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Gender and socio-economic factors influencing domestication of indigenous medicinal plants in the West Usambara Mountains, northern Tanzania

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The limited capacity of governments in developing countries to service primary health care has resulted in a rapid increase in use of indigenous medicinal plants. This increase, together with other biological and non-biological factors, has rendered these plants vulnerable to over-use and extirpation. Domestication is a conservation intervention that can relieve pressure on medicinal species. In order to ensure effectiveness and sustainability of an intervention, understanding the influencing factors is imperative. We examined the influence of gender and some socio-economic factors on domestication of medicinal plants in the West Usambara Mountains of northern Tanzania. Participatory wealth ranking, structured and semi-structured interviews, botanical surveys and participant observations were employed in data collection. Results showed that domestication has played a fundamental role in conservation of medicinal plants in the study area. Forty (89%) and twelve (27%) of forty-five indigenous plant species were domesticated on farms and around homesteads, respectively. A total of 89% of respondents ($n = 173$) had domesticated medicinal plants on their farms and around homesteads. Gender was the most important factor that influenced this practice, with more male-headed than female-headed households involved in the domestication effort. This can be attributed to social and cultural factors that, besides dispossessing women of tenure rights over resources and land, also subject them to heavy workloads and therefore diminish the time available for plant domestication. The number of domesticated medicinal plants also depended on age, affluence, farm size, household size and ethnicity. We recommend that agroforestry research should focus not only on integrating forest plants in farmlands, but also on cultural, socio-economic and institutional aspects affecting the whole system of domestication.

Keywords: medicinal plants; primary health care; conservation; domestication; gender; socio-economic factors

Introduction

Medicinal plants are essential components of primary health care, especially for rural communities who for geographical and economic reasons cannot access modern Western medical services. The World Health Organisation (WHO) estimates the world population relying on traditional medicines for their primary health care at four billion people, 80% of whom coming from developing countries (Augustino and Gillah 2005; Schippmann et al. 2006). High reliance on traditional medicines may be attributed to a low ratio of university-trained doctors to rural residents. Statistics indicate that in Sub-Saharan Africa, the ratio of traditional healers and medical doctors to patients is approximately 1:500 and 1:40,000, respectively (Richter 2003). This imbalance is growing; in Tanzania, for example, the ratio of doctors to patients had decreased from 1:22,600 in 1970 to 1:24,880 in 1990 (Abdallah et al. 2007).

The prominence of medicinal plants is increasing globally. Data indicate that between 1991 and 1998, the 12 countries importing the most medicinal plant material paid over US$1 billion to import 343,000 t, while the 12 most exporting countries earned over US$640 million from export of 282,000 t (Lange 1998). The top three exporters of medicinal plants in the world were China, India and Germany, which exported 139,750; 36,750 and 15,050 t, respectively. The three leading importers [with tonnage shown in brackets] were Hong Kong (73,650 t), Japan (56,759 t) and the USA (56,000 t) (Lange 1998). The US National Cancer Institute identified over 1400 tropical forest plants with the potential to fight cancer (WCMC 1992). *Catharanthus roseus*, native to Madagascar, is one such plant, which has been used for generations by traditional healers and is now an important raw material for drugs effective against Hodgkins lymphoma and other forms of cancer (WCMC 1992).

The need for domestication of medicinal plants

Domestication can be defined as an indigenous forestry practice that involves retaining plant species of forest origin in farms during the process of clearing land for cultivation, or bringing forest plants to farms or homesteads for the purpose of reducing exploitation pressure on wild stocks (Shepherd 1992). The practice is regarded as a conservation intervention that can relieve pressure on wild populations of medicinal species that are most susceptible to extinction due to various biological and non-biological factors, such as narrow geographic distribution, habitat specificity, slow growth rate and excessive and destructive harvesting of roots, bark or entire plants (WCMC 1992; Augustino and Gillah 2005; Schippmann et al. 2006; Msuya and Kideghesho 2009).

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The WHO (cited in Govaerts 2001) estimates the number of plant species used medicinally worldwide at 72,000. This is about 17% of the total number of flowering plant species i.e. about 422,000. World trends, such as market forces, population growth and high demand for these species – not only for primary health care but also for commercial and other purposes such as fuelwood, timber and poles – have subjected them to over-exploitation. About 21% of known medicinal plant species (15,000) are threatened worldwide (Bramwell 2003). Land clearing for agriculture, settlements and other developments, as well as accidental and deliberate fires have also contributed immensely to destruction and loss of species (Millennium Ecosystem Assessment 2005; IUCN 2006, 2008).

