and the cultivation of medicinal and nutritious plants. The area of their parcel that overlaps the East African Coastal Forest Mosaic, internationally recognized for its high biodiversity and endemism, will be conserved. The larger area will be developed as a nursery and cultivation/education center. The vision is that the forest-farm will be a site for the production of plants to support people living with HIV/AIDS, training (cultivation, conservation, plant uses, plant harvesting techniques), and income generation. Although still emerging, this forest-farm is an example of the role medicinal plants can play in innovative community-based conservation that benefits local livelihoods and makes direct contributions to human health.

Village environmental committees who are making the transition to JFM with the Ministry of Natural Resources and Tourism's Forestry and Beekeeping Division have designated medicinal plants as motivations for preserving habitats and limiting
harvesting. In the East Usambaras, Woodcock (forthcoming) noted a village that has put a ban on the removal of all forest products from their village forests so that their sources of medicinal plants can have time to regenerate. In the West Usambaras, I met with a village environmental committee that has incorporated traditional taboos into their forest management bylaws which prohibit the harvest species that are known to be used in ancestor veneration ceremonies (as mentioned in Chapter Ten). In the West Usambaras, I also visited a privately owned traditional forest which has been managed by a line of healers. They have reserved the area for its value to medicinal plant access and prevented it from being cleared for agricultural or other purposes. The removal of forest products must be done with their permission and follow traditional harvesting pre- and proscriptions. A final example is in very early stages but worth mentioning. It is the group I described at the close of Chapter Seven, a collaborative effort of healers, vendors, foresters and others who are interested in conserving and cultivating medicinal plant species, habitat, and knowledge in Tanga.

11.4.3 Significance to Tanga

This research complements existing work done in Tanga on specialist knowledge and the use of medicinal plants (e.g., Ruffo, et al. 1989; Schlage, et al. 2000) and the sparse research on the commercial trade of medicinal plants in Tanga (Kessy 1998; Marshall 1998). This dissertation provides quantitative and qualitative detail on the market and its key components in their broader sociocultural and ecological contexts. Further, my detailed descriptions of how I determined and verified important species will enable future researchers to do the same, track changes over time, and go more in depth.
These findings also provide valuable information to policy makers and resource planners in Tanga. "Paucity of reliable information is a major reason for the frequent low level of awareness among decision-makers of the significance of the trade in terms of conservation impacts and human livelihoods" (Hamilton 2006:259). This research is a first step toward addressing this deficit of information. I have established baseline data on the important people, places, and plants in the trade. Future researchers can build upon this work. Also of importance to decision-makers and managers is the message that a range of people, not just healers and local leaders, are widely knowledgeable stakeholders in the medicinal plant trade and they (i.e., vendors, harvesters, widows, young people, pastoralists) should also be involved in planning conservation and management. They are the links to livelihoods and human and forest health, which are stated goals of Tanzania's national forestry policy (United Republic of Tanzania 2001).

A discussion of the significance of the research to Tanga would not be complete without my thoughts on how my work has impacted the ethnographic site. Tanga is a place I began working in ten years ago. Since that time, I have been aware that my work has not occurred in a vacuum, but rather has affected (and been affected by) the people and place where I work. My initial interest in Tanga centered on the interaction between hospital health workers and healers, and this magnified TAWG’s endeavors to enhance their relationship with healers. My focus on one of the plants used by TAWG and the healer they primarily work with (Mohomed Kassomo) brought more attention to that plant and person and heightened local people’s awareness of the plant’s value, and drew more attention to Kassomo as an important figure both locally and to outsiders.
Most recently, during my dissertation research I saw my role in the community as an exchanger of knowledge, a liaison between groups, and an advocate for groups that are less heard. From the beginning, instead of simply extracting knowledge from the community, I focused on exchanging knowledge with them. Through my training and travels I have acquired knowledge that is of interest to local stakeholders and they appreciated learning from me and treated me like a peer. Healers introduced me as a "doctor" to their fellow doctors. Another example of my influence is how my questions to local stakeholders about the availability of plants and changes in that availability, and stories of how they have become threatened elsewhere heightened local awareness to these issues and their relevance to local livelihoods and to the future availability of these important plants.

By liaison, I mean that I facilitated local people making connections with each other and seeing how their goals overlap when they do not typically have the occasion or the resources to work together. This means healers and foresters, harvesters and foresters, harvesters and healers, and health workers and forestry workers interacted with each other in ways they had not before. To my delight, at the end of my field research period they initiated a community organization and a mechanism to maintain contact with each other and work toward common health and conservation goals. Although I felt creating such an organization was important, I knew that initiating it as an outsider would not be appropriate or sustainable.

