



SUSTAINABLE USE OF EAST AFRICAN ALOES: THE CASE OF COMMERCIAL ALOES IN KENYA

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I. BACKGROUND INFORMATION ON THE TAXA

1. BIOLOGICAL DATA

1.1 Scientific names:

Aloe spp. (*Aloe secundiflora*, *Aloe turkanensis*, *Aloe scabrifolia*, *Aloe calidophila* and *Aloe rivae*)

Common Names: Aloes (English), Turkos (Pokot), Tangaratwe(Tugen), Suguroi (Maa & Samburu), Kipapa(Taita), Mugwanugu (Kikuyu), Ejichuka (Turkana), Kiluma (Kamba), Kolonje (Duruma) and dahr (Somali).

1.2 Distribution (Specify the currently known range of the species. If possible, provide information to indicate whether or not the distribution of the species is continuous, or to what degree it is fragmented. If possible, include a map).

Sub-Saharan Africa, including the Island of Madagascar accounts for over 90% of the 450 or so taxa (species, subspecies or varieties) of the genus *Aloe* known today, with concentration in Southern Africa (over 260 taxa), in Eastern Africa (over 180 taxa) and on the Island of Madagascar (Ca 77 taxa). A few species have been recorded in the Arabian Peninsular and on small Islands off the Coast of Africa. Kenya is home to about 60 species, five of which have been identified as being commercially exploited for aloe bitter gum trade.

As a genus, aloes are a common feature of the landscape in many dryland areas of Africa. However, aloes are rarely dominant in the ecological sense, except in places devoid of other vegetation. Indeed, many taxa are rare and with narrow range of distribution and high levels of endemism have been recorded in all the main centres of diversity. Of the five commercial species identified for Kenya, the most common and widely distributed species is *A. secundiflora* with considerable variation across its geographical range. According to Wabuye et al. (2006), the Extent of Occurrence (EOO) for *A. secundiflora* in Kenya alone is at least 136 200 km². Two varieties are recognised in this species; the first, *A. secundiflora* var. *secundiflora* occurs in Ethiopia, Kenya, northern Tanzania, Uganda, Rwanda and Sudan. The second variety, *A. secundiflora* var. *tweediae* occurs in northern Uganda, northern Kenya and in southern Sudan. In undisturbed pristine habitats, the species occurs in more or less continuous populations, except in marshes and other water-logged soils.

Generally, the geographical distribution of the other four commercial aloes is more restricted in comparison with *A. secundiflora*; *A. turkanensis* occurs in Kenya and Uganda; both *A. calidophila* and *A. rivae* occur in Kenya and Ethiopia, while *A. scabrifolia* is endemic to Kenya. However, all the species are locally common within their distribution ranges. The Kenyan distribution of the five commercially exploited species is shown in figure 1.