Medicinal plants are subject to excessive harvesting when exploited at a rate that exceeds their annual sustained yield. This can lead to genetic erosion of species that are not in cultivation, as exemplified by *Parkia roxburghii* in East Java and *Dioscorea deltoides* in the Himalayan foothills of northern India (WCMC 1992). The latter is a major source of diosgenin, once used in the manufacture of contraceptives (WCMC 1992). Also, destructive harvesting involves extraction of medicinal plants through ring-barking and root-cutting, which kills the entire plant, as with *Prunus africana* in West Africa and *Warbugia salutaris* in Kenya (Kokwaro 1993) and South Africa (Schippmann et al. 2006).

The growing demand for medicinal plants and its impact globally has increasingly been acknowledged in the literature. For example, loss of valuable genetic resources due to over-exploitation of medicinal species has been documented in some countries of Asia, e.g. *Curcuma* spp., *Voacanga grandifolia, Orthosiphon aristasus* and *Rauvolfia serpentina* (WCMC 1992). In Tanzania, about nine medicinal plant species reported to be traded locally and internationally have been identified by the Wildlife Trade Monitoring Network (TRAFFIC) as most in need of conservation, management and research due to their endangered status caused by excessive harvesting. These species are: *Dioscorea dumetorum*, *Cadaba farinosa*, *Milicia excelsa*, *Acalypha fructicosa, Harrisonia abyssinica, Steganotaenia araliacea, Acacia melifera, Ehretia amoena* and *Wedelia mossambicensis* (Marshall 1998). Similar impacts of trade are reported for *Prunus africana* in West Africa and Madagascar, *Warbugia salutaris* in South Africa and *Saussurea costus* in the Himalaya (Schippmann et al. 2006). The threat of extinction prompted addition of the following 17 medicinal plants to CITES (Convention on International Trade of Endangered Species of Wild Fauna and Flora) Appendices: *Adonis vernalis, Aquilaria malaccensis, Cistanche deserticola, Dioscorea deltoides, Guaiacum officinale, Guaiacum sanctum, Hydrastis canadensis, Nardostachys grandiflora, Panax ginseng, P. quinquefolius, Picrorhiza kurroo, Podophyllum hexandrum, Prunus africana, Pterocarpus santalinus*, *Rauvolfia serpentina, Saussurea costus* and *Taxus wallichiana* (Schippmann et al. 2006). It is because of the threats facing medicinal plants, that the Medicinal Plant Specialist Group was founded in 1994, under the auspices of the Species Survival Commission of the World Conservation Union (IUCN). The major roles of the commission regarding medicinal plants are to increase global awareness of conservation threats to these plants and to promote conservation actions, domestication being one such action.

In addition to relieving pressure of over-exploitation, domestication of medicinal plants has other numerous advantages over wild collection. According to Schippmann et al. (2006) domestication may guarantee a continuing supply of raw material; makes reliable botanical identification possible prior to harvesting; secures a steady supply of herbal medicines (from home gardens); makes quality standards easy to maintain; makes controlled post-harvest handling possible and comprises an in-country, value-added industry. Furthermore, with domestication, wholesalers and pharmaceutical companies can agree on volumes and prices over time with the grower; the resource price remains relatively stable over time; certification as *organic* is possible; and the selection and development of genotypes with commercially desirable traits from the wild or managed populations may offer opportunities for economic development of the medicinal plant species as a crop.

Influence of gender and socio-economic factors on domestication of medicinal plants

Domestication of medicinal plants has been practiced since pre-historic times (Wiersum et al. 1985; Kaoneka and Solberg 1997; Moshi 1997; Msuya 1998). Although it is unlikely that the situation will change in the near future, there are a number of factors affecting domestication of medicinal plants, which need to be examined critically and documented for sustainable use and management purposes. We focused on gender and socio-economic factors. An understanding of these factors is essential, as it may provide a framework for prioritization of management actions and help to create sufficient and sustainable measures on how to hedge against the threats facing medicinal plants.

Gender refers to the socially constructed roles, behavior, activities and attributes that a particular society considers appropriate for men and women (www.who.int/topics/gender/en). In particular, gender can influence conservation of natural resources and domestication efforts. The main focus of gender issues is women's relations with men, their roles, access to and control over resources, division of labour, interests and needs (Augustino and Gillah 2005; Kingazi et al. 2008). In almost all communities worldwide, women and men have different gender-based roles, responsibilities, needs, as well as local knowledge of, access to and control over their environment. Women's capacities and willingness to conserve resources differ from those of men. Similarly, the way women are affected by environmental degradation and declining biodiversity resources, and the strategies they employ to cope with these effects are different from those of men. However, there is a tendency to overlook these factors (Talhouk et al. 2001). Augustino and Gillah (2005) argued that women are not more important than men, but they deserve special attention as their roles and needs are often

overlooked. These authors consider domestication as an important coping and adaptive strategy for most women due to their marginal economic status and their special interest in plants. In rural societies, women are responsible for the health of the family and spend more time caring for the sick. This reality, therefore, makes careful analysis of the influence of gender on domestication of medicinal plants imperative.