Finally, my work has helped to validate harvester and vendor knowledge, something that was shunned, denigrated, and seen as inauthentic by healers, health workers, and foresters. More broadly, I have shown local stakeholders that their
knowledge (LEK) and experiences are valuable, interesting, important, and relevant to outsiders, scientists, and government workers—and that it has a wider significance than to just their own village.

In order to continue with this process of exchanging information, I will return my research findings in appropriate ways to community members who were involved in my work. For academic institutions (e.g., NHT, SUA) I will provide a copy of my dissertation. For local non-academic institutions such as the Forestry Office and Tanga AIDS Working Group, I will also provide a summary of the dissertation and recommendations of how it relates to their work. For other non-academic community groups I will write a letter in Swahili summarizing my work, their role in it, and its relevance to their endeavors. These efforts are especially important to me as I have been driven to do work that is of interest to the local ethnographic setting as well as the wider international research community.
APPENDIX A: Swahili Agreement for Specialists to Participate in Research

MAKUBALIANO YA KUSHIRIKIANA UTAFITI
"Dawa za Miti Shamba na Mazingira Zao"
"Erica" Heather McMillen

University of Hawai‘i
Department of Anthropology
Honolulu, HI 98822 US

PO Box 6132 Tanga, Tanzania
Simu ya Tanzania 255 0748 589 711
Barua pepe hcmillle@hawaii.edu

Nia yangu ni kutaka kuelewa tabia na desturi za watu wa Tanga na hali ya mazingira ambayo yanalingana na matumizi, ukuzanyaji, na shughuli zote kwa ujumla wa mali asili, haswa dawa za miti shamba. Ningependa kuongea na watu ambao wanaokusanya, wanaouza, na wanaotumia dawa za miti shamba ili niuju mawazo yao. Kutokana na maelezo ya watu ambao wana uzoefu na miti ambayo inayotumia kwa dawa nimelewana kwamba mnelali upatakanaji wa miti hiyo tangu kale, sasa, na hata baadaye kwani ni maalum na muhimu. Sababu hili ndio iliyonifanya kuamua kuwafanya utafiti huu.

Ma/engo
- Kuelewa upatakanaje wa dawa za asili kuanzla chanzo chake (k.m. mstl, porinQ
- Kuelewa dawa zipo ni muhimu zaidi kwa watu kwa matumizi mbalimbali
- Kuelewa uguumu wa shughuli, ukuzanyaji, na upatikanaji wa dawa za asili

Utafiti huu hautesuza swala la tiba, kwa sababu nina hesabu muhimo ili wenu. Piachukua kama saa moja. Ukipendelea kuamua tazama kutoka la utafiti huu. Faidha na mataano, utafiti huu hau katika kadhaliku, kwa sababu si watu ambao wana kurejesha, wa mali, na watu ambao wanahesabu. Pia kama umeme wa utafiti huu, utafiti huu huwa na faida katika mavazi, ambayo hatunazungumza na hivyo wao nina maelezo yanayotaka. Kwa maeneo zinazoọngana na shughuhlaji, ukuzanyaji, na uguumu wa ujumla wa dawa za asili.

resa ya kumaliza shughuli zangu, nitaandikia kitabu kwa ajili ya masomo yangu kuwepo. Cha msingi mimi, ni kuandika kitabu ambacho nitafanya kuwa kama nina maelezo yanayotaka. Kwa atakayetaka kuwasiliana na chuo kujua kuhusu utafiti huu: Committee on Human Studies, University of Hawai‘i, 2540 Maile Way, Honolulu, HI 96822 USA. Simu: +001 (808) 956-5007.


- Kabla ya kuelewa, je una maswali au wasi wa wote?
- Je, unakubali kushiriki na utafiti huu?

Kwa atakayetaka kuwasiliana na chuo kujua kuhusu utafiti huu: Committee on Human Studies, University of Hawai‘i, 2540 Maile Way, Honolulu, HI 96822 USA. Simu: +001 (808) 956-5007.
APPENDIX B: Translated Agreement for Specialists to Participate in Research

AGREEMENT TO PARTICIPATE IN RESEARCH
“Medicinal Plants and Their Environment”
“Erics” Heather McMillen

University of Hawai‘i
Department of Anthropology
Honolulu, HI 96822 USA

PO Box 8132 Tanga, Tanzania
Telephone 255 0748 669 711
Email hmcmillen@hawaii.edu

My goals are to understand the cultural and environmental influences in Tanga related to the use, collection, and other practices concerning natural resources, especially medicinal plants. I would like to speak with people who collect, sell, and use medicinal plants so I can understand their thoughts and ideas. Medicinal plant experts have expressed their concerns about the present and future availability of these plants because they are important. For this reason I have decided to do this research.

