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The Role of Indigenous Gums and Resins in Pastoralists' Livelihood Security and Climate Change Adaptation in Garba Tula Area of Northern Kenya

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Summary

The current study investigates the role of indigenous gums and resins in pastoralists' livelihood security and climate change adaptation in Garba Tula area of northern Kenya. The communities in the area are heavily dependent on natural resources which are influenced by prevailing climatic conditions. In recent years droughts have increased in frequency and magnitude, constraining the livestock sector which is the mainstay of the pastoral communities in Garba Tula. Due to dwindling income from the livestock sector as a result of drought, community members are exploring complementary and alternative livelihoods to survive. One of the activities that has taken precedence in filling the gap in Garba Tula is exploitation of the abundant gums and resins found in the area.

This study asks to what extent income from livestock is diversified or complemented by other livelihood strategies, in particular activities that act as climate change adaptation mechanisms. Garba Tula is predominantly occupied by pastoralists, and the investigation of gum and resin activities in the area is used as case study to understand the dynamics of livelihood diversification or complementation of livestock keeping activities in the face of climate change.

The study found that with increasing magnitude and frequency of droughts many pastoralists are taking up exploitation of gums and resins as a complementary livelihood strategy to livestock keeping. Income generated from gums and resins is mainly used for subsistence, with some portion ploughed back into supporting livestock keeping activities by buying salts, medication and livestock. Underdeveloped markets and value chains and lack of financial capital and technical skills are key constraints facing the sector. For the gums and resins sector to sustainably contribute to income of pastoral communities the study recommends market and value chain development; technical capacity building in gum and resin exploitation and business skills; financial support through grants from the government and links to private sector investors or microfinance organisations to provide start-up funds; and formation of collector groups to foster cooperation and coordination of the collection and sale of the gums and resins.

1. Introduction

Exploitation of gums and resins from trees is an old tradition in the Horn of Africa and northern Kenya. Communities use gums and resins for various domestic purposes and as an item of trade locally and cross-border. In northern Kenya, recurrent and prolonged drought is reducing livestock productivity and forcing pastoral communities to look for complementary and alternative livelihood strategies. Currently there are efforts to explore and enhance any activities that can supplement livestock keeping activities in pastoral communities. One of the proximate items or activities that can generate income for pastoral communities is exploitation of abundant

gum and resin producing trees, which thrive well under harsh climatic conditions and are almost certain to survive anticipated climate change. Some institutions are currently exploring the possibilities of up-scaling the exploitation of gums and resins, though this is not clearly earmarked as a climate change adaptation activity. The International Union for Conservation of Nature (IUCN), for example, is engaged in exploring market opportunities that enable community benefits from sustainably managed drylands where gums and resins are among the items of concern (Gibbons et al. 2013). The former Arid Lands Resource Management Program also established producer associations consisting of local producers, aimed at boosting production levels.

This paper explores the use of gums and resins among pastoral communities in northern Kenya as a complimentary livelihood strategy and climate change adaptation mechanism. Although gum and resin resources are available in northern Kenya, the extent to which the community members fully utilise these resources to derive maximum benefits is not well documented. Realising the full potential of gums and resins and enhancing their contribution to the livelihood of pastoral communities requires facilitation of the people involved in exploitation, value addition and marketing. Policies geared toward development of the gums and resins sector, and in particular elements that strengthen sustainable and equitable resource exploitation such as in-trust land/community land (i.e. land held in trust for community members previously by County Councils but currently by county government), warrant much investigation to ascertain what exists and what needs to be up-scaled. The existing value chain, actors and policy environment under which the gums and resins sector operates in northern Kenya is not well understood.

In particular, this paper addresses the question of sustainable exploitation of gums and resins in the changing environment, with special emphasis on climate change and exploration of complimentary livelihoods based on bio-enterprises in pastoral communities. To date there has been little analysis of ways of enhancing socio-economic and environmental benefits of gum and resin exploitation activities, nor of the policy or attitude changes required to achieve sustainable gum and resin exploitation. The current study uses Garba Tula area in northern Kenya, an area predominantly occupied by pastoral communities, as a case study to provide insight into the effectiveness and dynamics of exploitation of gums and resins as an alternative and complimentary income generating activity to livestock keeping. The study puts a focus on the effect of exacerbated climatic conditions as a driver of community efforts to explore ways of generating additional income to livestock keeping, and to what extent the shift or extra activities are serving as an adaptation mechanism to climate change. With increasing incidence of drought, the pastoral communities in Garba Tula are quickly up-scaling their involvement in gum and resin exploitation as a complimentary livelihood strategy to livestock keeping. The bulk of the revenue generated from gum and resin

exploitation is used to purchase food, but a considerable amount is diverted to strengthening livestock keeping activities through purchase of salts, medication and even additional livestock. Although drought poses challenges to pastoral communities in terms of rearing livestock, any gains from other income generating activities are swiftly directed to livestock keeping, a clear indication of community attachment to livestock keeping as the most favoured livelihood strategy.

