FROM THE WILD TO MARKETS AND FARMLANDS: PLANT SPECIES IN BIOTRADE

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ABSTRACT

Wild collection of plant products mainly served subsistence needs but is now increasingly becoming an income generating activity. The needs include food, gums, tubers, fibers, materials for construction and herbal medicine among others. This niche market, part of biotrade in Kenya and is sometimes viewed as crime against wild plants because it is undocumented, largely unregulated and economically unaccounted for. Market surveys were carried out in towns in 8 Kenyan counties served by ports of entry/exit, bordering Uganda and Tanzania. Plant species in trade, products, volumes, sources, market players and associated challenges were documented. The results indicate widespread trade in plants locally, regionally or internationally. More than 100 flowering plant species were documented in trade in Kenyan markets, mainly wild-sourced for various uses. Most are sourced from forest reserves, communal land and small holder farms. This trade is dominated by the male gender, p-value: 0.000128 and product knowledge derives heavily from indigenous knowledge. The average number of species per stall was 28 species, with a mode of 10. The value of the K-S test statistic (D) is .32207 and as it is < .00001, this data is not normally distributed. Skewness: 2.525802 and Kurtosis: 6.846425 values indicate preference of certain species over others and that some species are collected and traded more frequently compared to others. Some 22 species frequently in trade, were identified, profiled and prioritized for conservation. Strategies are needed to sustain supply of the species in trade, hence domestication, farm forestry and restoration on communal land and natural forests are proposed.

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Key words: biotrade, ethno botany, conservation, indigenous knowledge

INTRODUCTION

Products derived from biodiversity and are in trade comprise biotrade. These include plants for food, ornaments, instruments, timber, tourist souvenirs, perfumes and medicines. Biotrade is legal trade, domiciled under Non-wood forest products (NWFPs) in the forest, agriculture and wildlife sectors. The products may be sourced from natural forests and protected areas (*in situ*) or through cultivation (*in domo*). Medicinal plants tend to dominate biotrade. In deed, the use of plants and their derivatives as medicine and food, to heal and cure diseases, or to improve health and wellbeing is widely acknowledged, including by the World Health Organization-WHO (WHO, 1978). The world's annual trade in medicinal plants in 2011 was estimated to be worth about USD 2.2B (Anon, 2015). These comprise some of 50,000 to 70,000 medicinal and aromatic plant species used in both conventional and traditional medicine. For Kenya, it is estimated that some 1,200 plant species have medicinal value (Johns and Kokwaro, 1991; Gachathi, 1989; Kokwaro, 1976; Maundu *et al*., (1999) recorded more than 80 nutraceutical species (vegetables, pulses, fruits, stimulants, gums and resins) locally traded in parts of the country. Dharani *et al*., (2010) documented trees for management of Malaria. Biotrade is important in Kenya and needs to be documented.

Illegal wildlife trade is not new to Kenya, as the country has battled trade in ivory for decades. Kenya is home to more than 7,000 species of plants (Beentje, 1994) and recognizes the challenges associated with wild-collection of plants and the

associated trade. Further, Kenya's economic blue print-vision 2030 emphasizes the need to diversify subsistence production and incomes, also the basis for the development of the biotrade sector. In deed efforts, focusing on groups of species and ecosystems abound, including the Natural Capital Map (Western *et al.,* 2015). Research and management frameworks also exist including the proposal to establish centres to study specific groups such as medicinal plants (Odunga, 2013). However, Kenya lacks data on particular species, markets, volumes and market trends of indigenous non-timber plants and products in trade. For example, ornamental plants in the black markets can be easily disguised by cutting off leaves. Uncertainty also affects identification of pre-processed materials e.g. gum from commercial Aloe species (Mukonyi *et al*., 2007). Lack of certainty makes it difficult for reporting licensed collection, harvesting, trade and trends, for law enforcement agents to document cases of crime against wild plants.