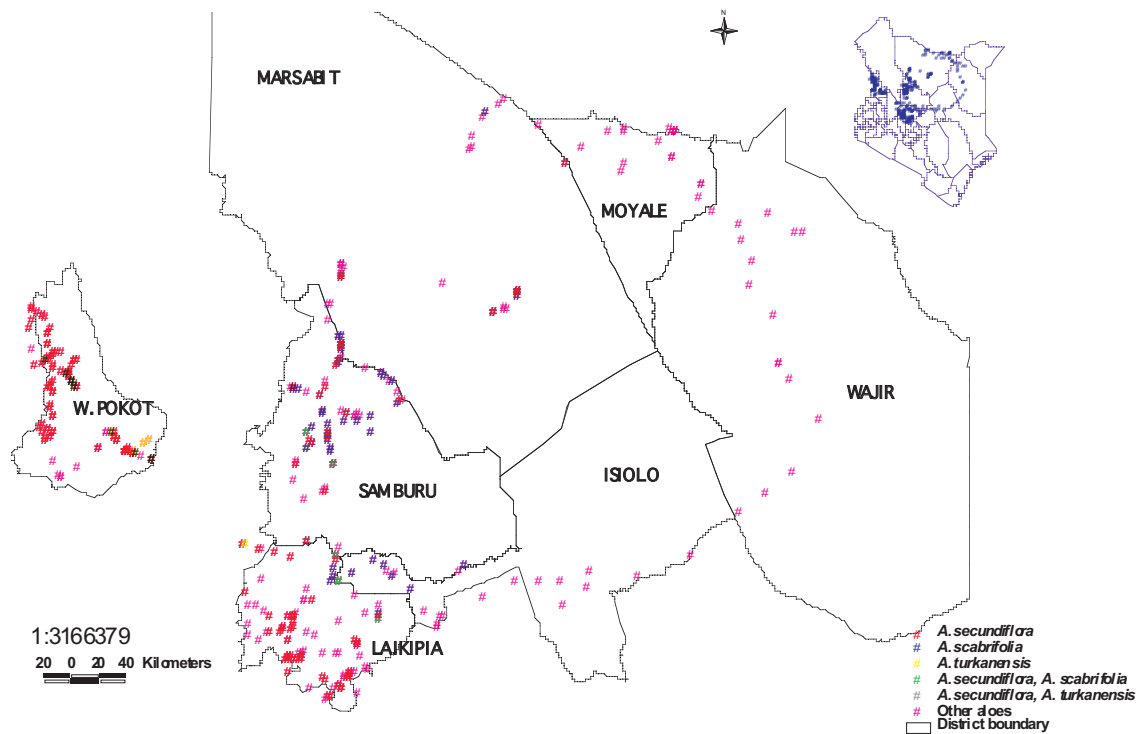


Figure 1

1.3 Biological characteristics

1.3.1 Provide a summary of general biological and life history characteristics of the species (e.g. reproduction, recruitment, survival rate, migration, sex ratio, regeneration or reproductive strategies, tolerance toward humans).

Aloes are perennial monoecious plants with a variety of sizes that include the miniature herbs such as the grass aloes, stemless rosette-forming species, stemmed and sprawling shrubs and small trees. The leaves in the stemmed aloes may be borne in terminal rosettes or may be spaced along the stem, which in some cases emerges to about 15 meters in height. The inflorescence in aloes is a raceme, simple or compound; flowers are tubular, brightly coloured red, yellow, orange or rarely white and produce large amounts of sugary nectar with which pollinators are rewarded. Cross pollination in aloes (by sunbirds) is promoted by the protandrous nature of the flowers. Aloes reproduce both vegetatively and by seed and they have been observed to hybridise extensively in nature as well as in cultivation. The fruits of aloes bear numerous seeds that are dispersed by wind. Generally, all aloes have a long lifespan that is estimated at 150 years (Newton & Vaughan, 1996).

Although aloes produce high numbers of seeds and suckers, establishment of recruits is only occasional and dependent on availability of rainfall that is more often than not scanty and erratic in the range areas. This phenomenon combined with the long-lived perennial habit of the plants leads to predominance of older plants in aloe populations. These observations have been corroborated by studies by Wabuye (2000) on the population structure of maculate aloes in Kenya and Ethiopia that showed a greater proportion of 'juvenile' and 'adult' size classes as opposed to the 'seedling' and 'post-reproductive' plants. Other observations by Mukonyi *et al.* (2005) noted that most populations of the commercial species in Kenya were dominated by mature individuals. It is important to note here that despite the apparent lack of active recruitment of new individuals, the *Aloe* populations studied displayed healthy genetic composition with no signs of inbreeding depression.

In general, aloes have been observed to respond to physical disturbance like injury of plant organs by increasing growth and suckering. Aloes have also been reported as being tolerant of fires especially as occurs in many rangeland vegetation types. Mukonyi *et al.* (2005) observed that, among the five identified commercial species; *Aloe scabrifolia* and *A. calidophila* are least tolerant to fire. *A. secundiflora* has been demonstrated to be tolerant of trampling by livestock and wil-

dlife as demonstrated on trial plots in Laikipia district of Kenya (Gilfred Powys, Pers.com). However, detailed studies on ecological response to other forms of disturbance are not available.

