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Review Article

Assessing Key Non-wood Forest Products in Kenya: Insights for Conservation and Sustainable Development

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Abstract

Non-wood forest products (NWFP) present opportunities for diversifying livelihoods in Kenya especially in the arid and semi-arid lands. This paper examines the current status, investment opportunities, challenges, and potential mitigation measures in key non-wood forest product value chains in Kenya in relation to conservation and sustainable development. It focuses on aloe, gums and resins, dyes and tannins, indigenous fruits and, honey and bee products. The study adopted a desk-based literature review methodology, drawing on research outputs from the Kenya Forestry Research Institute (KEFRI) and other scholarly and policy-related sources. A structured value chain lens was used to examine technological, institutional, and infrastructural factors influencing the development of NWFPs. Key findings focusing on current practices, existing technologies, gaps and inefficiencies, infrastructure bottlenecks and opportunities for upgrading are presented, along with lessons learned and recommendations for improving the development of these value chains. Major challenges identified include technological limitations in harvesting and processing, natural resource availability and degradation issues, inadequate technical capacity and extension services, high investment and operational costs, financial constraints, weak market linkages and value addition, and gaps in policy and legal frameworks. Despite these constraints, the review highlights several investment opportunities. These include the development of forest-based bio-enterprises, the expansion of local and international markets, implementation of certification and quality standards, capacity-building and knowledge transfer programs, increasing demand for forest products, and enhanced governance and support through Kenya's devolved government system. The ongoing review of The Forest Conservation and Management Act of 2016 is also noted as a potential enabler of growth in these sectors. This paper offers valuable insights for investors, researchers, policymakers, farmers, students and other stakeholders aiming to support evidence-based planning and the sustainable commercialization of NWFPs in Kenya.

Keywords

Non Wood Forest Products, Value Chains, Investment Opportunities, Forest Bio-enterprises, Market Linkages, Policy Framework, Kenya

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1. Introduction

1.1. Overview of Non-wood Forest Products (NWFPs) Sector in Kenya

The forest sector plays a vital role in supporting the livelihoods of the Kenyan population, providing both forest-based goods and services. According to the Kenya Green Economy Strategy Implementation Plan 2015, natural resource-based sectors contribute approximately 42% to the country's Gross Domestic Product (GDP), with forestry alone accounting for about 36% of this share [1]. Forest products in Kenya can be broadly categorized into wood and non-wood products. Wood products include timber, furniture, poles, posts, wood fuel, pulp, paper, wood composites, and carvings, while Non-Wood Forest Products (NWFPs) [2] on the other hand, comprise a diverse range of plant and animal-based resources, such as plant gums, resins, essential oils, dyes, tannins, indigenous fruits, medicinal plants (e.g., aloes), bee products, and fibers [3].

The utilization of NWFPs is significant in Kenya particularly in the arid and semi-arid lands (ASALs), where they offer vital opportunities for diversifying livelihoods. Unlike wood products, NWFPs are mostly gathered rather than cultivated, and value addition at the source remains limited. Key NWFPs with significant commercial potential in Kenya include aloes, indigenous fruits, and gums and resins, products that can greatly improve food security, health care, and resource conservation in rural communities. The utilization of NWFPs in Kenya varies considerably across regions influenced by ecological zones and land use patterns. In regions with higher rainfall, modern agricultural crop production tends to be more prevalent resulting in lower dependence on NWFPs. Conversely, in drylands where agriculture activities are less intensive, NWFPs serve as a crucial resource. Additionally, most NWFPs are harvested from government-owned or communal lands, rather than private lands, presenting challenges to investment and sustainable management of these valuable resources.

Interest in NWFPs has grown rapidly [4] particularly among conservation and development organizations [5]. This growing attention is due to the emerging markets for natural products [6], such as phyto-chemicals in the pharmaceutical industry and natural additives in the food industry [7], which highlight the economic and environmental significance of NWFPs. These products have the potential to create alternative livelihoods, improve food security, and enhance community resilience to climate change and natural disasters.