Second to loss of habitats, illegal trade can easily put species at the risk of extinction (Botha *et al.,* 2004; Cunningham, 1996). The Convention on International Trade in Endangered Species of wild Flora and Fauna (CITES) is a conservation and trade treaty (Anon, 2018a; 2018b). Over 35,000 species of flora and fauna in trade are internationally protected under this treaty. CITES regulates international trade in the listed species, so that trade neither threatens their survival nor contributes to the current extinction crisis. Some 220 species of Kenyan plants are CITES-listed and they include Aloes (medicinal), orchids and Euphorbias (ornamentals) and medicinal tree species such as *Prunus Africana* (Hook.f.) Kalkm Rosaceae and *Osyris lanceolata* Hoechst Santalaceae-East African Sandalwood. Literature and media reports decry the unregulated harvesting of wild plants for trade as it easily transforms into international trade. Marshall (1998) noted an increase in trade in medicinal plants locally, regionally and internationally in response to the rapid urbanization and globalization. Kenya is rapidly undergoing urbanization and globalization. Urbanization, moves and concentrates migrants in urban areas; away from natural forests and thus creates niche markets and market intermediaries (Bodeker, 1997). The critical connections among the peoples persist through trade and cultural constructs such as the practice of traditional medicine. On the other hand, globalization has accelerated interchange among remote communities including researchers, investors, intermediaries and markets, by providing the critical feedback loop for all partners (Leonti and Casu, 2013). Both trends have combined to greatly boost trade in and the practice of herbal medicine.

The aim of this study was to document species of plants and plant products in legal and illegal trade in Kenyan markets, barcode the species and to propose measures for their sustainable utilization. A database of plants species in biotrade could aid resource managers in managment planning and guide tree species selection for on-farm tree-planting schemes and enrichment planting in natural forests and on communal lands. The article profiles some 22 commonly traded medicinal plant species. These are of great interest to this market and may be promoted for restoration, on-farm and community forestry and tree domestication schemes.

Materials and methods

Study sites

This study was conducted in Kenya, (Nairobi County- 1.2921°S, 36.8219°E, Kikuyu County- 1.2472°S, 36.6791°E, Kakamega County- 0.2827°N, 34.7519°E, in counties bordering Tanzania (Kajiado county- 2.0981°S, 36.7820°E, Narok county- 1.1041°S, 36.0893°E) and Uganda- (Bungoma County- 0.5695° N, 34.5584°E, Trans Nzoia County- 1.0567° N, 34.9507°E , West Pokot County- 1.6210° N, 35.3905° E) served by ports of entry/exit. Most have recently experienced emigration of youth to nearby urban centres, have some area under natural forest and previous studies indicate some level of biotrade. The data was collected from urban and peri-urban market centers in these counties. Specifically, these market centres are; Kibra, Kariakor, Ngara, Kawangware, Westlands, Lavington, Ngandu-Lenana, -Nairobi County, Dagoretti-Kikuyu County, Kakamega town-Kakamega County, Luanda and Mbale markets-Vihiga, Bungoma town, Mayanja, Kimilili-Bungoma County, Kitale town-Trans Nzoia County, Ngongmarket, Kiserian market, Ilbisil, Nguruman, Oloitoktok, Namanga-Kajiado county, Ntulele, Suswa, Narok town, Oldonyo, Ntulele, Ewaso-Nyiro- Narok county,

and Kapenguria-West Pokot County (Figure 1).

Collection of market data

Data was collected on the wild-collected plant species in trade, in open-air markets in the study area. The markets were visited on various dates between January 2016 and November 2017, to interview the vendors, nurserymen and women, traders, street vendors, collectors, retailers and herbalists. There are no crude estimates for these vendors in Kenya, therefore non-probability purposive sampling, incorporating aspects of snowball sampling were used (Denscombe, 2003). First, the interviewees signed a consent form, affirming their willingness to participate in the research. Data on plants in trade was collected by interviewing vendors of the plants/products at the open market centres as well as free listing and observation. Data recorded includes the biodata of the interviewee, their roles, plant products that they traded, customer base, markets, sources, quantities, pricing and general procurement of the products. The views of the vendors on the status of plants in the wild, impact of this trade on wild populations and their ideas for sustainable production were also recorded. The sampling targeted only the vendors practicing the trade and who could lead the interviewer to the next vendor. In some cases, interviews were facilitated by translators who knew and spoke the local language as well as English or Swahili very well.