Goals
- To understand the pathways of traditional medicines beginning with their sources (for example in the forest or bush) until they reach the people who use them
- To understand which medicines are most important to people
- To understand the difficulties of related activities, including gathering and obtaining traditional medicines

This research is not investigating treatments because I respect your knowledge. It has no relationship with a laboratory and no goal to manufacture medicine. My studies are not about those topics and I have no intent or ability to do carry out such research. My studies are about culture, the environment, and the ways people use natural resources.

My plan is to visit places where medicinal plants are obtained and to speak with those involved. Today I would like to speak about medicines or plants you use, how you obtain them, and if their availability has changed — but I do not intend to discuss how you use the plants in treatments.

I invite you to participate in my research, to ask and be asked questions, and to share your ideas. The questions I have prepared will take about an hour. If you agree, I would like to record our conversation with pen and paper. These notes I take in my notebook are for my use to help me remember what you say.

After I finish my research activities, I will write a book for my studies at the university. More importantly, I plan to write a booklet to return to you, so you can see what I have studied from you. In my writing, I will not include anything that can identify you as a participant unless you agree. Alternatively, if you prefer your name be included, I will include it. This is your choice completely.

Similarly, it is your choice to agree or not to agree to participate in this research. Feel free. Even if you agree today and later you change your mind, feel free to tell me. Also, if you are asked questions that you do not feel like answering, feel free to decline to discuss them. In short, I would like you to be open and free to do as you like.

- Before continuing, do you have any questions or concerns?
- Do you agree to participate in this research?

If you want to communicate with my university about this research contact: Committee on Human Studies, University of Hawai‘i, 2540 Mailê Way, Honolulu, HI 96822 USA. Telephone: +001 (808) 956-3007.
APPENDIX C: Swahili Agreement for Lay People to Participate in Research

AGREEMENT TO PARTICIPATE IN RESEARCH
“Medicinal Plants and Their Environment”
“Erica” Heather McMillen

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Honolulu, HI 96822

PO Box 6132
Tanga, Tanzania
Simu ya Tanzania 255 0748 569 711
Barua pepe hmcmllie@hawal1.edu

Nia yangu ni kutaka kuelewa utumaji wa dawa za aina mbali mbali. Pia ni kuelewa tabia na desturi za watu wa Tanga na hali ya mazingira ambayo yanalingana na matumizi, ukusanyaji, na shughuli zote kwa kwa umunia wa mali asili, haswa dawa za miti shamba. Ningepeenda kuongea na watu ambao wanaokusanya, wanaouza, na wanaoctumia dawa za miti shamba ili njie mawazo yao.

Malango
• Kuelewa upatakanaje wa dawa za asili kuanzia chanzo chake (k.m. msitu, porini) mpaka zifike kwa watu ambao wanaoctumia.
• Kuelewa dawa zlpl ni muhimu zaidi kwa watu kwa matumizi mbalimbali.
• Kuelewa ugumu wa shughuli, ukusanyaji, na upatikanaji wa dawa za asili.

Utafiti huu hautauliza swala la tiba. Pia utafiti huu hauhusiani chochote na maabara, kwani hauna nia wala lengo la utengenezaji wa dawa. Masomo yangu si kuhusu mambo hayo, na sina nia wala uwezo wa kufanya mambo hayo. Masomo yangu ni kuhusu desturi ya watu, na jinsi wanaoctumia mali asili kutokana na mazingira yao.

Mpango wangu nikutembelea shehmu ambazo dawa za miti shamba zinatolewana na zinatumiwa ili kuelewa kwa kiasi gani watu wanaozitumia dawa za aina mbali mbali. Leo nitapendisha mazungumzia dawa mnaitumia, na jinsi mnayoziyipata.

Nakualika kushiriki katika kazi yangu, kuulizana maswali, na kutoa mawazo yako. Ukiukali, nitapendisha kuzungumzia dawa mnaitumia, na kuhusu kuna mabara, kwa kufanya kukumbuka kila ulichoema.