This paper provides an overview of the current status of NWFP utilization in Kenya, examines the challenges faced by the sector, explores investment opportunities, and offers recommendations for strengthening NWFP value chains in support of sustainable development.

1.2. Rationale

This review offers detailed insights into the current status and future opportunities of key non-wood forest product value chains in Kenya, targeting potential investors, students, researchers, policymakers, farmers, and other stakeholders. The information generated will be crucial for identifying gaps and opportunities in research, development, management, and investment, as well as guiding policy formulation. Moreover, it will contribute to updating the database on major forest product developments in Kenya, and highlight emerging investment opportunities in the sector.

1.3. Methodology

The study employed a desk-based review of existing information both from published and grey literature, drawing on data and findings from the Kenya Forest Research Institute (KEFRI) supplemented by relevant academic journals, government reports, policy documents, and credible online databases (e.g., FAO, World Agroforestry, Scopus, Google Scholar). The key NWFP value chains considered include; gums and resins, aloes, indigenous fruits, honey and bee products and dyes and tannins. The information gathered was analyzed, synthesized, and key findings, lessons learned, and recommendations were summarized to inform policy and development strategies aimed at enhancing the sustainable development and commercialization of NWFPs in Kenya.

2. Status of Key Non-wood Forest Products (NWFPs) Value Chains

The key non-wood forest products (NWFPs) reviewed have commercial value and are widely utilized. They can therefore be domesticated to enhance their production and utilization. This section provides an overview of their current status focusing on key value chains, the challenges facing these sectors, and potential interventions. The section also explores opportunities for investment, utilization, and market expansion.

2.1. Gums and Resins

Gums and resins, particularly gum arabic from *Senegalia senegal* (formerly *Acacia senegal*), *Acacia seyal*, and commercial resins like; myrrh from *Commiphora myrrha*, Hagar from *Commiphora holtziana*, and frankincense from *Boswellia neglecta*, are critical to the economic development of Kenya's ASAL regions. Currently, gums and resins are produced in at least eight ASALs counties namely; Marsabit, Wajir, Garissa, Mandera, Tana River, Turkana, Samburu and Isiolo [8]. There are also a number of other counties such as Kitui and Meru with some limited resources. These products contribute to improved livelihoods, food security, and foreign exchange earnings. Key players in the gums and resins value chain are producer groups, local traders, wholesalers and

exporters. The other players are the service providers including policy and decision-makers at county and national levels. While the collection of gums and resins for local and commercial use has been ongoing for decades, current production levels are well below the potential. For example, Kenya's production of gum arabic is approximately 16,291 metric tons (MT), far lower than the annual export of 1,510 MT [9]. A study by Muga and Chikamai [10] reported that most of the gums and resins produced in Kenya are exported in raw form except for a small quantity of the total volume produced that is processed for essential oils. Gums and resins are marketed through the local, national and export marketing outlets. Kenya is the third largest exporter of resins (myrrh, hagar and frankincense) after Ethiopia and Somalia and has a niche market for gum Arabic in Europe [11]. A number of initiatives have been undertaken since 1990 including taxonomic and ecological characterization of the producing species [12-14], chemical characterization of the gums and resins [15, 16], resource assessment and mapping [8, 17-20], piloting production and management of *Senegalia senegal* trees [21, 22], and training and capacity building [23, 24]. The establishment of a processing facility in Wajir County, aimed at adding value to gum resins such as myrrh (*Commiphora myrrha*), frankincense (*Boswellia neglecta*), and opoponax (*Commiphora holtziana*) [25] is one of the efforts towards forest-based bio enterprise development. The government of Kenya has also prepared the gums and resins regulations that are waiting gazetting. Through these past initiatives, major barriers that limit the realization of full potential for the gums and resins in the dry lands of Kenya as well as existing opportunities have been identified.