The study's methodology involved a combination of desk review and fieldwork techniques. First, existing government policies were reviewed, particularly those directed towards enhancement of the bio-enterprise sector with bias toward gums and resins, as well as those that might be undermining the development of the sector. Fieldwork results form a basis for critical analysis of the potential or challenges that exist in exploitation of gums and resins as a complimentary or alternative income generating activity and as an adaptation mechanism to climate change. What structures and infrastructures exist at the grassroots level with regards to exploitation, sale and value addition greatly informed the study on difficulties or factors that hinder the sector. Finally the paper, based on these findings, gives some recommendations of ways of enhancing the gums and resins sector in northern Kenya to serve as a sustainable livelihood strategy and meaningfully contribute to climate change adaptation activities.

The next section gives a background on the use of gums and resins in Kenya. Section 3 explains the methodology for the case study. Section 4 presents findings on income and livelihood characteristics, followed by a discussion in section 5. Section 6 concludes and offers some key policy recommendations.

2. The use of gums and resins in Kenya

2.1. Background

Pastoralism is the main livelihood strategy in the Horn of Arica, especially in areas classified as arid and semi-arid lands (ASAL). In Kenya, it is the way of life of some 13.2 percent of the country's estimated 39m people (KNBS 2009). Pastoralism is practiced mainly in ASAL where 50 percent of livestock production is domiciled. Livestock production contributes substantially to the Kenyan Gross Domestic Product. The contribution of the ruminant livestock to GDP stood at Kshs 319bn in 2011 (Behnke and Muthama 2011). Pastoral areas record some of the highest incidences of poverty in Kenya. Pastoral populations in Kenya have the least access to basic services like education, nutrition, health and credit facilities (KNBS 2005). The worst conditions are found in the northern pastoral counties, comprising Garissa, Wajir, Mandera, Marsabit, Isiolo, Samburu and Turkana. Figures from 2007 showed that the share of the population falling below the poverty line was 95 percent in Turkana, 92 percent in Marsabit, 89 percent in Mandera

and 84 percent in Wajir. This contrasts with the national average of 53 percent (KNBS 2007).

Northern Kenya is endowed with a variety of gum and resin yielding trees. This resource is exploited for both commercial and domestic purposes. Commercial production of gums and resins in Kenya is mainly confined to the arid counties of Isiolo, Marsabit, Mandera, Wajir, Garissa and Samburu. Vegetation in these areas is dominated mostly by *Acacia* and *Commiphora* species, classified as *Acacia-Commiphora* woodlands (Beentje 1994). Gums are mainly produced by *Acacia* species while gum resins are extracted from *Commiphora*. The most common gum found in the area is gum arabic, extracted from *Acacia senegal* (L.) Willd. var. *kerensis* or *Acacia seyal* Del. var. *seyal*. Gum resins include myrrh from *Commiphora myrrha* (Nees) Engl., *opoponax* or *hagar* from *Commiphora holtziana* Engl. and frankincense from *Boswellia neglecta* S. Moore.

Commiphora, *Acacia* and *Boswellia* species and many other trees and shrubs in the arid and semi-arid area hold known or potential promise as producers of economically valuable products. For instance, myrrh from *Commiphora myrrha* is an important product used in pharmaceutical industries, cosmetics and perfumery as well as in traditional medicines (Massoud et al. 2001). Non-wood forest products are also used as a buffer by dryland inhabitants during harsh climatic conditions (Dube and Pickup 2001).

Dependence on non-wood forest products as an income source is well defined in many areas of the world. Some studies have reported contribution of non-wood forest products at more than 54 percent of household income, surpassing even agricultural activity (Neima 2008) and also serving as a complimentary function to other livelihood activities (Berhanu 2004; Shackleton and Shackleton 2004). Additionally, non-wood forest products have been found to be an important element in filling seasonal income gaps, acting as a buffer in times of hardship and an activity of last resort (Ruiz-Pérez and Arnold 1995; Dube and Pickup 2001).