Baada ya kumaliza shughuli zangu, nitaandika kitabu kwa ajili ya masomo yangu chuongi. Katika kitabu changu, hitatambuliwa kwa jina kwa sababu siteandika jina lako au kitu chochote ambacho kitapelekea kutambuliwa kwako bila ridhaa au ruksa kutoka kwako.

Ni chaguo lako kukubali au kukataa kushiriki katika utafiti huu. Uwe na uhuru, tu. Na ikiwa pia, kama utaulizwa maswali ambayo hutajikia kulijibu pia uwe uhuru kutuieleza kwani siyo lazima ikiwa mwenyewe hujaridhika nalo. Kwa kifupi nitapenda uwe wazi, tu.

• Kabla ya kuondolea, je una maswali au wasi wasi wo wote?
• Je, unakubali kushiriki na utafiti huu?

Kwa atakayetaka kuwaslliana na chuo kujua kuhusu utafiti huu:
Committee on Human Studies, University of Hawai‘i, 2540 Maile Way, Honolulu, HI 96822
USA. Simu: +001 (808) 956-5007.
APPENDIX D: Translated Agreement for Lay People to Participate in Research

AGREEMENT TO PARTICIPATE IN RESEARCH
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My goals are to understand the uses of different medicines and to understand the cultural and environmental influences in Tanga related to the use, collection, and other practices concerning natural resources, especially medicinal plants. I would like to speak with people who collect, sell, and use medicinal plants so I can understand their thoughts and ideas.

Goals
- To understand the pathways of traditional medicines beginning with their sources (for example in the forest or bush) until they reach the people who use them
- To understand which medicines are most important to people
- To understand the difficulties of related activities, including gathering and obtaining traditional medicines

This research is not investigating treatments. It has no relationship with a laboratory and no goal to manufacture medicine. My studies are not about those topics and I have no intent or ability to do carry out such research. My studies are about culture, the environment, and the ways people use natural resources.

My plan is to visit places where medicinal plants are obtained and used in order to understand to what degree people depend on various medicines. Today I would like to speak about medicines you use and the way you obtain them.

I invite you to participate in my research, to ask and be asked questions, and to share your ideas. If you agree, I would like to record our conversation with pen and paper. These notes I take in my notebook are for my use to help me remember what you say.

After I finish my research activities, I will write a book for my studies at the university. In my book, I will not include anything that can identify you as a participant unless you agree.

It is your choice to agree or not to agree to participate in this research. Feel free. If you are asked questions that you do not feel like answering, feel free to decline to discuss them. In short, I would like you to be open and free to do as you like.

- Before continuing, do you have any questions or concerns?
- Do you agree to participate in this research?

If you want to communicate with my university about this research contact: Committee on Human Studies, University of Hawai‘i, 2540 Maile Way, Honolulu, HI 96822 USA. Telephone: +001 (808) 956-5007.
## APPENDIX E: LEK Plants Botanical Species Names and Ethnospecies Names

<table>
<thead>
<tr>
<th>Botanical Species Names</th>
<th>Ethnospecies Names</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Zanthoxylum chalybeum</strong> Engl. Var. chalybeum, Rutaceae</td>
<td>Mlunguungu; Mjafari; Ololosuki; Hombo-Mungu; Mnangungu; Msele; Popwe; Mmungu; Mnangu-Gona; Mdungu; Mtata</td>
</tr>
<tr>
<td><strong>Albizia anthelmintica</strong> Brongn Fabaceae</td>
<td>Mfuleta; Omukutan; Mukutani; Almaro Mporojo, Mlikiti, Mseleza Chuma</td>
</tr>
<tr>
<td><strong>Morella salicifolia</strong> A. Rich. subsp. kilimandscharica Engl. Myricaceae</td>
<td>Mchekeche; Mshegeshe; Mshegesi Mgwangwi; Mkaakaa</td>
</tr>
<tr>
<td><strong>Artemisia afra</strong> Wild Asteraceae</td>
<td>Fivi; Fifi; Fifi Ushemeli; Kisomalia Dume</td>
</tr>
<tr>
<td><strong>Warburgia stuhlmannii</strong> Engl. Canellaceae</td>
<td>Msogonoi; Olsogonoi, Pilipili Mwitu Mkilifu; Kilifu; Mkilifi; Mkambaki Mwarobaini Wa Ki Asili. Mkaa, Mkaakaa;</td>
</tr>
<tr>
<td><strong>Ocotea usambarensis</strong> Engl. Lauraceae</td>
<td>Kulo; Mkamfo; Bwanga Mtoa-Mada; Mtambaa; Mkenene; Kivumba; Manyodo; Miseri</td>
</tr>
<tr>
<td><strong>Harrisonia abyssinica</strong> Oliv. Simaroubaceae</td>
<td>Ndelengwe; Mdaitai; Mkusu; Mkidori; Enilelo; Ngiloilo; Msoma; Mgole; Uwingi; Mkoromando, Mpapuradoko; Msaburini</td>
</tr>
<tr>
<td><strong>Aspilia mossambicensis</strong> (Oliv.) Wild Asteraceae</td>
<td>Mnonyga Nyanga; Mvuti M'pehe; Muhepe; Ihwula Aloiyavasei; Olchanipus</td>
</tr>
<tr>
<td><strong>Steganotaenia araliacea</strong> Hochst Apiaceae</td>
<td>Mnyanga Pembe Muogora; Mgola Mziwankanga; Mvuavui, Nariwa, Mjiapia</td>
</tr>
</tbody>
</table>
### APPENDIX F: Animals Used Medicinally that were Inventoried in Markets