2.1.1. Challenges and Gaps in Gums and Resins Value Chain

The gums and resins sub sector operates below its potential and there are several factors hampering the growth of the subsector such as:

1) Production issues: Unsustainable harvesting methods: many harvesters still use traditional, crude tools like machetes and axes, which damage trees and reduce yields over time. Inefficient tapping leads to poor-quality products with high levels of impurities; inadequate storage facilities for drying and storage; poor post-harvest handling: manual cleaning and sorting processes dominate reducing the quality and export competitiveness. Lack of mechanized dryers leads to long drying times for gum arabic and vulnerability to contamination by dust, insects, or moisture; Poor road networks: ASAL regions have seasonal, impassable roads, especially during rains, making transportation slow and costly. High transport costs reduce producer margins and limit market access; and low natural regeneration of gum-producing trees.
2) Limited value addition: Kenya exports raw or semi-processed gums/resins, forfeiting potential revenue from high-value derivatives (e.g., emulsifiers, incense, essential oils). Lack of local processing equipment for distillation, extraction, and refinement.
3) Market challenges: Weak market linkages, underdeveloped marketing systems, and low producer prices due to limited value addition.
4) Limited access to finance: Few financial institutions offer tailored products for this sector, stifling investments in transport or processing technology.
5) Environmental and social factors: Climate change impacts, insecurity, and the destruction of gum-producing trees for firewood and fencing materials.
6) Policy and institutional gaps: Lack of clear policies, weak regulatory oversight has led to informal trade and underreporting of exports, insufficient stakeholder collaboration, and inadequate resource data for effective management.

2.1.2. Recommendations in Gums and Resins Value Chain

The following strategies are recommended to enhance the gums and resins sector:

1. Production Strategies:
   1) Promote sustainable harvesting techniques, mobile processing units and drying technologies.
   2) Establishment of gums and resin plantations.
   3) Capacity building: Training programs for harvesters and cooperatives on quality handling and marketing.
   4) Establish local processing units for value addition.
   5) Conduct a comprehensive resource assessment to map gum and resin resources and update data regularly.
2. Marketing strategies:
   1) Strengthen producer associations and cooperatives to facilitate better market access and price negotiation.
   2) Invest in rural roads, storage warehouses, market centers.
   3) Promote linkages with international buyers, certification (organic, fair trade).
   4) Develop local collection and bulking facilities to improve supply consistency for export markets.
3. Finance access

Facilitate access to microloans and cooperative funding mechanisms.

4. Policy and institutional frameworks:
   1) Develop county-level legal frameworks to govern the gums and resins sub-sector [26].
   2) Establish quality control laboratories to support testing and certification of gums and resins.

2.1.3. Opportunities in Gums and Resins Value Chain

Key opportunities in the gums and resins value chain include: expanding the niche market for Kenyan gum arabic in Germany which could significantly boost production and

exports; strengthening the national gum resins association (GARA) to streamline supply chains and improve market access; capitalizing on the growing demand for gum resins in international markets, which currently exceeds supply; and leveraging on the Forest Conservation and Management Act 2016 and devolution to enhance sectoral development and investment.

2.2. Aloe Value Chain

The aloe sector in Kenya, with its diverse species such as *Aloe turkanensis* and *Aloe scabrifolia*, holds substantial commercial potential [27]. Aloe products, including aloe bitter gum and aloe gel, are used widely in the cosmetics and pharmaceutical industries. However, despite the increasing demand, production remains low, and market access is limited. Challenges include inadequate knowledge for commercial cultivation, inconsistent product quality, and poorly defined market channels.