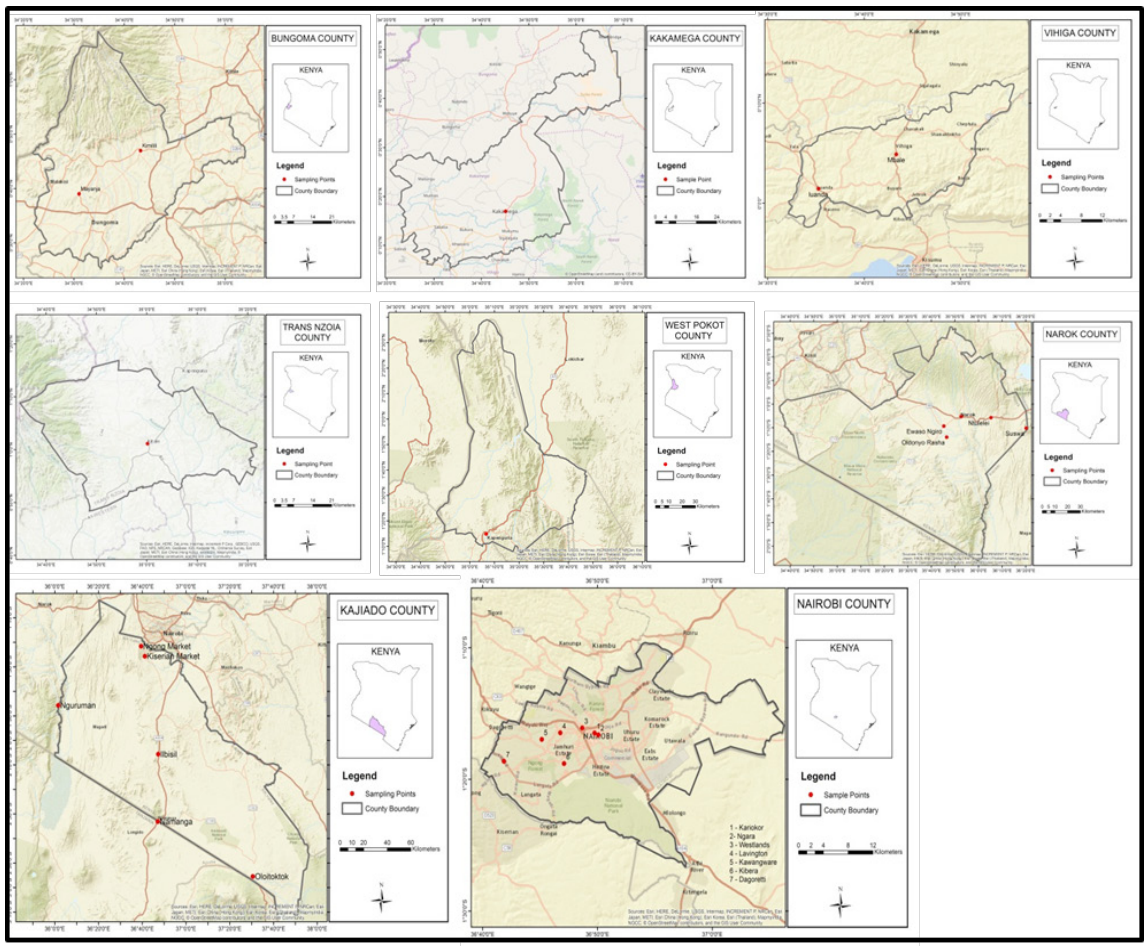

Figure1. Maps showing study sites

Identification of plants and samples

The vernacular or local name and the part of the plant from which it was sourced were recorded. Samples for DNA analysis and bar-coding of the plant materials were collected from each vendor. These samples

were labeled and sealed in ziplock bags and taken to the DNA laboratory at the National Museums of Kenya for verification. Herbarium specimens were identified with the help of parataxonomists, published literature, floras (Kokwaro, 2009; Maundu *et al*., 1999) and the herbarium reference collection. The vernacular names of the plants in trade were translated to botanical names by a parataxonomist and were later confirmed using literature and the herbarium reference collection. At ports of exit/ entry including airports, customs and Phytosanitary offices, confiscated and suspected contraband plant materials were recorded and sub-sampled for later identification using DNA techniques.