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Local Name       (Swahili unless noted)</th>
<th>Class</th>
<th>Part sold</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Tubipora musica</em></td>
<td>Pipe organ coral</td>
<td><em>Maua ya bahari / mawe ya bahari</em></td>
<td>Anthozoa</td>
<td>Whole</td>
</tr>
<tr>
<td><em>Gogonia spp.</em></td>
<td>Fan coral</td>
<td><em>Maua ya bahari / wavu ya bahari</em></td>
<td>Anthozoa</td>
<td>Whole</td>
</tr>
<tr>
<td><em>Crocuta crocuta</em></td>
<td>Hyena</td>
<td>Fisi</td>
<td>Mammalia</td>
<td>Nose, bones, fur</td>
</tr>
<tr>
<td><em>Atelerix spp.</em></td>
<td>Hedgehog</td>
<td><em>Kamunguyeye</em></td>
<td>Mammalia</td>
<td>Quills, skin</td>
</tr>
<tr>
<td><em>Manis temminckii</em></td>
<td>Pangolin</td>
<td><em>Kaka kuona</em></td>
<td>Mammalia</td>
<td>Scales</td>
</tr>
<tr>
<td>Possibilities are:</td>
<td></td>
<td></td>
<td>Reptilia</td>
<td>Shell</td>
</tr>
<tr>
<td><em>Chelonia mydas,</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Eretmochelys</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>imbricate,</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Caretta caretta</em> or</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Lepidochelys olivaceae</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>undetermined</em></td>
<td>Tortoise</td>
<td>Kobe</td>
<td>Reptilia</td>
<td>Shell</td>
</tr>
<tr>
<td><em>Loxodonta africana</em></td>
<td>African Elephant</td>
<td><em>Mauv ya tembo</em></td>
<td>Mammalia</td>
<td>Dung (dried)</td>
</tr>
<tr>
<td><em>Capra hircus</em></td>
<td>Domestic Goat</td>
<td><em>Mbuzi</em></td>
<td>Mammalia</td>
<td>Tail, bone</td>
</tr>
<tr>
<td><em>Mellivora capensis</em></td>
<td>Honey badger</td>
<td><em>Nyege</em></td>
<td>Mammalia</td>
<td>Tail, bones</td>
</tr>
<tr>
<td><em>Hystrix spp.</em></td>
<td>Porcupine</td>
<td><em>Nungunugu</em></td>
<td>Mammal</td>
<td>Quills</td>
</tr>
<tr>
<td>Various</td>
<td>Fish</td>
<td><em>Samaki</em></td>
<td>Various</td>
<td>Bones, skin</td>
</tr>
<tr>
<td><em>Panthera leo</em></td>
<td>Lion</td>
<td><em>Simba</em></td>
<td>Mammalia</td>
<td>Nose, bones, hairball</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(trichobezoar), fat</td>
</tr>
<tr>
<td><em>Cypraea spp.</em></td>
<td>Cowrie</td>
<td><em>Simbi</em></td>
<td>Gastropoda</td>
<td>Shells</td>
</tr>
<tr>
<td><em>Haliaeetus spp.</em></td>
<td>Eagle</td>
<td><em>Tai</em></td>
<td>Aves</td>
<td>Feathers</td>
</tr>
<tr>
<td><em>Gazella spp.</em></td>
<td>Gazelle</td>
<td><em>Paa</em></td>
<td>Mammalia</td>
<td>Horn</td>
</tr>
</tbody>
</table>
BIBLIOGRAPHY

Abrahams, Ray, ed.