Harvesting of indigenous aloe plants and trade in the aloe sap and gum are regulated by the Convention on International Trade in Endangered Species of the Wild Fauna and Flora (CITES) as they are over-exploited. Locally planting, harvesting and trade in aloe is managed by the Kenya Wildlife Service (KWS) who provides the appropriate licenses. Additionally, The Wildlife (Conservation and Management) Aloe Species Regulations, 2007 (L. N. No. 403 of 2007), require individuals to seek inclusion for propagating aloes for profit, aiming to regulate and sustain wild aloe populations [28]. There is increasing demand for indigenous aloes from international as well as local markets. However, the current production levels of aloe sap and gum are low. Currently, Kenya has the highest Aloe diversity in East Africa and is the main source of Aloe extracts traded internationally from the region. National dealers are concentrated in major urban centers especially Nairobi and Mombasa with a producer price of about KShs 200/kg. Main market for aloe bitter gum is Saudi Arabia, UK, Singapore, Pakistan and China with export prices of KShs 400—600/kg for aloe gum [29]. The Kenyan government has also recognized aloe vera's potential and is working with stakeholders to promote its cultivation and processing. For example, the Aloe Utilisation Guidelines and Strategy aim to bridge policy gaps and encourage sustainable commercialization [30]. In Laikipia North Sub County, indigenous women groups have embraced aloe vera farming as a livelihood strategy. Following the enactment of the Community Land Act in 2016, women gained land ownership rights, enabling them to engage in aloe cultivation for export markets. This empowerment has provided economic opportunities and improved social standing for women in the region [31].

2.2.1. Challenges in the Aloe Value Chain

The challenges that exist in the aloe value chain includes: Insufficient knowledge to develop and manage aloe plantations as a commercial enterprise; marketing of aloe gum is not well defined in the country and some is traded through black market resulting in low prices at the producer level; prices are highly variable and national dealers concentrated in urban centers; limited market access for the products; lack of product standardization; few aloe commercial nurseries; incidences of pests and diseases on aloes; limited domestication of the species; poor harvesting and post-harvest handling methods due to limited skills in value addition and quality control; The high cost of specialized processing equipment limits value addition at the local level; Aloe is often grown in remote arid and semi-arid lands (ASALs) like Samburu, Baringo, and West Pokot. Inadequate roads and transport infrastructure make it difficult and expensive to move raw aloe or finished products to markets; lack of clear policies and strategies on the development of aloes production at the county and national levels; insecurity in some of the producing areas interfere with collection, storage and trade.

2.2.2. Recommendations on Aloe Value Chain Development

The following recommendations are made to enhance aloe utilization: resource mapping to determine exactly how much of commercial aloe resources are available and its potential in terms of income generation; capacity building on propagation, sustainable harvesting, processing, product development, value addition and marketing of Aloe; documentation and dissemination of relevant information on Aloe and aloe products in suitable formats; streamlining Aloe market chain to ensure markets and market access for Aloe products including developing market information systems; undertaking regulation and certification of aloe products; establishment and strengthening of associations along the production and market chains for equitable benefit sharing; There should also be efforts in conservation of aloes through the establishment of demonstration plots, botanical gardens and germplasm preservation in gene banks and in their wild habitats.

2.2.3. Opportunities in Aloe Value Chain Development

The existing opportunities in aloe product development are: Kenya has the highest aloe diversity in East Africa and is the main source of aloe extracts traded internationally from the region, there is a ready market for aloe bitter gum in Saudi Arabia, UK, Singapore, Pakistan and China, and the potential for establishing aloe plantations in ASAL areas and the permits can be obtained from KWS [29].

2.3. Indigenous Fruits

Indigenous fruit are recognized as a significant source of essential nutrients as well as a source of income. There are 400 species of fruit plants from 57 families in Kenya. The seven most important indigenous fruits in their order of preference are: *Tamarindus indica* (tamarind), *Adansonia digitata*

*(*baobab), *Ximenia americana, Carissa edulis, Ancybotrystayloris, Ziziphus mauritiana* and *Dialium orientale* [32]. Others include*: Vitex doniana, Vitex payos, Sclerocarya birrea* (marula) and *Syzigium cuminii* [33]. Most of these indigenous fruit species grow wildly in rangelands and forested areas. Indigenous fruit trees play an important role in the livelihoods of some of the most vulnerable communities in the ASALs of Kenya during stress times. The fruits significantly improve nutrition by providing vital nutrients and essential vitamins [34, 35], and also as a source of food during droughts. Some indigenous fruits also traded as a source of alternative livelihoods by the farmers. KEFRI has developed production protocols for processing various indigenous fruit products; jams, juices and wine and trainings have been done to some SMEs on their production.