In East Africa, the optimal flowering season for aloes coincides with the rainy seasons. Most species flower during May to July and from September to November, corresponding to the two peak seasons of high moisture experienced in many localities of the region. Amongst the commercial species, *A. secundiflora* has been observed to seed and recruit more through seeds *A. scabrifolia*, *A. riva*e, *A. turkanensis* and *A. calidophila* recruit mainly by suckers. Efficient seed dispersal and seedling establishment may be one of the factors contributing to the ecological success of *A. secundiflora*.

1.3.2 Habitat types: Specify the types of habitats occupied by the species and, when relevant, the degree of habitat specificity

The ecological range of aloes generally excludes rain forest habitats, and except for species previously grouped under the genus *Lomatophyllum*, aloes do not occur in lowland moist forests. Aloe plants growing in shade are generally more robust than those growing on exposed grounds. However, judged by their successful cultivation in different soil mixtures, aloes are apparently tolerant to many soil types. Analysis of habitat preferences for Kenyan aloes showed that 66% of aloes occur in deciduous bushland /woodland, 14% in grasslands while the remaining 20% inhabit edges of thickets, riverine woodlands, scrubland or rock outcrops. The range of altitudes is wide, from 0 m (*Aloe massawana*) to over 2300 m for *Aloe juvenna*. The highest proportion of aloes (32%) occurs between 100-1500 m above sea level. Higher altitudes have been reported from some species in Ethiopia.

With respect to commercial species in Kenya, it has been observed that *A. secundiflora* occurs in a range of grassland and deciduous woodlands in both relatively wet to arid localities. The species does not occur on very steep terrain and is absent in marshy vegetation and other water-logged environments. While *A. secundiflora* is more or less an ecological 'generalist', *A. scabrifolia*, *A. riva*e, *A. turkanensis* and *A. calidophila* tend to be 'specialists', with and natural ranges are restricted to harsher and more arid localities in northern Kenya, Southern Ethiopia and eastern Uganda.

1.3.3 Role of the species in its ecosystem

Aloes are an important component of the dryland ecosystems where they are associated with species of such as *Acacia*, *Kleinia*, *Cissus*, and *Euphorbia*. It has been suggested that aloes may be primary colonisers of habitats that enable later habitation by other less resilient plants.

Observations made on *A. secundiflora* have shown that vegetation diversity, litter cover, soil retention and soil seed bank are greatly enhanced in the immediate vicinity of the plants. Apparently, the presence of *A. secundiflora* creates microhabitats for associated plants (and animals) probably due to the physical protection, shade and perennial ground cover (King, 2003). In addition, aloes produce large amounts of nectar. In relation to honey-bees, the presence of flowering aloes has been observed to enhance the quantity and quality of honey output over the seasons.

1.4. Population:

1.4.1. Global Population size: (Population size may be estimated by reference to population density, having due regard to habitat type and other methodological considerations, or simply inferred from anecdotic data) Detailed census of populations has not been done for many species of *Aloe* and hence difficulties in providing good estimates of population size. However, in a survey by Mukonyi *et al.* (2005) the Kenyan population of commercial aloes was estimated at 129 million plants, 83% of which were *A. secundiflora*. Considering the large ecological range of the species ($EOO \geq 136\,000\text{ km}^2$ for Kenya alone), the global population of *A. secundiflora* individuals is likely to be more than double the Kenyan estimate; a meagre 0.1% of commercial species was accounted for by *A. turkanensis*, *A. calidophila* and *A. rivae* combined while the endemic *A. scabrifolia* was estimated at 16.9% (2,180,100 individuals) of the total count.

1.4.2. Current global population trends:

Information on *Aloe* species population trends in East Africa is scanty since no specific studies have been undertaken in this area. However, except for species occurring in remote and isolated areas, aloes like all plants of the region, have suffered loss and fragmentation of habitat as a result of human population increase. Coupled with commercial exploitation as noted for the five Kenyan species, the projection is that population sizes are more or less on the decline, albeit at minimal pace. In the case of Kenya, this trend has been kept in check by recent efforts at dialogue with stakeholders and the legalisation in 2007 of sustainable extraction of aloes from the wild.