Data analyses

Data from the market survey was entered and analyzed using the Microsoft Office Excel spread sheet and further subjected to statistical significance tests using free online packages for social statistics. Data was summarized in tables and charts as appropriate.

RESULTS

Description of sample population

A total of 78 vendors participated in the survey, predominantly men (65%). To compare the two independent proportions for male and female vendors interviewed, the two-tailed p-value was computed. A p-value: 0.000128 was obtained, meaning more males compared to females actually were engaged in vending of these plant products.

The segregation of interviewees by level of education (Figure 2) reveals that most of the interviewees lacked elementary education 62%.

Motive for trading plants/plant products

Half (50%) of the vendors interviewed were in the business for income generation while 46% were exploiting their indigenous knowledge (IK) and skill acquired through apprenticeship

Sources of plants and plant products

Most vendors (89%) indicated that their materials were sourced from the wild either by the individual vendors (46%), or middlemen (23%). Farmlands as outlets provided 2% of the materials in trade (Figure 3).

Diversity of plant products in markets

Herbal medicine (85%) contributed the highest diversity of wild-source plants in trade) followed by other uses including food, beauty, carvings and instruments at 8%, then living plants used in landscaping and planted in home gardens (4%) and furniture (3%).

Challenges of collecting plants from the wild

The challenges that the traders associated with their practice of collecting materials from the wild include distance (43%), availability (17%) and licenses (8% (Figure 4).