In addition to gender, socio-economic factors such as age, education, wealth, ethnicity, farm and household size can influence domestication efforts (Michon and de Foresta 1996; Moshi 1997; Ndomba 2004; Augustino and Gillah 2005; Kingazi et al. 2008). However, the influence of these factors on medicinal plants, in particular, has not been well documented. These factors also need to be critically analysed to understand how they enhance or impede domestication of medicinal plants. This paper attempts to understand gender and socio-economic factors influencing domestication of medicinal plants in the West Usambara Mountains. Before embarking on analysis of these factors, medicinal plants domesticated in farms and around homesteads in the West Usambara Mountains were identified, along with the ailments they are used to treat.

Study area and methodology

Study area

The West Usambara Mountains are in northeastern Tanzania (Figure 1) between 4°24′–5°00′ S and 38°10′–38°36′ E. Covering an area of approximately 4500 km^2, the mountains are one of 13 mountain blocks of the Eastern Arc Mountains of East Africa. Along with the Taita Hills of Kenya and Tanzania's North and South Pare, the East Usambara, Nguu, Nguru, Ukaguru, Uluguru, Malundwe, Rubeho, Udzungwa and Mahenge Mountains, they form a chain of ridges stretching some 900 km (EAMCEF 2005; Burgess et al. 2007). The Eastern Arc Mountains are one of 25 globally important biodiversity hotspots (Myers et al. 2000), and one of the top ecoregions for biodiversity importance in Africa (Burgess et al. 2006). The mountains, at 400 to 2400 m a.s.l., are characterized by two rainy seasons: the short rainy period (October–December) and the long period (March–May). Mean annual rainfall ranges from 600 to 1200 mm. Temperatures vary with altitude; at 500 m, mean monthly temperature is 25°C to 27°C, while on the plateau, at 1500–2400 m, it is 13–18°C (Wiersum et al. 1985); minimum and maximum mean temperatures are 13°C and 27°C, respectively. However, in the coldest months from June to August, minimum temperatures can be as low as 7°C, and frost occurs above 1600 m (Msuya 1998). The three types of natural forest found in the West Usambara Mountains are lowland, intermediate (submontane) evergreen and highland (montane) evergreen forests. Soil of the area are mainly humic ferralitic and humic ferrisols, of red to yellowish color with top soil (not more than 30 cm deep) being darker because of a high organic matter content (Msuya 1998).

The last national census, conducted in 2002, estimated the human population in the study area at 419,970, with an annual growth rate of 1.8% (NBS 2002, 2003). Population density ranged from 100 to 400 persons/km^2 (NBS 2002, 2003). Ethnically, these mountains are dominated by the Shambaa tribe (78%) followed by the Pare (16%), the Mbugu (5%) and other tribes forming 1% of the population (Moshi 1997; Msuya 1998). The Pare, Mbugu and other tribes beside Shambaa are immigrants to the study area in the last four decades (Kitojo, personal communication 2009). People's livelihoods depend on subsistence farming of food crops, including maize (*Zea mays*), bean (*Phaseolus vulgaris*), wheat (*Triticum* spp.), potato (*Solanum tuberosum*), yam (*Dioscorea* spp.), banana (*Musa* spp.) and cassava (*Manihot esculenta*). Coffee (*Coffea arabica*), tea (*Camellia sinensis*), cardamom (*Elattaria cardamomum*), sugarcane (*Saccharum officinarum*), fruits (plums, pears and apples) and vegetables are grown as cash crops.

Data collection

Data were collected from six villages (Irente, Kwemakame, Viti, Mwangoi, Lwandai-Mlola and Kiluwai). Purposive and stratified random samplings were employed in selecting the study villages in relation to forest reserves; Irente, Kwemakame and Viti villages were randomly selected from the villages bordering the forest reserves (Mkussu and Shume-Magamba), and Mwangoi, Lwandai-Mlola and Kiluwai were picked as villages that did not border forest reserves. It was assumed that being adjacent to forest reserves could influence the domestication of medicinal plants.