1.5. Conservation status

1.5.1. Global conservation status (according to IUCN Red List).

IUCN Redlisting for aloes of Southern Africa has been extensive and conservation status of many species of the region already established.

For East African aloes, Red list Assessments of twenty-five Aloe species endemic to Kenya were done by Wabuye et al. (2006). Nine of the species were listed as critically endangered, seven are endangered, four are vulnerable, three near-threatened and two are of Least Concern. The endemic and commercially exploited *A. scabrifoia* was assessed as being vulnerable [(B1ab(v))]. Other Redlisting efforts for East African plants have been coordinated under the Critical Ecosystem Partnership funded project of the Eastern Arc Mountains and Coastal forests of Kenya and Tanzania Project. Under this project, twenty-four *Aloe* species occurring in the two East African biodiversity hotspots were targeted for conservation assessment, none of which is exploited on commercial basis.

1.5.2. *National conservation status for the case study country*

Although no objective data was available to make formal conservation assessments, all Kenyan aloes have been regarded as endangered since the 1980s and have been given high priority in conservation efforts. Indeed, reports of indiscriminate harvesting of the commercial species in the wild led to a Presidential Decree in 1986 that banned commercial exploitation of wild-growing aloes. In a recent mapping exercise by Mukonyi et al. (2005) of the major aloe growing areas in the country, approximately 129 million individual plants of the five identified commercial aloe species were counted. Although this number is considerably large, the species should be considered 'vulnerable' in the face of habitat loss and alteration and unregulated commercial harvesting, which is the single most potent threat.

1.5.3. *Main threats within the case study country*

As demonstrated by the population census of commercially exploited aloes, Kenya is endowed with a high diversity of species that occur in large numbers. One of the species, *A. secundiflora* is very common and widespread, whereas the other four are more restricted in distribution. Regardless of the distribution trends of the species, sustainable utilisation is possible only for as long as efficient management measures are established. The main threats to aloes in Kenya can be summarised as a) Unregulated commercial exploitation in the case of species harvested for the aloe bitter gum and b) habitat fragmentation and destruction

Unregulated commercial-scale exploitation is a major threat for species that are harvested for aloe bitter gum production. This is most important for species that have a restricted distribution and narrow ecological range. It is hoped that with the new strategy, stakeholders will be more vigilant and avoid indiscriminate harvesting from the wild.

Habitat destruction and fragmentation occurs mainly due to increased human and livestock populations that in turn increase the need for settlement and development activities like road construction and quarrying. Overgrazing in the rangelands leads to decreased ability of aloes and other native plants to compete as invasive alien species take over habitats. In localities with low to medium potential for agricultural production, aloes are cleared to make way for arable land. This problem is exacerbated by the changing land tenure systems in which expansive communally-owned land is subdivided into smaller parcels, a situation that is not helped by the fact that a large number of species occur outside protected areas.

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED

2.1 Management measures

2.1.1 *Management history*

Due to their multi-use nature, aloes have been harvested at household level over many years mainly for use as herbal remedies in combination with other plants. Large scale harvesting of aloes for commercial purposes started in Kenya in the 1950s and, by the mid 1980s, the rate of off take was alarming. Thus, a Presidential Ban was declared in 1968 prohibiting commercial harvesting from the wild. However, for over two decades, enforcement of this Decree remained a challenge since it was never translated into law.

In consideration of the economic potential of aloes, national stakeholders felt the need to streamline their use by developing a framework for regulation. It is against this background that stakeholders consulted widely and came up with Aloe Utilization guidelines that were gazetted by the Kenya government at the end of 2007 as subsidiary legislation; The Wildlife (Conservation and Management) (*Aloe* Species) Regulations, 2007 hence bridging the legal gap in the aloe industry. A National Strategy for Conservation and Management of Commercial *Aloe* species was subsequently formulated and launched in July 2008 to spearhead developments in the aloe commercialisation process and implementation of the Regulations. The Commercial *Aloe* Strategy as a Management Plan for Kenyan commercial species prescribes systems, procedures and institutional arrangements for sustainable management of the species in accordance with the national legislation on wildlife and international obligations regarding international trade in wildlife species and their derivatives.