In pastoral areas, alternative and complimentary livelihood activities being pursued also include trading in manufactured goods for those who open shops and kiosks in trading centres, which are coming up due to mushrooming of settlements. Livelihood diversification around non-livestock activities brings its own challenges. Exploitation of other forms of natural resources for commercial and trading purposes is still at a nascent stage, partly due to a lack of information on the income generating potential and location of those goods and services in remote areas where movement to trading centres is hampered by a poor road network. Furthermore, locals are unable to buy vehicles. Information on market price and demand trends of natural products is non-existent.

The traders who organise themselves in cartel-type operations have some access to market information, though they are not well informed due to their localised

operations. The exporters of natural products (gums and resins) who are at the end of the value chain at the national level are more informed on price and demand due to their linkages with buyers on the international market. The current market operation benefits few individuals, primarily the traders who buy the products at low prices and sell them to the next traders in the value chain. The collectors, tasked with the bulk of the work in terms of locating and collecting the products, get prices which are far below the market price. There is little government involvement in terms of developing the sector through capacity building of the collectors so that they are informed about the price and market trends to guide them in appropriately marketing their products. The Government of Kenya takes an active role in developing and empowering farmers involved in crop production by putting in place mechanisms that enable them get the best market price, but it neglects bio-enterprises in northern Kenya, providing neither material nor policy support.

2.2. Policy context

There is almost no support from the government side in advising the collectors on methods of sustainable harvesting or boosting production of gums and resins in northern Kenya. Communities still use traditional systems of harvesting with basic tools and improper collection vessels. Gums and resins require proper storage facilities to maintain quality and quantity of the product. Most of the gums and resins contain an oil/fluid component which dries up if not subjected to proper storage conditions. In northern Kenya most collectors store their collections in gunny bags, resulting in loss of quality and quantity of the harvested gums and resins. Collectors lack appropriate collection equipment and storage materials. Appropriate sacks like polypropylene are not available to collectors so they are forced to store the fresh produce in a variety of often unclean paper and plastic bags. Handling the products with poor hygiene interferes with the quality and jeopardises smooth entry into lucrative international markets. Communities also don't have access to warehouse facilities or central storage areas which can facilitate proper storage and transportation to market destinations.

Collection of gums and resins involves walking long distances, sometimes traversing transitional border areas occupied by different tribal groups. This is mainly due to scarcity of the gums and resins in areas occupied by collectors as a result of exploitation or areas being unfavourable for the growth of gum and resin yielding trees. In most cases these transitional areas are occupied by communities who are involved in cattle raiding and inter-tribal skirmishes. For instance, transitional areas where Borana and Samburu tribal groups live have plenty of gums and resins, but due to tribal feuds there is currently no collection of gums or resins in those areas. Collection of the gums and resins in these localities is hampered by insecurity, and in most cases the government takes little action to solve conflict in these areas, so they act as a disincentive to development

of the gums and resins sector in the region. Insecurity has been cited as one of the major factors undermining development in northern Kenya and is anticipated to slow down the positive impacts that are expected to accrue as a result of the devolved county government. The former Minister of State for Development of Northern Kenya and Other Arid Lands Mohamed Elmi has indicated that 13 pastoral counties may lag behind in reaping benefits of the devolved government as compared to more secure zones because of insecurity prevalent in the areas (The Star 2011).

The Forest Policy (2005), the most recent policy in Kenya on forest resources, aims to enhance the contribution of the forest sector in the provision of economic, social and environmental goods and services. Among the specific objectives of the policy is to promote dryland forestry to produce wood fuel and supply wood and non-wood forest products. The policy mentions the potential of the dryland forest to supply marketable commodities on a sustainable basis such as gums and resins, aloe, commercial juices etc., but apart from mentioning gums and resins in the policy document there is no effort in place to effectively and sustainably develop the sector so that it can yield substantial income to support communities in the ASAL.