Data collection involved three phases. In phase one, participatory wealth ranking and focus group discussions were conducted with 30 people of different age group and gender selected from each village. The selection of people who participated in these exercises was based on the depth of their knowledge of the medicinal plants. Village leaders assisted in identification and invitation of the participants. For wealth ranking, communities were requested to mention the medicinal plant species domesticated in their locality and diseases treated. Researchers know the consequences of allowing different interpretations of the term *domestication* in local communities; therefore, definitions from literature were provided and agreed upon prior to the exercise. These definitions were: (1) an indigenous agroforestry practice that involves retaining plant species of forest origin in farms during the process of clearing land for cultivation; or (2) the process of bringing forest plants of medicinal value to farms or homesteads (Shepherd 1992).

Phase two involved structured questionnaires administered to a total of 173 household heads and semi-structured interviews that were directed to key informants: four district government officials, eight village leaders and elders, two ritual priests and four traditional healers. The sample consisted of 25 households from Irente, 38 from Kwemakame, 15 from Viti and 35 from Mwangoi; Lwandai-Mlola and Kiluwai had a sample size of 30 households each. For the

Figure 1. Location of the Ruvu North and West Usambara Mountains within the Eastern Arc Mountains, Tanzania.

purpose of this study, a household was defined as a group of one or more persons living together under the same roof or in several rooms within the same dwelling and eating from the same pot, or making common provision of food and other living arrangements. The sampling intensity was 5% of the total population, as recommended by Boyd et al. (1985). We adopted purposive sampling in order to ensure inclusion of people of different gender, age and wealth categories, as reflected in the results of participatory wealth ranking. Prior to the actual survey, a questionnaire was pre-tested with 20 households from two selected villages (which were not involved in the study). The questionnaire was adjusted by omitting some details, but without affecting the purpose of the study.

Phase three involved botanical surveys, which aimed at identifying medicinal plants domesticated on farms and around homesteads. Traditionally, people in the Eastern Arc Mountains (including the West Usambara Mountains) built their homes in areas where there was sufficient nearby land for cultivation. In other words, places of residence were often located close to big farms (at least 1.6 ha). This allowed us to survey and identify medicinal plants in farms belonging to all 173 sampled households. Medicinal plants domesticated around homesteads were also identified. A homestead comprises a home garden surrounding a residential house. A botanist from the Tanzania Forest Research Institute Herbarium in Lushoto assisted in identification of the plants. The respondents showed the domesticated plants in their farms and around homesteads to the botanist, who assigned scientific names. We recorded and counted the plants accordingly. All wild plants found in farms and around homesteads were also identified, and medicinal plants were marked. In addition to the skills and experience of the botanist and researchers, two field guides

(books) for identification of tropical plants (Blundell 1987; Dharani 2002) were used to verify the identified species. A few species that could not be identified immediately in the field were pressed and taken to the herbarium for identification using special taxonomic keys.

Data analysis

Data collected in phase one were analysed with the help of the communities, and results were communicated back to them. The results were triangulated with data from the second and third phases. Data collected in phases two and three were analysed using both qualitative and quantitative methods. The qualitative data were analysed using content and functional analysis techniques, whereas quantitative data were analysed using the Statistical Package for Social Science (SPSS) and Microsoft Excel software. Regression analysis was used to establish the influence of different socio-economic parameters on domestication of medicinal plants. The general model used in regression analysis was in the form of:

$$Y_i = a + b_1x_1 + b_2x_2 + \ldots + b_kx_k + e_2, \qquad (1)$$

where Y_i = the ith observed value of the dependent variables (i.e. domestication effort), x_1 to x_k = independent variables (i.e. gender, age, family size, farm size, education, wealth and ethnicity), a = intercept at y-axis (dependent variable), b_1 to b_k = regression coefficients, e = random disturbance error, $i = 1, 2, \ldots, n$; where n is the total number of variables.

Specifically, the hypotheses tested were:

H_0:ß = 0: i.e. no correlation between domestication effort and independent variables (gender, age, family size, farm size, education, wealth and ethnicity); and

H_0:ß ≠ 0: i.e. a positive or negative relationship between domestication effort and independent variables (gender, age, family size, farm size, education, wealth and ethnicity).

A t-test was employed to determine the influence of gender by comparing the number of trees domesticated between male- and female-headed households.

Results and discussion

Domestication of medicinal plants

Being an important agroforestry practice, domestication has played a fundamental role in conservation of medicinal plants in the study area. Forty (89%) and 12 (27%) out of 45 indigenous medicinal plant species were domesticated on farms and around homesteads, respectively, and are used to treat numerous diseases (Table 1). On average, each household domesticated 5 ± 3 (SE) medicinal plants. The villages far from the forest reserves domesticated more medicinal plants (6 ± 4 (SE)) per household compared to those close to forest reserves (4 ± 2 (SE)). Statistically, this difference was significant ($P = 0.009$, $t = 2.62$). Village-wise response reflected a similar situation (Figure 2). Kiluwai, Lwandai-Mlola and Mwangoi (villages not adjacent to forest reserves) had a higher proportion of respondents who domesticated medicinal plants compared to Irente, Kwemakame and Viti (villages that bordered the forest reserves) (Figure 2). This could be attributed to the fact that people from villages sharing immediate boundaries with the forest reserves can easily meet their medicinal needs from the forests, while domestication is a more feasible option for those living far away from the reserves.