Agrawal, Arun

Akerele, Olayiwola
1987 The best of both worlds: Bringing traditional medicine up to date. Social Science & Medicine 24(2):177-181.

Alcorn, Janis B.


Alexiades, Miguel N., and Jennie Wood Sheldon, eds.

Amani Nature Reserve

Anderson, M. Kat

Anyinam, Charles

Arnold, J.E.M., and Manuel Ruiz Peréz

Atran, Scott, Douglas Medin, and Norbert Ross

Balasingh, J., et al.
Balunas, Marcy J., et al.

Balée, W., and A. Gély

Barany, M., C. Holding-Anyonge, D. Kayambazinthu, and A. Sitoe.

Barany, Marc, A.L. Hamnett, Abdou Sene, and Beyhan Amichev

Beckerleg, Susan

Beentje, H.J., ed.

Beentje, H.J., and D.J.N Hind

Begossi, Alpina, Natalia Hanazaki, and Jorge Y. Tamashiro

Begossi, Alpina

Beidelman, Thomas O.

Berkes, Fikret

Berkes, Fikret, Johan Colding, and Carl Folke

Berkes, Fikret, Carl Folke, and Johan Colding, eds.

Berlin, Brent

Bernard, H. Russell  
1995 Research Methods in Anthropology: Qualitative and Quantitative Approaches. Walnut Creek: Alta Mira Press.

Bodeker, Gerard  

Bodeker, Gerard, et al.  

Botha, J, E.T.F. Witkowski, and C.M. Shackleton  


Boyd, Jr., Harper W., Ralph Westfall, and Stanley F. Stasch  

Brenan, J.P.M  

Brockington, Daniel  

Brodt, Sonja B.  

Brush, Stephen B.  

Burgess, N.D., et al.  

Bye, Jr., Robert A., and Edelmira Linares  

Caniago, I., and S.F. Siebert  
Cassagrande, David Gregory

2001 Ecology, Cognition, and Cultural Transmission of Tzeltal Maya Medicinal Plant Knowledge, University of Georgia.

Chapin, Mac

Chapman, Colin A., Lauren J. Chapman, Less Kaufman, and Amy E. Zanne

CIFOR
2006 Forest Livelihood Briefs: Forests as safety nets for mitigating the impacts of HIV/AIDS in southern Africa: Center for International Forestry Research.

Cocks, M. L., and A. P. Dold

Cocks, M.L., A.P. Dold, and I.M. Grundy

Coe, F.G., and G.J. Anderson

Colding, Johan, and Carl Folke

Colwell, R.K.

Conservation International

Costanza, Robert, et al.

Cristancho, Sergio, and Joanne Vining

Crouch, N. R., and T. Edwards

397
Cunningham, Anthony B.


Cunningham, A.B., E. Ayuk, S. Franzel, B. Duguma and C. Asanga.


Davis, Anthony, and John R. Wagner


Davis, S.D., V. Heywood, and A. C. Hamilton


de Albuquerque, Ulysses Paulino, and Reinaldo Farias Pavia de Lucena

2005 Can apparency affect the use of plants by local people in tropical forests? Interciencia 30(8).

de Albuquerque, Ulysses Paulino, Laise de Holanda Cavalcanti Andrade II, and Ana Carolina Oliveira de Silval


Department of Peacekeeping Operations, Cartographic Section


Dold, AP., and ML. Cocks

Earthskine, S.

Ehret, Christopher

Ellen, R., P. Parkes, and A. Bicker, eds.

Ethnobiology Working Group

Etkin, N.L., and Paul J. Ross


Etkin, Nina L.


—, ed.


Etkin, Nina L., Paul J. Ross, and Ibrahim Muazzam

Farmer, Paul

Farnsworth, Norman R., et al.
Feierman, Steven

Feierman, Steven, and John M. Janzen, eds.

Fordham, Alfred J.

Frei, Barbara, O. Sticher, and M. Heinrich

Gadgil, Madhav, Fikret Berkes, and Carl Folke

Ganeshaiah, K.N., et al.

Garibaldi, Ann, and Nancy Turner

Gazzaneo, Luiz Rodrigo Saldanha, Reinaldo Farias Pavia de Lucean, and U.P. de Albuquerque
2005 Knowledge and use of medicinal plants by local specialists in an region of Atlantic Forest in the state of Pernambuco (Northeastern Brazil). Journal of Ethnobiology and Ethnomedicine 1(9).