Following their ascent to power the recent governments (National Rainbow Coalition 2002–2007, Coalition government 2008–2013) had shown some willingness to develop northeast Kenya, an area predominantly occupied by pastoral communities. The latest initiative was the creation of the Ministry of State for Development of Northern Kenya and Other Arid Lands to develop previously marginalized areas and redress some of the historical imbalance seen in the country, where resources in the past were predominantly directed to the 'high potential' agricultural areas. Although this ministry was set up to facilitate development, the amount of resources allocated to the ministry in national budgets was wanting, and with the advent of the new constitution wherein the government aimed to streamline and reduce the number of ministries, the ministry was disbanded. The current constitution stipulates a county system of government in which resources are expected to be distributed to counties to facilitate development. Expectations are high among previously disadvantaged communities in terms of accessing devolved funds to initiate development activities which were not forthcoming under the previous system of resource allocation to different regions and sectors. The extent to which the devolved structure is going to support the gums and resins sector is yet to be seen in various counties endowed with the resources.

The government had also formulated Vision 2030, a policy document that targets to achieve middle-income status by 2030 through implementing activities that will enable an average annual economic growth rate of 10 percent. The Vision highlights what needs to be done to improve development in the pastoral areas, including marketing of livestock and alternative livelihood options like gums and resins, although there isn't much by way of practice towards achieving this intent. While the

Vision mentions drylands, forest resources in these areas have been undervalued or ignored by decision-makers because of the difficulty in valuation, and they are often situated outside formal markets and pricing mechanisms (Republic of Kenya 2003).

The government had also formulated an ASAL Policy (Republic of Kenya 2012) that aim at fostering sustainable development of northern Kenya and other arid lands. In the policy, the government takes cognisance of the importance of livelihood diversification as a strategy to reduce vulnerability to hazards in northern Kenya. The policy recognises that ASALs are rich in natural resources and highlights that there is growing interest in the production and marketing of natural products such as gums, resins and medicinal plants. The government's plan in this regard is support of livelihood diversification strategies which add value within the livestock sector and complement livestock production, as well as facilitation of production and marketing of dryland products. The policy, if properly implemented, is a step in the right direction and can act as a tool to develop the gums and resins sector in northern Kenya.

3. Methods and study areas

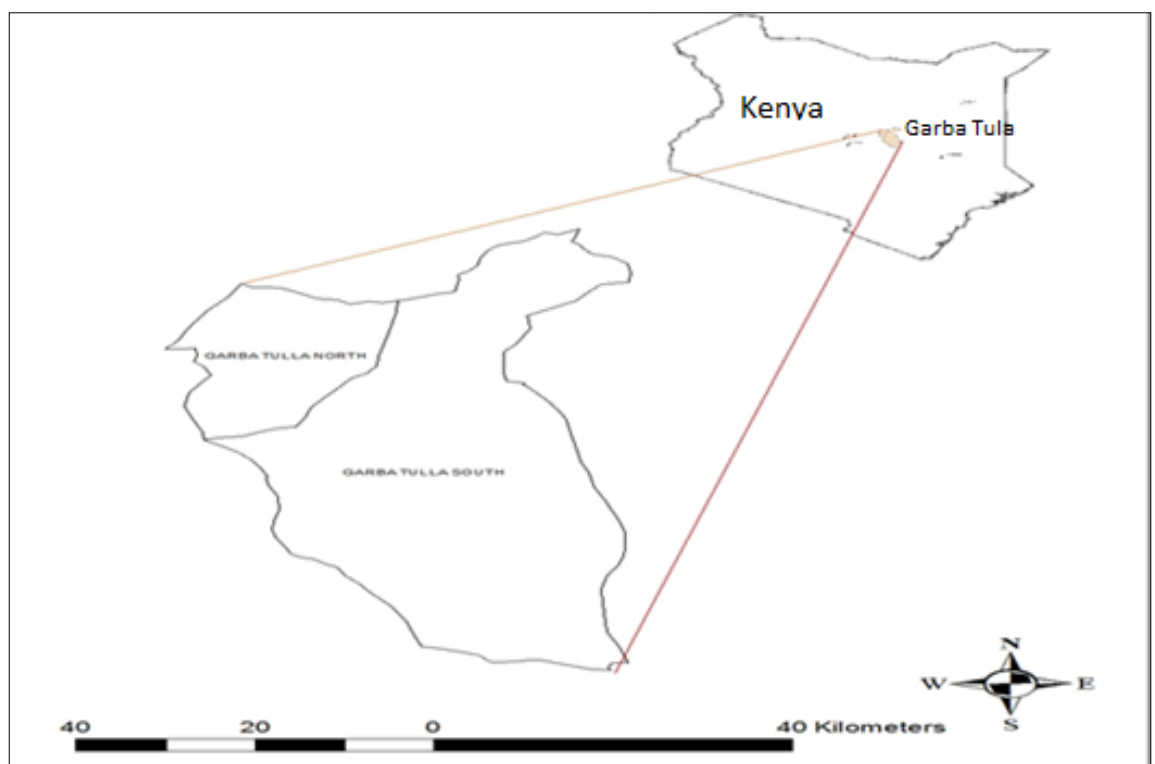
The study was conducted in four villages in Garba Tula district of northern Kenya, namely Barambate, Belgesh, Biliqo and Malka daka. Like most areas in northern Kenya, Garba Tula has high levels of distribution, collection and marketing of gums and resins and the area has potential for yield increment (Wekesa et al. 2009). Moreover, the study area is currently at the centre of attention due to extraction of opoponax (*hagar* in Somali) for export (Hilary Sommerlatte pers. comm. 2011). Garba Tula