Plant species traded in the markets

More than 100 plant species were recorded in the

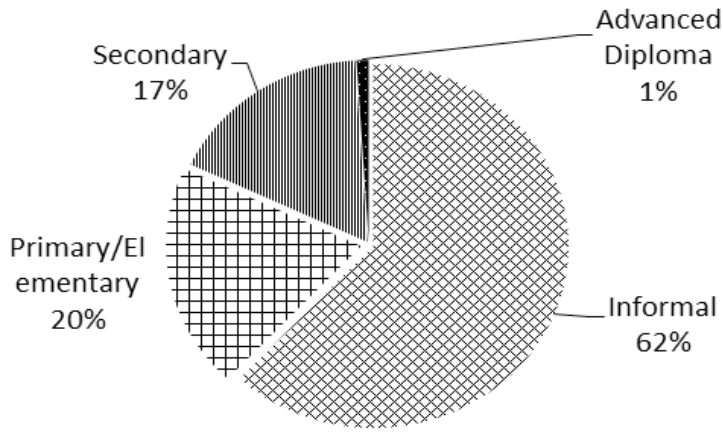

Figure 2. Level of education of vendors of plants and plant products

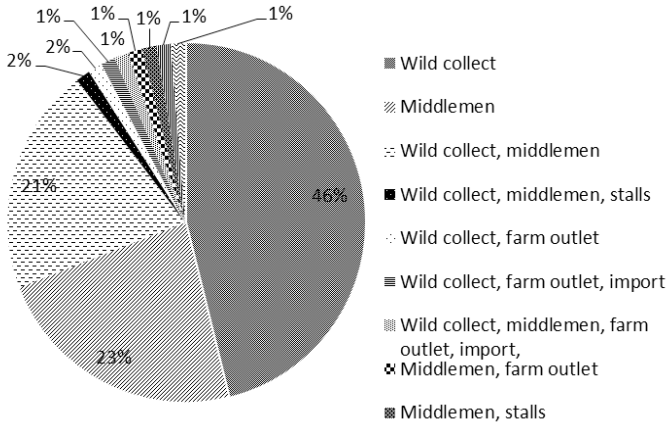

Figure 3. Sources of plants and plant products in the market

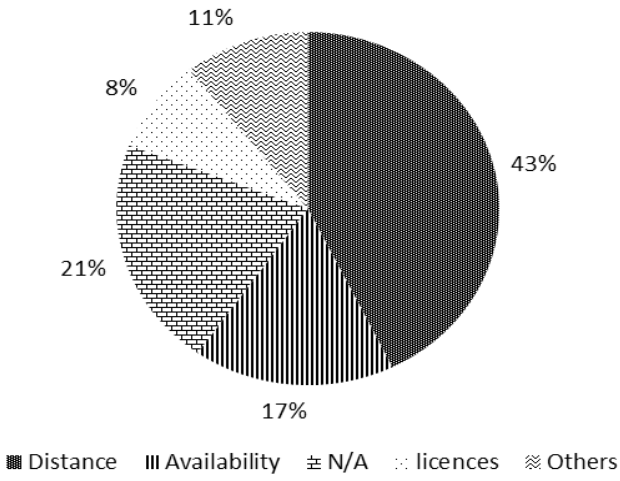

Figure 4. Challenges associated with collecting plant products from the wild

markets survey. Plant species in trade were recorded from each vendor and the central values in species distribution were computed as mean 28 species, median 15 species and modal value of 10. Standard Deviation, the square root of the variance was 33.92769 compared to a mean of 27.93. The more spread out the group of numbers are, the higher the standard deviation. The difference between the two is 6 species, which is reasonable. This statistic is useful for inform managers of plant and forest resources, indicating roughly how many species could be covered in issuing an access permit for plant collection to collectors and for extension officers in advising on species diversity for on-farm forest schemes.

To test for normality of distribution the market prevalence of the species recorded was subjected to The Kolmogorov-Smirnov Test of Normality. The value of the K-S test statistic (D) is .32207

The p-value is < .00001 is evidence that this data is not normally distributed. Also values for Skewness (2.5) which tells the amount and direction of skew and Kurtosis (6.8) which tells how tall and sharp the central peak is were calculated. The data is skewed right meaning that the right tail is long, relative to the left tail. Based on right skewness in the data, there are more species with single mentions and compared to the species recorded by multiple mentions. This shows that some species are collected and traded more frequently compared to others. Higher Kurtisis

values (greater than 3) indicate a higher, sharper peak. The data collected from the markets gives leptokurtic distribution, with longer tails and higher and sharper central peak. Confirms some level preference of certain species over others.

The most frequently traded species (22) belong to 17 plant families. They are ranked by market prevalence, name, natural distribution, habit, habitat, uses and matching agro-climatic (Table I).

TABLE I - FREQUENTLY TRADED SPECIES PROPOSED FOR FORESTRY SCHEMES

Market rank	Species (Family)	Distrib./ Flora reg.	Habit	Habitat preference	Uses-	Agro-climatic. zone
1	*Rhamnu prinioides* (Rhamnaceae)	K13456	Shrub, Tree to 9 m	Forest edges, rarely in secondary bushland	Med., L/s, Agrfor	IV, V, VII
2	*Rhamnus staddo* (Rhamnaceae)	K13456	Shrub or tree to 7.5 m	Dry upland forest edges, secondary evergreen bushland, bushed grassland	Med. L/s	IV, V, VII
3	*Osyris lanceolata* (Santalaceae)	K123467	Shrub or Tree, to 6 m	Forest margins, evergreen bushland, grassland, thickets, Rocky sites	Med., Dye, Fb, Fr.Fd, oil, L/s	I, II, VI, VII
4	*Warbugia ugandensis* (Canellaceae	K3456	Tree to 30 m, evergreen	Riverine forests, Dry upland forest, wooded grassland, Woodland (A.*xanthophloea*)	T., Med.,Fd, Glue, L/s, Agrfor	II, III, IV, V, VI
5	*Acacia nilotica* (Mimosaceae)	K123467	Tree to 12 m	Wooded grassland, *Acacia* grassland, open and clump bushland	Med., poles, Agrfor	I, II, VI, VII
6	*Pappe acapensis* (Sapindaceae)	K1234567	Shrub or tree 2-9 m	Bushed or wooded grassland, rockysites, semi-evergreen bush/ woodland	Med., Fr, Wood, L/s	I-VII
7	*Carissa edulis* (Apocynaceae)	K1234567	Shrub/ scrambler to 14 m	Forest edge, bushland, grasslands, rocky places	Fd, Fr, Med. L/s, Agrfor	I-VII
8	*Clerodendrum myricoides* (Verbenaceae)	K1234567	Shrub to 3.5 m	Dry or semi-evergreen bushland, wooded grassland, rocky sites	Med., L/s	I-VII
9	*Todalia asiatica* (Rutaceae)	K1234567	Shrub/ Liana	Forest margins, secondary regrowth, grassland thickets	Med.	I-VII
10	*Turraea mombasana* (Meliaceae)	K13467	Shrub to 3 m	Dry forest (margins), semi-evergreen bushland	Med., L/s	III, IV, V,VI VII