2.1.2 *Purpose of the management plan in place*

The Strategy for Conservation and Management of Commercial *Aloe* Species in Kenya (Lubia *et al.* 2008) was formulated to guide sustainable utilisation of the resource, with the aim of striking a balance between socio-cultural, economic and ecological needs necessary for sustainable development of the sub-sector. The Strategy provides for sustainable utilization of aloes sourced from both domesticated and wild populations.

2.1.3 *General elements of the management plan*

The aloe commercialisation process proposes both *in-situ* and *ex-situ* strategies to promote the sustainable utilisation of aloes in Kenya. The *in situ* strategy targets sustainable harvesting and production from natural populations in the so-called *Aloe* Management Units (AMUs) that have been identified on the basis of holding large quantities of commercial aloes. *Ex-situ* production targets areas with low densities or no aloes where establishment of plantations will boost production and alleviate pressure on natural populations. In addition, the Strategy explores ways of promoting sustainable utilisation by proposing incentives for salvaging aloes in cases of land use change; promotes aloe cultivation as a competitive land use option and encourages multiple use of land that combines intercropping of aloes with conventional crops as well as grazing.

2.1.4 *Restoration or alleviation measures*

For conservation purposes, aloes in protected areas will not be exploited for trade. Sustainable utilization of the wild populations will be controlled using areas delineated as *Aloe* Management Units (AMUs) through certification and tracking of the custody chain. *Ex situ* collections will be maintained in botanical gardens and other facilities to augment the natural gene pool. However, no specific measures have been proposed for re-introduction of the species to localities where they may become depleted.

2.2. **Monitoring system**

2.2.1. *Methods used to monitor harvest*

Prior to the recently gazetted subsidiary legislation and subsequent development of a Management plan for utilization, aloe harvesting and trade in Kenya was illegal and *ad hoc*. The new Strategy proposes establishment of Management Units (AMUs) that will be used for periodic monitoring of the impact of harvesting on natural populations. Within each AMU, standards will be set on harvesting procedu-

res, quantities required and optimum seasons to avoid overexploitation. The amount of off-take and trade statistics will form the basis for allocation of harvesting quotas and eventual evaluation of sustainability.

2.2.2 *Confidence in the use of monitoring*

As already mentioned, implementation of the Strategy for aloe commercialisation in Kenya is at its infancy. However, formulation of this strategy was based on wide consultations amongst stakeholders, making it a people-owned strategy that is founded on best scientific information accruing from a national inventory of the commercial aloe species undertaken in 2005. In addition, the AMUs as proposed here will have internal management structures and production standards agreed upon by the membership and acceptable to the wildlife regulatory authorities. It is therefore anticipated that the system will be cohesive enough to realise the aspirations of aloe farmers and conservation agencies alike.

2.3. **Legal framework and law enforcement:** Provide details of national and international legislation relating to the conservation of the species.

In Kenya, the Forest Policy (2005) and the Environmental Management and Coordination Act (1999) generally relate to management of biodiversity resources of the country. The Wildlife (Conservation and Management) (Amendment) Act 1989; CAP 376, provides for conservation and management of all wild fauna and flora. However, the recently gazetted subsidiary legislation on aloes: "The Wildlife (Conservation and Management) (Aloe Species) Regulations, 2007" based on powers conferred by Section 67 of the Wildlife (Conservation and Management) Act to the Minister responsible for wildlife provide the most relevant/specific basis for Aloe Commercialisation in the country.