is a predominantly pastoral area with few available alternative income generating activities.

The study area is dominated by flat, low-lying plains, rising from the Lorian Swamp in the north to the Daaba and Merti Plateaus further south and the volcanic hills of Laikipia district in the west. It is hot and dry most of the year. It has two rainfall seasons: the short rains, coming in October and November, and the long rains which fall between March and May. The rainfall pattern in the area is erratic with an average annual amount of 580.2mm, typical of arid lands in northern Kenya. The wettest months are November during the short rains with an average of 143mm, and April during the long rains with an average of 149mm.

Across the study sites the communities are predominantly pastoral, with a few involved in cultivation activities, mainly in Biliqo due to its proximity to the Ewaso Nyiro River. Small trading centres are common in all of the study sites, with a presence of traders/agents involved in buying and selling gums and resins. Four villages were purposely selected for data collection. The four villages were identified based on the level of engagement of the local communities in harvesting and sale of gums and resins. These are areas where there are abundant gum and resin resources, and like all other areas in northern Kenya, they experience recurrent drought. Key informants, mainly gum and resin traders, were instrumental in identifying the target sites. Economic importance and potential of the gums and resins in boosting income level is poorly understood among the community members, except in Belgesh. The level of awareness is high in Belgesh due to experience gained by community members during their stay in Somalia. Most

Figure 1. Location of study area (Garba Tula district)



of the populace in Belgesh are returnees who migrated during the Shifta War to Somalia but returned after the outbreak of the Somali Civil War in the 1990s. During their stay in Somalia they were exposed to gum and resin exploitation and harvesting, which they actively pursued after their return.

The study applied different data collection techniques to gather a wide range of information during the fieldwork. Household surveys, focus group discussions, trader surveys and community-based organisation (CBO) and non-governmental organisation (NGO) surveys were the main techniques applied. In each village households were randomly selected and one-on-one interviews were conducted using both structured and open-ended questions. A total of 100 questionnaires were completed across four study sites, i.e. Barambate, Belgesh, Biliqo and Malka daka villages. Four focus group discussions, five trader interviews and two CBO interviews were also conducted across the study sites. The study used mixed methods for triangulation purposes. Detailed information on methods of data collection and themes covered is provided in Annex 1.

Questions touching on policy formulation and development by the government in the gum and resin sector were posed to respondents in all the groups. Elements of concern around the policy issue include the level of government involvement in the gums and resins sector in terms of providing technical and financial support; consultation of the stakeholders on ways of developing the sector, mainly on infrastructural development, markets and value addition; and the government plan of putting in place a gums and resins policy or development strategy.

Collected data were analysed using both quantitative and qualitative data analysis techniques. Income from the gums and resins and livestock sectors were analysed using graphs and percentages to gauge the level of community engagement in gum and resin collection and amounts they derive from collection and trade in gums and resins. Pearson correlation analysis was used to analyse the relationship between the amount of income derived from gums and resins and the number of livestock

possessed by a particular household. Correlation analysis gives an indication of the extent to which poor and wealthy households depend on collecting and trading in gums and resins as an alternative or complimentary livelihood activity.