The domestication rate of 89% is in line with the findings of Hamilton (1989), which revealed that domestication as part of the traditional agroforestry system and a conservation practice started in the West Usambara Mountains as early as about 2000 years ago. Similarly, other researchers reported domestication in the study area (Kaoneka 1996; Moshi 1997; Msuya 1998; Msuya et al. 2008). Certain medicinal plants, such as *Albizia* spp., *Erythrina abyssinica*, *Catha edulis* and *Tamarindus indica*, were domesticated deliberately to conserve them against excessive harvesting from their natural habitats (the forests). Domestication of medicinal plants as a strategy to overcome the problem of over-exploitation is recognized globally. For example, in Cameroon and Madagascar, *Prunus africana,* which is threatened by excessive debarking for export, is domesticated in areas bordering natural forests (Cunningham and Mbenkum 1993; Dawson 1997). This bark is used as effective medicine for ailments such as hernia, cancer and neck ache (Msuya 1998; Augustino and Gillah 2005). Quinine (*Cinchona ledgeriana*), used to manufacture anti-malaria drugs, has been developed as a major crop in Indonesia, Tanzania, Democratic Republic of Congo, Burundi, Kenya, Guatemala, Peru, Ecuador, Bolivia, Sri Lanka, Columbia and Costa Rica (WCMC 1992). Formerly, the entire world supply came from only one source – the Andes, and thus the species was at a risk of extinction (WCMC 1992). *Papaver somniferum* is domesticated throughout Asia, while *Carica papaya* is domesticated in Asia and Africa (WCMC 1992).

Gender influence on domestication of medicinal plants

From this study, gender had significant influence on conservation of medicinal plants through domestication. Female-headed households domesticated more medicinal plants around homesteads than on farms, while in male-headed households more domestication took place on the farms (Figure 3). Overall, male-headed households domesticated more medicinal plants [6 ± 4 (SE)] than female-headed households [3 ± 4 (SE), $t = 3.77$, $P = 0.002$]. Studies in Njombe District (Chingonikaya et al. 2004), Kilosa District (Nduwamungu et al. 2004), East Usambara Mountains (Kweka 2004) and the Uluguru Mountains (Kajembe et al. 2008) reported similar results, with men planting more trees than women. Given that women are more vulnerable to environmental problems and declining biodiversity, one would have expected the female-headed households to domesticate more medicinal plants than male-headed households. This, however, is not the case because of land

Table 1. Domesticated medicinal plants identified in West Usambara Mountains, sites of domestication and diseases treated (X = species present).