At the international level, all aloes except Aloe vera are listed on Appendix I & II of CITES. All East African species are listed on Appendix II, for which trade is regulated through use of permits and certificates and in accordance with Article IV of the CITES Convention, the basis for Non-Detriment Finding Studies if the trade involves specimens collected from the wild. The responsibility for enforcement of both domestic and CITES regulations on wildlife trade is vested upon the Kenya Wildlife Service and the National Museums of Kenya being the national wildlife Management and CITES Scientific Authorities, respectively. Vigilance on movement of plant materials is in addition provided by national Customs and Kenya Plant Health Inspectorate Services

(KEPHIS) to ensure enforcement and compliance with the national legislation and the international protocols relating to trade in the species.

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

3.1. Type of use (origin) and destinations (purposes) (e.g. commercial, medicinal, subsistence hunting, sport hunting, trophies, pet, food). Specify the types and extent of all known uses of the species. Indicate the extent to which utilization is from captive-bred, artificially propagated, or wild specimens

Alongside other medicinal plants extensive use of aloes in treatment of human and livestock diseases in Africa has been documented. Indeed, in some areas of East Africa, herbal treatments are the only option for up to 80% of the population. In an ethnobotanical survey of parts of Kenya Bjøra *et al.*, (in prep) documented many uses of aloes that were summarised as: a) human medicine, b) livestock medicine, c) fodder, d) fencing and hedging, e) soil conservation /compaction, f) traditional brewing and g) cosmetic/beauty therapy.

Up to 50% of the species were used as medicine, with malaria being the most common human ailment cured by aloes. Other uses of aloes include their use in traditional rituals and cultural practices in some groups of coastal Kenya. Generally, use of aloes seems to be dictated by availability (distribution) as well as morphology; the widespread *A. secundiflora* was most popular as compared to less well known species; *Aloe lateritia* with its high leaf gel content was popular in beauty therapy and leggy species such as *Aloe kedongenis* were preferred as hedges. Species such as *Aloe ruspoliana* that are known to be poisonous are used for killing hyenas and wayward dogs in northern Kenya.

Apart from the 'traditional' use of aloes outlined here, commercialisation of Kenyan aloes occurs at two levels; in the last decade or so, the sap of this species has gained popularity as an ingredient of 'homemade' soaps and detergents in many rural villages in Kenya. In this regard, individuals and community groups have taken to 'aloe soap' making as a cottage industry to subsidise income. On the other hand, large-scale commercial extraction of aloes targets markets abroad, mainly in Europe, and the Middle East (Oldfield, 2003) where it is used in the cosmetics and drug manufacturing industries. Farming of aloes is a recent undertaking in Kenya and no known plantations of mature plants exist. All known substantial harvesting of aloes is from wild-growing populations. As noted by Newton (1994) attempts to

establish plantations in the past have been flawed since whole plants were dug up from the wild for replanting on farmland.

3.2 Harvest:

3.2.1 *Harvesting regime* (extractive versus non extractive harvesting, demographic segment harvested, harvesting effort, harvesting method, harvest season)

For 'traditional' uses of aloes, only a few leaves were harvested from mature plants and except for use of the roots in fermentation of local brews, plants are not uprooted. The usual practice is to harvest older leaves starting from the base to that the younger leaves towards the growing tip are left intact. However, upsurge in demand for aloe sap in the advent of commercial production has meant that increasingly younger plants are harvested to obtain as much sap as possible. As observed by Bjøra *et al*, the local people have to walk longer distances to harvest aloes (and other plants) for routine use. This has prompted the establishment of herbal gardens closer to homesteads to ensure steady and easy access to these resources.

In a sense, 'illegal' harvesting of aloes has been largely opportunistic with no clear-cut seasons for the activity. This scenario is bound to change within the newly published Strategy in which emphasis is on establishment of AMUs with accepted quotas and standards of production such as safe off-take levels and seasons optimal for harvesting.

3.2.2 *Harvest management / control* (quotas, seasons, permits, etc.)

According to the recently published *Aloe* commercialisation strategy, production from natural populations will revolve around AMUs for which members of each Unit shall be involved in setting internal standards and the levels of performance to which their activities should aspire. The standards will then be assessed and interpreted by the national wildlife authorities and other national partners. Failure to comply with stipulated standards will lead to cancellation of rights to harvest and revocation of trade permits by the Management Authority.