4. Findings

4.1. Income and livelihood characteristics

Communities in Garba Tula area are predominantly pastoralists, relying on livestock as a major source of income and livelihood strategy. The level of dependence on livestock varies from household to household based on the size of herd kept. The bulk of the households derive both financial and domestic gain from their livestock keeping activities. Community members are also involved in collection and sale of gums, resins and charcoal; selling of poles and mats; collection of precious stones; and to a lesser extent trading in food materials and other commodities, mostly by shopkeepers.

The survey established that 52 percent of the households interviewed derive financial benefits from the sale of livestock. The average monthly income from livestock stands at Kshs 4,730, with some earning as little as 700 and others as much as 20,000. Gum and resin collection and sale is another major income generating activity in the area. The practice is widespread in all the target villages with 59 percent of the households engaged in the collection and selling of gums and resins. There are other livelihood strategies pursued by community members, and in most cases a household is involved in multiple activities.

Livelihoods are changing in the study area. Alongside livestock keeping, people are increasing their involvement in a variety of non-livestock activities such as crop cultivation, exploiting precious stones, seeking employment in towns or starting small businesses. Collecting gums and resins is practiced by 59 percent of respondents in the survey, consisting of mainly poor

Table 1: Livelihood strategies pursued by households in study area

Livelihood activities	Percentage practising
Livestock sale	52
Dairy products	1
Poles	4
Gums and resins	59
Hide and skin	13
Vegetables	1
Sale of poultry products	1
Mat making	1
Shopkeeping	1
Charcoal burning	8

households. Many of these have no or few livestock and are involved in the collection and sale of gums and resins as a source of alternative or complimentary income to livestock keeping activities. Others are herders who spare time to collect as they graze their animals, or opportunists cashing in on emerging opportunities in addition to their normal livelihood activities. The survey indicates that 37 percent of the respondents depend on gums and resins as a primary income generating activity, while 31 percent use it as a complementary activity. Respondents also indicate that the importance of gums and resins as an income generating activity has gained impetus in recent years due to drought in the area. Survey data indicates that 68 percent of the respondent have been engaged in gum and resin collection and selling activities for a period of less than five years.

During the course of the survey, community members listed varied constraints they are facing in shifting from pastoralism to alternative livelihood strategies. The main constraints highlighted by respondents were:

- Lack of financial capital: about 51 percent of the respondents attributed lack of financial means as a major constraint in changing their livelihood. Many claimed to have entrepreneurial skills for starting their own business but stated that lack of capital is the major bottleneck. In the case of gum and resin collection, a lack of financial capital to buy subsistence required during gum and resin collection is a major factor. Inadequate finance limits the efforts of collectors and results in inefficient collection. Respondents indicated that they require food, water and other subsistence, especially when they travel far distances and in cases where they spend a protracted period of days staying in the field.
- Lack of knowledge: 40 percent of the respondents are not knowledgeable on alternative livelihood strategies and stated that the only livelihood they are used to is pastoralism.
- Lack of water and rainfall: scarcity of water is a major challenge for community members who had intentions of shifting to crop production. The only area where crops are a viable option is along the riverbanks, but here the water level is also declining due to a ravaging drought that had lasted more than three years, according to many respondents.
- Currently there is no restriction in place on the amount of harvesting done by an individual or group of people. The involvement of government, civil society or NGOs in sensitising the community on a sustainable harvesting regime is currently non-existent. Additionally, there are no current initiatives that educate and sensitize the community on the benefits and market potential that exists

for gums and resins within the country and beyond Kenya's borders.

Due to these constraints, the number of people who have managed to shift to another lifestyle entirely is negligible. The study found that only one percent of the households who abandoned livestock keeping managed to shift to crop production and exclusive exploitation of gums and resins. They partly attributed their shift to total loss of livestock and assistance from NGOs in the area that provided them with support to start crop production. They stated that NGOs provided them with water pumps to irrigate their crops, but currently they are facing resource constraints in buying fuel.