Species name	Family	Sites of domestication		Diseases treated
		On farms	Around homesteads	
Adansonia digitata	Bombacaceae	X		Stomach pain, tooth problems
Adenia cissampeloides	Passifloraceae		X	Malaria, stomach ache
Albizia gummifera	Mimosaceae	X		Chest pain, headache, occasional fever
Albizia schimperiana	Mimosaceae	X		Coughs, rheumatism
Artemisia afra	Compositae		X	Malaria, sore throat, expulsion of intestinal worms
Basella alba	Basellaceae		X	Stomach problems especially for women
Bridelia micrantha	Euphorbiaceae	X		Worms, diarrhoea, headache
Catha edulis	Celastraceae	X		Malaria, coughs, stomach ache, gonorrhoea, influenza
Clausena anisata	Rutaceae	X		Stomach pains, worms, diarrhoea, headache, malaria, influenza
Clerodendrum myricoides	Verbenaceae	X	X	Venereal diseases, malaria
Commelina latifolia	Commelinaceae		X	Eye diseases
Commiphora eminii	Burseraceae	X		Stomach pains, snakebite, dysentery, leprosy, fever
Cussonia arborea	Araliaceae	X		Snakebite, malaria, constipation
Deinbollia borbonica	Sapindaceae	X		Hernia, infertility to women
Dodonaea angustifolia	Sapindaceae	X	X	Toothache and intestinal worms
Dracaena usambarensis	Agavaceae	X	X	Abdominal pain
Dracaena afromontana	Agavaceae	X		Abdominal pain
Ehretia cymosa	Boraginaceae	X		Brucellosis
Erythrina abyssinica	Mimosaceae	X		Malaria, convulsions in children, anthrax, snakebite
Euclea divinorum	Ebenaceae	X		Tooth ache, stomach ulcers
Ficus sycomorus	Moracaceae	X		Diarrhoea, sore throat, chest pain
Ficus thorningii	Moracaceae	X		To cure bewitched people
Flueggea virosa	Euphorbiaceae	X		Bilharzia, malaria, stomach ache, itching
Harrisonia abyssinica	Simaroubaceae	X		Fever, nausea, vomiting, snakebite, tuberculosis, stomach ache, malaria
Grewia similis	Tiliaceae	X		Wounds, sore throat, snakebite
Hibiscus fuscus	Malvaceae	X		Pneumonia, sore throat
Jasticia engleriana	Acanthaceae		X	Stomach pains, coughs, colds
Lonchocarpus capassa	Fabaceae		X	Stomach disorders, hookworm, cough
Maesa lanceolata	Myrisinaceae	X		Diarrhoea, tooth ache, rashes
Markamia lutea	Bignoniaceae	X		Gonorrhoea, intestinal worms, backache, fresh wounds
Microglossa oblongifolia	Compositae	X		Stomach ache, hernia
Myrica salicifolia	Myricaceae	X		Tuberculosis, chest pain, reduce pain for cancer patients
Newtonia buchananii	Mimosoidae	X		Brucellosis, inflammation of joints
Parinari excelsa	Chrysobalanaceae	X		Gonorrhoea, colds, coughs
Plectranthus barbatus	Labiatae	X	X	Malaria, tooth ache, stomach pain
Prunus africana	Rosaceae	X		Hernia, neck ache, cancer
Psidium guajava	Myrtaceae	X	X	Stomach pain
Rauvolfia caffra	Apocynaceae	X		Rheumatism, pneumonia, intestinal worms, hypertension
Senna singueana	Caesalpiniaceae	X		Malaria, convulsions, epilepsy, coughs, intestinal worms, constipation
Solanum nigrum	Solanaceae	X	X	Malaria, cough
Syzygium guinensee	Myrtaceae	X		Intestinal worms, dysentery
Tefairia pedata	Cucurbitaceae	X	X	Improve lactation after childbirth
Toddalia asiatica	Rutaceae	X		Malaria, chest pain, convulsions in children, infertility in women
Trema orientalis	Ulmaceae	X		Coughs, sore throat, asthma, gonorrhoea, malaria, yellow fever, tooth ache, intestinal worms
Vangueria infausta	Rubiaceae	X		Headache, stomach ache, fever
Zanthoxylum chalybeum	Rutaceae	X		Stomach pain, convulsions

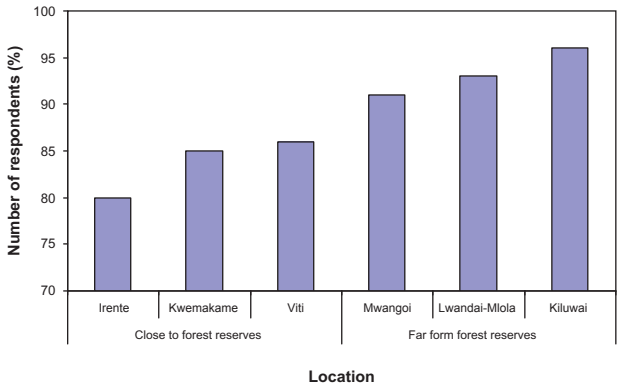

Figure 2. Percentage of respondents with domesticated medicinal plants in each of the six villages of West Usambara Mountains, Tanzania.

Figure 3. Gender effect on domestication of medicinal plants on farms and around homesteads in the West Usambara Mountains, Tanzania.

tenure insecurity for women. In these mountains and elsewhere in Tanzania, male dominance in and control over productive resources, including land, is common. Land ownership had for years been patriarchal, with only a few widows inheriting land (Kaoneka 1996; Msuya 1998; Chingonikaya et al. 2004; Kweka 2004; Luoga et al. 2004). In a household, the husband makes all strategic decisions regarding crops, tree planting and marketing of products, but the women shoulder over 90% of the workload. However, there is optimism for change following enactment of the Land Act of 1999, which took effect on 1 May 2001 and empowers women to own land, regardless of customary and religious restrictions (URT 1999). The heavy workload could also explain why female-headed households had fewer domesticated medicinal plants. In Africa, virtually all household chores (washing, cooking, fetching water, feeding livestock, caring for children, etc.) are exclusively women's responsibility. Culturally, it would shame a man to do these tasks. Women perform these household chores in addition to other economic activities such as farming. This gives women less time than men to invest in domesticating medicinal plants. Furthermore, in most cases female-headed households are economically disempowered, and therefore, they can rarely employ people to domesticate and care for medicinal plants. Elsewhere in the world, e.g. Thailand, domestication of indigenous forest plant species by women is not uncommon, and women were reported to domesticate 230 species for food, medicine and decorative value around homesteads (Moreno-Black et al. 1994).