3.3 Legal and illegal trade levels: To the extent possible, quantify the level of legal and illegal use nationally and export and describe its nature

Local trade

In all regions where aloes occur, domestic trade has been ongoing for many years mainly as part of the herbal remedies traded/exchanged with neighbours. Market surveys of medicinal plants traded in

Southern- and East Africa reveal substantial volumes of aloes traded. Indeed, many supermarkets in Kenya stock 'Aloe vera' juices and soaps that are locally manufactured and that have become quite popular in recent years. However, documentation of this trade is scanty and insufficient as a basis for identifying species and quantities exploited.

International trade

International trade in wild collected specimens of aloes was banned in Kenya in 1986 through a Presidential Decree and materials authorized for export under CITES Permits and certificates from Kenya have been small quantities of dried leaf material, sap or seeds that were mainly for scientific analysis abroad.

However, illegal trade in aloe bitter gum has been reported in Baringo, Taita-Taveta, Samburu, Wajir and West Pokot districts. The aloe trade chain in Kenya is very discreet and very little information is available to determine the volumes of this illegal trade. The available information in this regard has been sourced from few local people and some of the trade agents who were unaware of the civil obligations / implications and who have been willing to volunteer the information. In Loruk area of Baringo District, it is reported that between 200-250 plants were required to obtain 5 litres of raw sap that would then be sold for a maximum of USD 0.3/litre.

Despite national and CITES obligations on international trade in aloes and their derivatives, it is apparent that vigilance at the ports of entry/exit has been porous enough to allow passage of substantial amounts of aloes. For instance, according to a report by NAREDA (cited in Oldfield 2003) about 125, 800 kg of dried aloe bitter gum sourced from natural populations was shipped through the port of Mombasa in the years 1995 to 1999. Up to four registered companies, dealing in wood products, resins, essential oil extracts and vegetable products were involved in the business. This suggests that inspection of exports over the period was inefficient and failed to detect aloe products that may have been disguised as vegetables or resins. Ultimately, the laxity of the system is attributable to difficulties in enforcing a Presidential Decree that did not have a legal basis. Thus, the development of subsidiary legislation and formulation of the strategy for conservation and management of commercial aloes that was institutionalized in 2008 is a milestone that provides a framework for mainstreaming the industry in Kenya. This provides a mechanism for monitoring trade and a pathway for undertaking Non-Detriment Finding studies for use and application in adaptive management of commercially exploited species.

Non-detrimental Finding procedure (NDFs)

a) NDF methodology used (Provide detailed information on the procedure used to make the non-detriment finding for the species evaluated.)

The NDF study on commercial aloes in Kenya systematically followed the IUCN checklist for NDFs (Rosser, 2008). Qualitative assessments were augmented by quantitative data generated in the mapping and inventory survey by Mukonyi et al. (2005) and other previous field assessments on aloes in general. Sampling procedures for the inventory were modified from methods used for non-wood forest products, taking into consideration species habits, sizes and distribution.

Optimal harvesting regimes of the species were conceived on the basis of information gathered from the surveys, taking cognizance of the national legal provisions governing the conservation and management of the species. Generally, the IUCN checklist for NDF has been extensively referred to in the process of developing the strategy for conservation and management of commercial aloes in Kenya.

Criteria, parameters and/or indicators used

Final assessment of the impact of commercialisation on species was made in consideration of distributions of species, biological characteristics such as growth habit, potential for regeneration, ecological resilience and tolerance to human disturbance. In order to gauge sustainability of harvesting, information on both legal and illegal trade at domestic and international scales were assessed. Trade statistics were sourced from previous surveys (NAREDA) and from informants in commercial aloe producing centres.

Main sources of data and analysis used (including field evaluation or sampling methodologies)

The following are the sources of data used in making NDF on the commercial *Aloe* species in Kenya. The same methodologies used to generate the data shall continue to be used when undertaking future NDFs on the species.

a) Aloe inventory report: Status and distribution of Commercial aloes in Kenya (Mukonyi *et al.* 2005)

This is a field assessment that focused on all districts of Kenya where aloes are exploited on commercial basis. During this survey the research team established the national distribution and abundance of species, harvesting and processing techniques, approximate yields per season as well as wild and cultivated sources of aloes.