Geldenhuys, Coert J.

Gessler, M. C., et al.

Ghimire, Suresh Kumar, Doyle McKey, and Yildiz Aumeeruddy-Thomas


Giles, Linda L.
Gollin, Lisa X

Grace, O.M., et al.

Green, E. C.
1999 Indigenous Theories of Contagious Disease. Walnut Creek: Alta Mira Press.

Green, Edward C.

Greenway, P.J.

Grifo, Francesca, and Joshua Rosenthal, eds.

Hall, Pamela, and Kamaljit Bawa

Hamilton, Alan C.

Hamilton, Alan, and Patrick Hamilton

Hanazaki, Natalia, Vinícius Castro Souza, and Ricardo Ribeiro Rodrigues

Hanazaki, Natalia, et al.

Hegde, R., et al.

Heine, Bernd, and Karsten Legère.

Holmes, John
Ibn Qayyim, al-Jawziyya

Ibrahim, Fouad, and Barbara Ibrahim

Infoplease encyclopedia

ISL Software Corporation

Janzen, J.

Johns, T., R. L. A. Mahunnah, P. Sanaya, L. Chapman, and T. Ticktin

Johns, Timothy, John O. Kokwaro, and Ebi K. Kimanani

Johns, Timothy

Joyal, Elaine

Jungerius, P.D.

Kajembe, G.C., et al.

Kakudidi, E. K.

Kayambazinthu, Dennis, et al.

Kayombo, Edmund J, et al.

Keirungi, J., and C. Fabricius
Kessy, John Francis

Kohn, E. O.

Kokwaro, J.O.

Krog, Mogens, Mario P. Falcão, and Carsten S. Olsen
2004 Medicinal Plant Trade in Maputo, Mozambique. Pp. 44. Maputo: The FORLIFE Plot field project.

Kyoshabire, Medius
1998 Medicinal Plants and Herbalist Preferences Around Bwindi Impenetrable Forest, Uganda. MSc, Makerere University.

Laird, Sarah A., and A.R. Pierce

Lawrence, Anna, et al.

Letšela, T., E.T.F Witkowski, and K. Balkwill

Lévi-Strauss, Claude

Kyoshabire, Medius
1998 Medicinal Plants and Herbalist Preferences Around Bwindi Impenetrable Forest, Uganda. MSc, Makerere University.

Linares, Edelmira, and Robert Bye

Lovett, Jon C.

Luoga, Emmanuel J., E.T.F Witkowski, and Kevin Balkwill

Macía, Manuel J., Emilia Garcia, and Prem Jai Vidaurre

Madoffe, S.S., and P.K.T. Munishi

Maguire, Patricia

Mahonge, C.P.I., et al.

Mahunnah, R. L. A.

Mander, Myles

Maroyi, A.
2000 Options for the recovery of Warburgia salutaris populations in Zimbabwe. The Zimbabwe Science News 34(3&4).

Marshall, Nina T.

Martin, Gary J.

Martin, Gary, et al.

Mauambeta, D.D.C.


Monteiro, Julio Marcelino, et al.

Mshana, Giliard N.
2004 A Case Study on Medicinal Plants in Amani Division, Muheza District-Tanga, Forestry Training Institute at Olmononyi.

Mshiu, E.N., and R. L. A. Mahunnah

Murali, K.S., et al.

Newmark, W.D.

Niamir-Fuller, Maryam

Olsen, Carsten Smith
1997 Commercial non-timber forestry in central Nepal: emerging themes and priorities., Royal Veterinary and Agricultural University.

Olsen, Carsten Smith, and Helle Overgaard Larsen

Orlove, Benjamin S., and Stephen B. Brush

Palmer, E., and N. Pitman


Planning Commission in Dar es Salaam and the Regional Commissioner's Office in Tanga
1997 Tanga Region Socio-Economic Profile. Pp. 188. Tanga.

Polhill, R.M., and B. Verdcourt

Posey, Darrell A.
Posey, Darrell A.


Pruess, James B.

Rabinowitz, D., S. Cairns, and T. Dillon

Rare Species Conservatory Foundation

Rashford, John

Rekdal, Ole Bjorn

Reyes-Garcia, Victoria, et al.