11	*Albizia anthelmintica* (Mimosaceae)	K123467	Shrub or tree 3-7 m	Dry bushland, on lava or along seasonal rivers, wooded or bushed grassland, coastal evergreen bushland	Med., Wood, Agrfor	II, IV, V, VI, VII
12	*Olea europaea Africana* (Oleaceae)	K1234567	Tree/ shrub evergreen to 24 m	Dry upland evergreen forest, woodland	T, F/w, Med. Fr., Agrfor	I-VII
13	*Euclea divinorum* (Ebenaceae)	K1234567	Shrub or tree 1-9 m evergreen	Dry forest (margins), riverine in bushland or forest, bushed, wooded grassland, bushland, pastureland weed	Med., L/s, Agrfor	I-VII
14	*Embelia schimperi* (Myrsinaceae)	K3456	Shrub/ Climber	Upland evergreen forest	Med, Fd	II, III, IV, V, VI
15	*Myrsine melanophloeos* (Myrsinaceae)	K1234567	Tree evergreen 4.5-20 m	Upland forest to edge of moorland	T, Med, L/	I-VII
16	*Ximenia Americana* (Olacaceae)	K1234567	Tree, Shrub to 6 m	Coastal bushland, wooded grassland, dry woodland	T, Fr, Med., Oil, Agrfor	I-VII
17	*Zanthoxylum chalybeum* (Rutaceae)	K123457	Shrub or tree	Semi-evergreen or dry bushland. Rocky sites, wooded grassland, dry forest, thickets	Med., L/s, Agrfor	I, III, IV, V, VI, VII
18	*Zanthoxylum usambarense* (Rutaceae)	K134567	Tree 2.5-15 m	Dry forest or remnant clump thickets, secondary bushland	Med., L/s	II, III, IV, V, VI VII
19	*Trimeria grandifolia* (Flacourtiaceae)	K1234567	Shrub (scrambler) or tree to 12 m	Dry evergreen forest, less often in moist or evergreen (clump) bushland	Med., L/s	I-VII
20	*Dovyalis abyssinica* (Flacourtiaceae)	K1234567	Shrub or tree to 13 m	Upland moist or dry forest (edges), riverine, clump evergreen bushland	Med., L/s, Fr.	I-VII
21	*Strychno shenningsii*- (Loganiaceae)	K1234567	Shrub/ Tree to 12 m	Dry forest, riverine, rocky hillsides	Med., L/s, Agrfor	I-VII
22	*Combretum molle* (Combretaceae)	K1234567	Tree to 8 m	Wooded grassland, woodland, bushland/ forest transition zone, in shallow rocky soils/ hillsides/lava	Med., W/ fuel, Agrfor	I-VII

Key to described uses: Dye, Fb-Fibre, Fr-Fruit, Fd-Food, L/s-Landscape, Med., -Medicinal, T-Timber, W/fuel-Woodfuel, Agrfor: Agroforestry species

DISCUSSION

Trade in plants and plant products play important roles in individual and household incomes (Botha *et al*., 2004). Most vendors in the markets surveyed said they are in this trade for income and exploiting their indigenous knowledge. The vendors generally had elementary or no education and learnt about plant uses through appprenticeship. Biotrade therefore has a two-fold role, i.e. income generation and employment, congruent with findings by Mbuvi and Boon, (2008); Botha *et al.* (2004) and Tieguhong and Ndoye (2004).

Men dominate biotrade in these markets and similar studies have returned comparable results for biotrade (Kuipers, 1997). However, FAO (2014), found that women generally rely more on NWFP for household use and income. The harvesting of plant materials from the wild is a laborious activity which may explain why it is dominated by men.