Based on the information gathered, recommendations were made of appropriate adaptive conservation and utilization approaches for target species.

The aloe inventory exercise was a pioneer study for which methodology is not standardised. Therefore, in consideration of growth forms, patterns, sizes and distribution, methods of sampling for quantification were modified from those used for non-wood forest products. Cluster sampling method was adopted for predominantly suckering species-*A. turkanensis*, *A. scabrifolia*, *A. rivae* and *A. calidophila* while total counts approach was adopted for *A. secundiflora*

Information was collected on entities involved in commercial aloe domestication programs and projections made of current and potential production levels. Interviews were carried out to establish initiatives made towards sustainable utilization of the aloes, the distribution of critical masses of the species as well as the land tenure system in aloe-rich localities. Harvesting methods and the market chain in the commercial aloe industry has been documented as a basis for current and future comprehensive NDF studies.

- b) Export permits issued for export of the commercial aloe species and their derivatives. This documentation is kept by the Kenya Wildlife service which is the Management Authority for Kenya.
- c) Review of Significant Trade report on East African aloes to the CITES Plants Committee; CITES PC14 Do.9.2.2 Annex 4. This paper draws from a survey by Oldfield (2003) in which trade statistics for the aloes in east Africa were reviewed. On the basis of trade data, it was concluded that significant levels of trade occur on aloes in the region exists. However, the trade is poorly documented and difficult to quantify.
- d) Field assessments on the conservation status and economic potential of the genus Aloe in Kenya. This is an unpublished report by Wabuye (2004) based on field surveys in the main aloe producing areas of Kenya. The survey documented distribution, use and threats to aloes in the country.
- e) Studies on Eastern African aloes: Aspects of taxonomy, Conservation and ethno-botany. This is a comprehensive study of regional aloes based on PhD studies from 2003 to 2006.

Evaluation of data quantity and quality for the assessment

Data obtained from the outlined sources was analyzed to determine suitability and approvals for establishing Aloe Management Units (AMUs) as entities for controlled and sustainable harvesting of target species from the wild for commercial trade.

The data was used to develop the national strategy for conservation and management of the commercial aloe species in Kenya published in July 2008.

Applications for exports from these AMUs will be compared with the expected levels of production as stipulated in the Management Plans for the species to ensure compliance and enforcement. Regular field assessments shall be undertaken for purposes of monitoring any changes to the species population status and impact of management so as to provide feedback and timely adjustment to the management plan.

Main problems, challenges or difficulties on elaboration of NDF

The major challenge in the elaboration of NDF studies on the commercial aloe species in Kenya is inadequate information on aspects such as auto-ecology, demography and population dynamics especially in areas not covered under the inventory and mapping exercise. The methods adopted in sampling may require further testing and validation. In addition the discrete nature of hitherto illegal trade in specimens of the commercial aloes hampers systematic documentation of trade volumes and market trends thus making it difficult to assess the levels of harvest and the impact of trade on the natural populations.

Recommendations

The IUCN checklist for NDF studies is a practical tool applicable to the case of commercial aloes in Kenya. Efforts shall therefore be made to use the checklist combined with other guidelines and methodologies and procedures to formulate future NDFs for the species. For efficient implementation of the Kenya Strategy for conservation and management of commercial aloes as a management plan and make it as adaptive as possible, it will be crucial to obtain baseline information that will enable future monitoring of the impact of off-take on natural populations. It is recommended that:

- Detailed studies are carried out on the five species to establish pertinent information as relates to spatial and genetic structure and dynamics of populations. Data accruing from such studies will enhance objectivity in application of the IUCN Checklist for NDF on these species.
- In addition, it will be crucial to develop efficient identification and authentication tools for the various commercial species and their products for surveillance at the ports of exit from the country.

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