The influence of gender on domestication of medicinal plants is not surprising because the way in which a culture or society defines gender roles affects several aspects of life, such as household security, family welfare and planning production (Evans 1990; Stichter and Parpart 1990; Adepoju and Oppong 1994; Anker 1997). In most communities worldwide, women and men have different gender-based roles, responsibilities and needs, as well as local knowledge pertaining to, access to and control over their environment (Augustino and Gillah 2005; Kingazi et al. 2008). Similarly, the way women are affected by environmental degradation and declining biodiversity resources, and their coping strategies against these effects, are quite different from those of men. Women have been recognized as both the victims of environmental degradation and a part of the solution to address the underlying causes of this problem (Augustino and Gillah 2005). However, as observed in this study, women's coping strategies for environmental problems are stalled by cultural and economic limits.

Influence of socio-economic factors on domestication of medicinal plants

Age

Age of respondent had a significant effect on the number of domesticated medicinal plants in the study area (Table 2). Older people had more medicinal plants retained or planted on their farms and around homesteads than young people ($P = 0.002$, $R^2 = 65\%$, $t = 3.15$). This is likely because most of the older people owned bigger farms and were more familiar with medicinal plants. It also seems likely they would have domesticated more species because they had more time available. Similar results were reported in the East Usambara Mountains (Kweka 2004), although in the Uluguru Mountains domestication efforts were much higher by younger people than older people (Kajembe et al. 2008). The issue of knowledge as a possible reason for older people to domesticate more medicinal plants has also been reported in Kenya, where people below 20 years old knew nothing about medicinal plants, unlike their elders (above 60 years old) (Quiroz 1994). There is a general consensus that the transfer of indigenous knowledge, which was previously handed down through generations by cultural transmission, is now decreasing (Songorwa et al. 2000; Kideghesho 2008). The means of transmitting this knowledge, which included folklore or storytelling, continuous observations, practise and attachment to natural resources are no longer effective. Because of formal education, there is less time for the potential student (youth) to interact with traditional teachers (elders) and the 'laboratory' (natural resources). In the Tanzanian education system, for example, nursery school begins at the age of five, followed by primary school

Table 2. Summary of the regression analysis, indicating the influence of socio-economic factors (Xi) on the number of plants retained on farms and around homesteads in the West Usambara Mountains, Tanzania.

	Y		
Socio-economic factors (Xi)	R^2 (%)	t	P
Age	65	3.15	0.002
Wealth (assets and income)	81	3.52	0.001
Education	26	0.27	0.21
Farm size	45	2.29	0.023
Household size	52	2.54	0.012

at the age of seven, which lasts for 7 years, then secondary school and college for 4–8 years, often in boarding schools away from their place of birth. Furthermore, the youth are more inclined to Western rather than traditional medicines (pers. obs.).

Affluence

A wealth ranking exercise indicated that the majority of households were poor, followed by the middle class and only 5% were ranked as rich. The number of domesticated medicinal plants was significantly influenced by affluence ($P = 0.001$, $R^2 = 81\%$, $t = 3.52$; Table 2). Although the poor constituted the majority of households in the study area, they domesticated fewer medicinal plants than the few wealthy households. The high domestication effort among wealthy households can be attributed to the cost of maintaining or managing farms, as poor farmers often spend more time looking for food than caring for medicinal plants that they can easily collect from the forests for free. Dependence of the poor on natural resources from protected areas is widespread; in the western part of Serengeti National Park, for example, households who had few or no livestock constituted the higher proportion of illegal users of resources compared to those who were rich (Loibooki et al. 2002; Kideghesho et al. 2005). Sometimes, poor households supplement their income by working for payment on farms owned by affluent households. This implies that although domestication of medicinal plants can be seen as an important coping strategy for the poor, economic reasons can impede its adoption.

Education

From this study, education had no significant influence on the number of domesticated medicinal plants ($P = 0.21$, $R^2 = 26\%$, $t = 0.27$), possibly because virtually all household heads interviewed had formal primary education. Formal education in the Usambara Mountains started during the colonial period and thus many respondents had access to education (Kaoneka 1996; Msuya 1998). Given the uniformity in education level among respondents, it is difficult to find an influence of education on conservation, and on domestication in particular. Those educated beyond primary level, who we might expect to domesticate more trees due to a relatively high level of awareness, spent most of their time in towns, engaging in business and other activities. Therefore, it would not be surprising if domestication effort were low for the most educated people as they often spend less time in villages (Kweka 2004).