Different plants and plant products are traded in Kenyan markets, but the main product in the study area is medicinal plants. Similar findings have been documented in research on medicinal plants in trade, in other parts of the world (Mcmullin *et al*., 2012; FAO 2003; Kuipers, 1997). Thus, this data is important in natural products reporting and can also guide bioprospecting for drug development (Botha *et al.*, 2004). Medicinal plants are harvested from different wild habitats, including natural forests, woodlands, grasslands and riverine vegetation.

Vendors indicated overwhelming preference for trading in wild-sourced plant products. Also, markets have shown preference for wild-source materials claimed to be more potent, even though domestication and cultivation promise more sustainable production, to meet the growing local, regional and international markets. Wild-sources are not easily or freely accessible due to long distance and low availability. Farmlands represented 2% of the sources, meaning that they may become depleted of the materials if demand increases (Mcmullin *et al*., 2012. Some vendors said that they source these products from as far as Uganda, Rwanda, South Sudan and even Congo, displaying the transnational nature of this trade as documented in FAO (2003). On the flipside, this also points at the urgency for a regional approach to developing the framework for biotrade.

The vendors predominantly use local names, for their products, making it easy to communicate among themselves, suppliers and with their customers. Local names perhaps reinforce consumer confidence, that the materials are indigenous, wild-sourced and that the vendors are sufficiently skilled in the trade. However, the use of local names makes it difficult to record and regulate this trade and enforce relevant legislation. Botha *et al*. (2004) noted a positive correlation between the number of plant species and markets with growing populations and higher ethnic diversity. The positive skeweness level further implies that forest resource managers may need to learn to identify more species besides the commonly planted species. Some 22 plant species were commonly traded (by more than 10% of the vendors). Published reports indicate that most were previously widespread and growing naturally in different Kenyan habitats and ecosystems (Beentje, 1994). As such, they can be easily re-introduced into those areas to augment local biodiversity, or as part of on-farm forestry to support incomes through biotrade so long as they are cultivated in suitable habitats.

CONCLUSION AND RECOMMENDATIONS

This study documented over 100 species of plants and plant products in legal and illegal trade in Kenyan markets. It has generated market data on biotraders in this informal market, their motivationg for trading in the plants, customer base, markets, sources, quantities and their views on the status of plants in the wild, impact of this trade on wild populations and their ideas for sustainable production and utilization.

The information generated from this market survey is important in understing and recognizing the existence of a biotrade sub-sector. The database of plants species in biotrade could aid resource managers inmanagment planning and guide tree species selection for on-farm tree-planting schemes and enrichment planting in natural forests and on communal lands. Also, conservation in-situ and restoration of the source areas including communal

lands, natural forests are important. The regional/ international nature of biotrade has particular implications for conservation of these indigenous species. A regional approach is important because like other types of trade, biotrade is transnational.

The biotrade subsector presents economic prospects in terms of income and employment generation. However, a regulatory framework is lacking. Also, the indigenous species documented require the practicing forester, environmentalist and agricultural extension officers to provide additional information on more species, their ecological requirements and their management for non-timber products. In deed, its important to continuously apply simple evidence-based methods that can support native species selection to facilitate afforestation at different scales.

Overall, there is need to support farmers in silviculture of the species being proposed, their utilization and information, quality planting materials market intelligence and marketing strategies. Also, special consideration for the farmers' economic realities and elimination of socio-political disincentives are also imperative.

The Forest conservation and management Act, 2016 (GOK, 2016) spells out incentives for increasing forest and tree cover, including trade in forest products even from private forests. However, the current legislative framework would benefit from practical guidance for achieving the desired 10 % forest and tree cover in a way that also enables biotrade to flourish.

The following are recommendations to take biotrade in Kenya forward:

- At the technical level, there is need for well researched and simple, evidence-based methods for native species selection to support and facilitate local forest restoration and afforestation efforts including farm forestry.
- For research, there is need to replicate this study in other markets around the country, because market surveys provide real time data on local values and status of conservation of indigenous plants.
- There is need to take pressure off the wild sources of plants and to reduce challenges associated with collecting bioresources and domestication is perhaps the way to go.
- Providers need skills to navigate the markets while buyers should be sensitized on responsible sourcing as part of the environmental and ecological safeguards in this biosector.
- Therefore, a regulatory framework is required for this biotrade market to guide its growth and development.

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