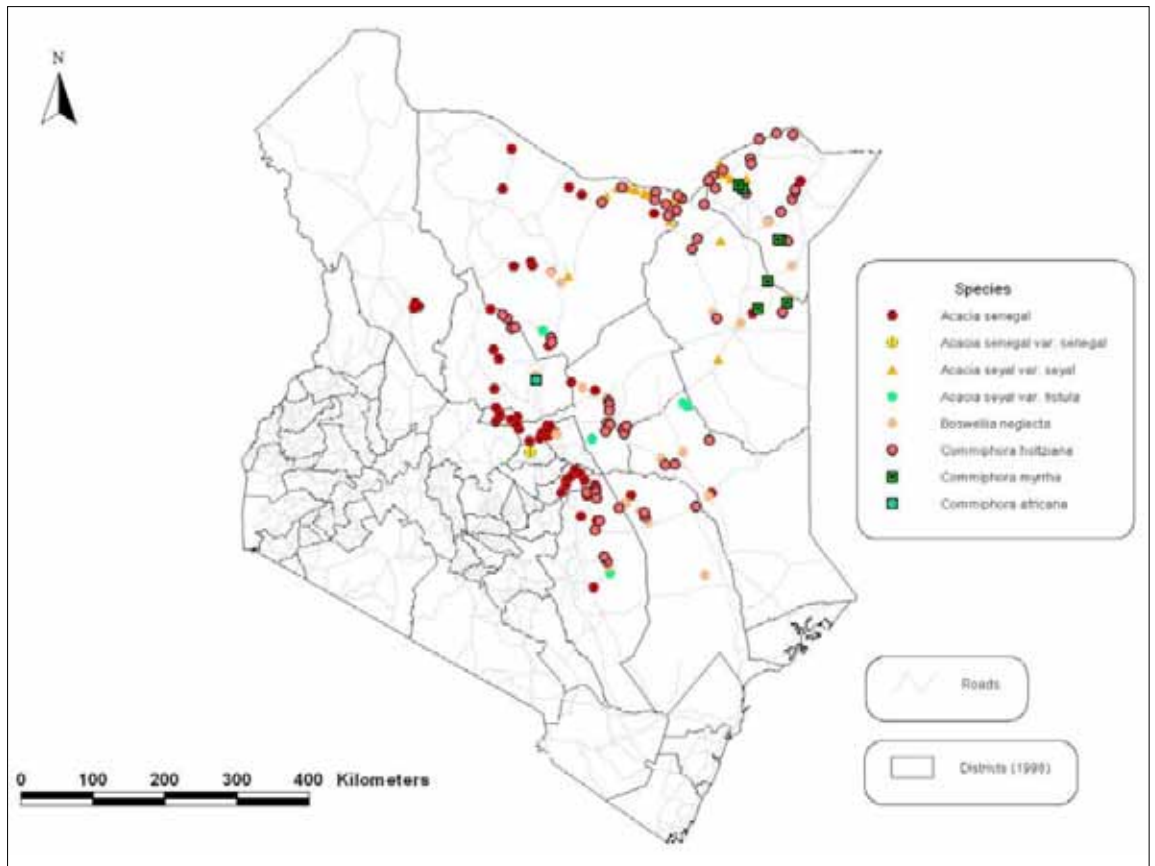
4.2. Gum and resin resource availability

In Garba Tula, the most abundant and commercially preferred gum resin is opoanax, locally referred to as *hur* in the Borana language and *hagar* in Somali. Frankincense and gum arabic are also items of trade, though not as popular currently due to low market price.

Gum and resin yielding trees are abundant around the homestead and in almost all grazing areas where the herders normally take their livestock. Collection of the gums and resins is done in areas around the homestead, though some collectors travel as far as 80km in search of gums and resins. People travel long distances in search of gums and resins due to decreases in the amount found in some locales. Collection of the gums and resins is taxing, according to most respondents. Community members also organise themselves in groups to carry out gum and resin collections. In the majority of households collection is done by the husband (65 percent), though wives (in 34 percent of households) and young boys (in 22 percent) are also involved.

The quantity of gums and resins harvested per month in households varies considerably based on the level of income from livestock and availability of gum and resin yielding trees. Average amount of collection in the households surveyed was 38kg, but the values varied significantly among households and villages. The value ranges from as small as 3kg and can even reach 100kg per month. The amount of opoanax produced by individual trees also varied, ranging from 40g to 2kg. The yield was dependent on the season, the age of the tree and whether or not the tree is damaged by making a cut on the stem/branches. The survey indicates that old trees produced more than young trees; that the dry season is the period of highest production; and that making cuts or damage to the trees resulted in more production of opoanax. About 58 percent of the respondents follow the practice of making cuts on the stems and branches to increase yield. After wounding the tree, sap oozes out and is ready for collection after two days, or sometimes even weeks, according to respondents. The time spent in collecting 1kg of opoanax can vary from 15 minutes up to 20 hours depending on the availability of the gums and resins, distance travelled and the number of collectors

Figure 2. Distribution of gum and resin resources in Kenya (Gachathi and Eriksen 2011)



involved. Other varieties of gum and resin tree species take longer from the time of wounding to the time of collection. For example, in Nigeria gum arabic takes three to four weeks (Sagay and Mesilke 2011) and subsequent collection is done bi-weekly or weekly.