Rodgers, W.A., and K.M. Homewood

Rokaya, M. B., M. R. Shrestha, and S. K. Ghimire

Romney, A. Kimball, Susan C. Weller, and William H. Batchelder
1986 Culture as Consensus: A Theory of Culture and Informant Accuracy.

Ross, I.A.

Ruffo, C.K., Anne Birnie, and Bo Tengnäs

Ruffo, C.K., I.V. Mwasha, and C. Mmari
Sa'id, Hakim Mohammed

Sangai, G.R. Williams
1963 Dictionary of Native Plant Names in the Bondei, Shambaa and Zigua Languages with Their English and Botanical Equivalents.

Schippman, Uwe, A.B. Cunningham, and Danna J. Leaman

Schlage, Christina, Charles Mabula, R.L.A. Mahunnah, and Michael Heinrich

Schuster, B.G.

Schwartz, Jeremy

Shaanker, R. Uma, Ravi Hegde, and Kamalfit Bawa

Shanley, Patricia, and Leda Luz

Shechambo, Fanuel, John Salehe, and Stephen Mariki
Sheldon, Jennie Wood, Michael J. Balick, and Sarah A. Laird
Shepard, Jr. G.H.
2004 A Sensory Ecology of Medicinal Plant Therapy in Two Amazonian

Shepard, Jr. G.H.
2002 Nature’s Madison Avenue: Sensory Clues as Mnemonic Devices in the
Transmission of Medicinal Plant Knowledge among the Matisgenka and Yora of
Peru. In Ethnobiology and Biocultural Diversity. J.R. Stepp, F.S. Wyndham, and

Sillitoe, Paul
1998 The Development of Indigenous Knowledge: A New Applied

Sillitoe, Paul
2006 Ethnobiology and applied anthropology: rapprochement of the academic
with the practical Journal of the Royal Anthropological Institute 12:S119-142.

Soeharto, Tonny, and Adrian C. Newton
2002 The Gaharu Trade in Indonesia: Is it Sustainable? Economic Botany

Spear, Thomas
Historical Studies 33(2):257.

Stannard, B.

Stepp, John R.
2004 The role of weeds as sources of pharmaceuticals. Journal of
Ethnopharmacology 92:163-166.

Stepp, John R.
2002 Highland Maya medical ethnobotany in ecological perspective (Mexico).
Dissertation, University of Georgia.

Stepp, John R., and Daniel E. Moerman
2001 The importance of weeds in ethnopharmacology. Journal of
Ethnopharmacology 75:19-23.

Stocking, Michael, and Scott Perkin
1992 Conservation-with-development: and application of the concept in the
Usambara Mountains, Tanzania. Transactions of the Institute of British
Geographers 17(3):337-349.

Swantz, Marja Liisa
1979 Community and healing among the Zaramo in Tanzania. Social Science
and Medicine 13B:169-173.

Swallow, B.
2004 Overview of links between HIV / AIDS and agroforestry. workshop on
agroforestry responses to HIV/AIDS in East and Southern Africa, World
Tanzania Government

Tengö, Maria, and Monica Hammer

Ticktin, Tamara

Ticktin, Tamara, A. Namaka Whitehead, and Ho'ala Fraiola

Ticktin, Tamara, et al.

Ticktin, Tamara, and Timothy Johns

Ticktin, Tamara Nantel, Patrick Ramirez, Fernando Johns, Timothy

Townsend, C.C.

Trager, Lillian

Turner, Nancy J., Marianne Boelscher Ignace, and Ronald Ignace

UNICEF

United Republic of Tanzania

Usher, Ann Danaiya

van Andel, Tinde, et al.
van der Geest, Sjaak, and Susan Reynolds Whyte

van der Geest, Sjaak, Susan Reynolds Whyte, and Anita Hardon

Veeman, Terrence S., et al.

Verdcourt, B.

Voeks, Robert A.
1996 Tropical forest healers and habitat preference. Economic Botany 50(381-400).


Voeks, Robert A., and Angela Leony

Waldram, James B.

Waldstein, Anna, and Cameron Adams

Walter, S.

Warren, D. Michael, and Jennifer Pinkston

Weller, Susan C.

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Williams, Vivienne L.


Williams, Vivienne L., Kevin Balkwill, and Edward T.F. Witkowski

Williams, Vivienne L., Edward T.F. Witkowski, and Kevin Balkwill


Wilson, Allison

Witkowski, E.T.F. & Lamont, B.B.

Woodcock, Kerry A.

World Bank
World Health Organization


Xu, Jianchu, et al.


Zschocke, S., et al.