2.3.1. Challenges in Indigenous Fruits Value Chain

The potential of these fruits remains underutilized due to challenges such as: Lack of awareness by farmers on the benefits and need to plant and manage more Indigenous fruit trees; planting material-seedlings of indigenous fruit trees often unavailable in local tree nurseries; lack of improved germplasm; slow growth and low quality of indigenous fruit species seedlings compared with exotic fruits; high postharvest losses; Lack of proper marketing channels and low pricing of products; and lack of information on propagation, pre and post harvesting and processing technologies.

2.3.2. Recommendations on Indigenous Fruits

To enhance development of the indigenous fruits value chain, there is need to create awareness on the benefits of indigenous fruits; document and disseminate relevant information on indigenous fruits, undertake research on indigenous fruits to address issues of improved germplasm, propagation, pre and post-harvest losses to improve growth rate, fruit production and their domestication; develop simple storage and processing methods to add value to end products; build capacity in production and processing of indigenous fruits; conduct market research and develop marketing strategies to improve the marketing of fruits and fruit products both locally and in the region as well as commercialize indigenous fruit tree production.

2.3.3. Opportunities in Indigenous Fruits Value Chain

Despite the challenges, the increasing global demand for natural and healthy foods presents a significant opportunity for the commercialization of indigenous fruits. Most of indigenous fruits grow in ASALs where there is less land competition from food crops and therefore can be domesticated. The indigenous fruits have high nutritional value and therefore a potential for being domesticated and commercialized. The high value indigenous fruits such as *Tamarindus indica, Adansonia digitata, Vitex payos, Sclerocarya birrea,* and *Berchemia discolor* can be a reliable supply of household income in the ASALs as an alternative sources of livelihood.

2.4. Dyes and Tannins

Dyes and tannins are natural products from trees and shrubs mainly in the drylands. They are essential in handicraft and other cottage industries providing vital alternative sources of income for the ASAL communities. Many of these communities use natural dyes and tannins to add value to their handicrafts, other household items and for beautification. Commercial dyes and tannins are used in leather industries, textiles and cosmetics and to a lesser extent in food industries [36]. Plantation grown *Acacia mearnsii* has been the main source of vegetable tannins. Kenya produces and exports 25,000 t/year of vegetable tannins from *Acacia mearnsii* and ranks second after South Africa. Small scale farmers in coastal region of Kenya have also been exporting about 1500 tonnes of Annato seeds and extracts of *Bixa orellana*. Exports of *Lawsonia inermis* (Henna) dye to Middle East has also been reported [37]. In spite of the potential of dyes and tannin in providing alternative sources of livelihood the dyes and tannins industry is not well developed.

2.4.1. Challenges in Dye and Tannin Development

The development of dye and tannin value chain experiences various challenges. For most of the dye and other tannin producing species, there is no clear data on the national market demand and the quantities traded. The products produced are also of low quality. Additionally, there is lack of product diversification.

2.4.2. Recommendations to Address Challenges

There is need to create awareness on the benefits and the need to conserve the dye and tannin species. Further resource mapping of key dye species in the ASAL counties should be undertaken to know their coverage. Conservation of the key dye species including establishment of conservation and demonstration plots is also necessary. There is also need to determine the national market demand and supply for dyes and tannins and develop marketing strategies. Further, there is need to improve on the extraction processes and identify other potential uses of dyes and tannin producing species.

2.4.3. Opportunities in Dye and Tannin Development

There is potential market for dyes and tannins in Kenyan leather industries, textiles, cosmetics and to a lesser extent in food industries.