In areas where the disparity in education level is relatively high, the impact of this factor on participation in or attitude towards conservation was more visible. This is because education can also enhance other factors that influence conservation efforts or attitudes, such as conservation awareness and affluence. For example, an attitude survey on factors influencing conservation in the western Serengeti, Tanzania, showed that highly educated people had more income because they had more access to employment opportunities. They were therefore more positive and supportive of conservation efforts because their livelihoods were minimally affected by conservation interventions (Kideghesho et al. 2007).

Family size and size of farm

Other socio-economic factors reported to significantly influence domestication of medicinal plants in the study area were size of the farm ($P = 0.023$, $R^2 = 45\%$, $t = 2.29$) and family size ($P = 0.012$, $R^2 = 52\%$, $t = 2.54$) (Table 2). Domestication of medicinal plants was higher in households with big farms and big families than those with small ones. This is likely because family size has implications for the household labour force, and thus big families have more labour, which could contribute positively to domestication of all wild plants, including medicinal plants. Studies conducted in Kibaha and Shinyanga, Tanzania, gave similar results, with big families planting more trees compared to small ones (Luoga et al. 2004). Other studies have also reported the positive correlation between farm size and domestication of wild plants (Michon and de Foresta 1996; Moshi 1997; Ndomba 2004). Studies conducted in the Uluguru Mountains (Kajembe et al. 2008) and Kilosa District (Nduwamungu et al. 2004) revealed that the number of plots and farm size had a significant and strong positive effect on tree-growing efforts.

Ethnicity

Ethnicity also influenced domestication of medicinal plants in the study area. The Shambaa tribe domesticated more plants (8 ± 4 (SE) than other tribes (4 ± 6 (SE), and the difference was significant ($P = 0.001$, $t = 5.84$). This difference could be attributed to the fact that the Shambaa is the native tribe in the study area and other tribes are immigrants to the West Usambara Mountains, and that domestication has been an indigenous conservation practice for wild plants in these mountains for over 2000 years (Hamilton 1989; Msuya 1998; Msuya et al. 2008). Also, most of the Shambaa are traditional healers and hence domestication of medicinal plants is pursued as a way of facilitating their services, and traditional healing as a

business motivated domestication of these plants. Most often, traditional healing operates on the basis of secrecy (Msuya and Kideghesho 2009), and the traditional healers' knowledge of medicine is not commonly shared with other people. In treating patients, they never reveal the species used and their location; patients receive a ready-made medicine and details on how to use it. Traditional healers are often considered spiritually gifted, and their knowledge can be transmitted to their children. On some occasions, a person may acquire knowledge of a particular medicinal plant, but he/she has to pay for it. There is a belief that, even if one is familiar with the use and preparation of a medicinal species, s/he cannot assume the role of traditional healer, since performance and efficacy of a particular medicine in curing some ailments depends on who dispenses it (Msuya and Kideghesho 2009).

Conclusions and recommendations

West Usambara Mountains have great potential as a source of indigenous medicinal plants. Most species have survived to date because of meticulous conservation measures, including domestication. As part of indigenous agroforestry practices, domestication has played a key role in conservation of medicinal plants, especially species threatened by over-harvesting and other human activities. However, success of domestication as a conservation measure is a function of numerous factors. This study has presented gender, socio-economic and cultural factors (e.g. wealth (income), age, farm and household size and ethnicity) as important factors influencing domestication of medicinal plants. These factors are vital in developing effective domestication programmes. Understanding the way in which these factors influence domestication is increasingly becoming imperative as the urgent need for domestication is growing in response to increased pressures caused by rapid human population growth and land clearance. The following recommendations are pertinent in enhancing domestication efforts and, therefore, realizing conservation:

- Experience of domestication in West Usambara Mountains provides an opportunity on which conservationists can capitalize to further conserve threatened species in forests and elsewhere in the study area.
- Poor communities are the majority, and domestication can hardly be implemented by them. Economic empowerment is therefore imperative.
- The ability of women to adopt coping strategies (including domestication) against environmental problems and declining biodiversity is mainly impeded by cultural and economic factors. Strategies to promote domestication should aim, among other things, at gender mainstreaming, i.e. bringing a gender perspective to all aspects of an institution's policy and activities, through building gender capacity and accountability. Women should be empowered politically and economically, and campaigns against discriminatory cultural practices, including those denying women access to land and subjecting them to heavy workloads, should be intensified.

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