2.5. Honey and Bee Products Value Chain

Bee keeping is an important economic activity in Kenya with arid and semi-arid lands (ASALs) contributing to 80% of honey being produced. The value chain has a variety of products including honey, bees wax, bee's venom and propolis among others. Kenya is among the top four producers of honey and bees wax in Africa [38]. The annual production of honey in Kenya stands at about 17million MT with an annual consumption of about 47 million MT an indication that the deficit is being imported [39]. Various initiatives have been undertaken by the Kenyan government and international agencies to enhance the bee keeping sector [38] including transition from tradition log hives to modern bee hives. The sector has also witnessed the emergence of private sector companies offering access to modern beekeeping equipment, contract farming to beekeepers as well as ensuring ready market for honey produced by the contracted farmers.

2.5.1. Challenges in Honey and Bee Products Value Chain

The challenges experienced in beekeeping include: low volume of honey production which is insufficient for niche markets; poorly developed domestic and international marketing system due to problems of quality production and inadequate marketing organizations; environmental/climate change resulting in low colonies and bee occupation of colonies; inadequate training of extension staff and farmers and thus lack of farmers' skills in managing bees and hive products; lack of appropriate research on bee keeping technologies, equipment, honey bee and product utilization; lack of pesticide residue monitoring and management in honey; and lack of access to and/or adoption of appropriate bee equipment [40].

2.5.2. Recommendations to Address the Challenges

The following were recommendations [38]: development of superior bee varieties through selection and breeding; improvement of honey bee rearing practices such as queen rearing; regular inspection to make apiculture in the Country appealing and profitable for farmers to invest in. Further recommendations by Ndirangu et al [38] includes: conducting awareness campaigns among stakeholders by the National and County Governments regarding bee keeping opportunities; making bee keeping an important part of curriculum in primary and secondary education; and establishment of monitoring and evaluation for the bee colony multiplication and bulking programme.

2.5.3. Opportunities in Honey and Bee Products Value Chain

There is great opportunity for bee keeping in Kenya's arid and semi-arid lands owing to the availability of bee forage and land. Due to the low production, there is opportunity for private sector investment to enhance production and market for honey and bee products.

3. Lessons Learnt

There are several challenges of the value chains that can be broadly classified as: Technological, resource availability, human resource capacity, high investment costs, competition from imported products, financial constraints, poor market linkages and inadequate policy and legal framework.

There are several opportunities for investment in the non-wood forest products value chains which include: development of bio-enterprises, plantation development in ASALs, existence of more efficient technologies, enhanced forest management practices, existence of forest certification standards, opportunities of capacity building, growing demand of non-wood forest products, enhanced trade due to devolved system of government, existence of the Forest Conservation and Management Act 2016, existence of local and international markets for the non-wood forest products among others.

4. General Recommendations

To enhance the value chains of NWFPs, the following actions are crucial:

1) Sustainability measures: Promoting agroforestry and domestication of high-demand NWFP species to reduce pressure on wild populations.
2) Capacity building: Promoting sustainable practices in the harvesting, processing, and commercialization of NWFPs through capacity building on sustainable harvesting, processing techniques, and business skills.
3) Value addition: Encouraging investment in NWFP processing industries.
4) Support the establishment of bio-enterprises and facilitate market linkages for NWFP products by establishing cooperatives and digital trading platforms to connect producers with buyers, ensuring fair pricing and improved market access.
5) Develop a comprehensive knowledge management system to collect, store, and share information on NWFPs.
6) Policy reforms: The inclusion of NTFPs in Kenya's forest policies and land-use planning to provide clear guidelines on sustainable harvesting and commercialization. The development of relevant policies and regulations to enhance value chains development is key.

Abbreviations

ASALs	Arid and Semi-arid Lands
CITES	Convention on International Trade in Endangered Species
GARA	Gum Arabic and Resins Association

GDP	Gross Domestic Product
GoK	Government of Kenya
KEFRI	Kenya Forestry Research Institute
KWS	Kenya Wildlife Services
NFPRP	National Forest Products Research Programme
NTFPs	Non Timber Forest Products
NWFPs	Non Wood Forest Products

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Conflicts of Interest

The authors declare no conflicts of interest.

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