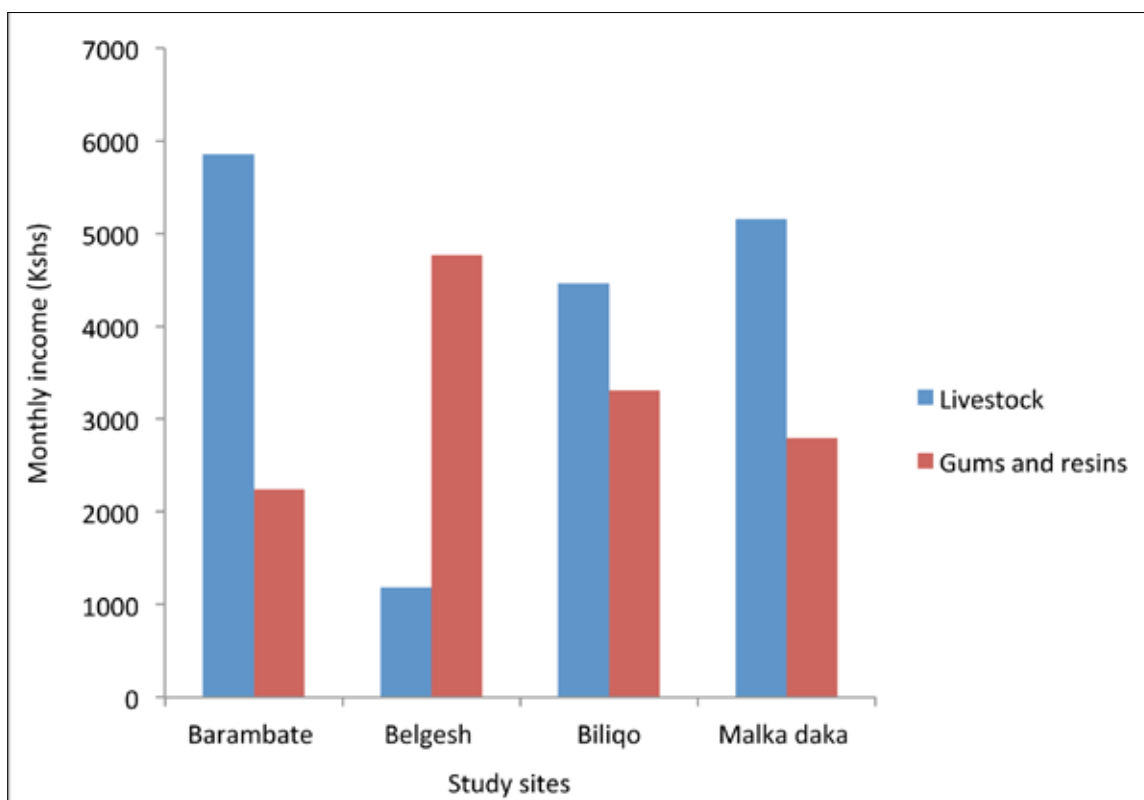
Collectors of opoponax observed that the amount of resin produced by trees has decreased. The decrease was reported by 55 percent of opoponax collectors. They attributed the decrease to recurrent drought, especially in the last three years (2008–2011), which they say has made the trees less productive. Respondents stated that the production of gums and resins is dependent on the cycle of rainy and dry seasons. In instances where there is abundant rain during the rainy season followed by a dry spell the trees produce a good yield, but if the cycle is interfered with, like in recent years of prolonged drought, the yield declines considerably. The increase in the number of collectors during this period has also resulted in competition for available gums and resins. Collectors indicate that people are venturing into gum and resin collection to gain supplementary income due to dwindling income from the livestock sector.

The respondents observed that the trees are becoming less healthy and decreasing in number. Drought (59 percent), livestock damage (10 percent) and human destruction (7 percent) were the major factors blamed for decline in the number and unhealthy conditions of gum and resin yielding trees in the area. Collectors are of the opinion that collection of the gums and resins does not affect the tree growth and survival. Some experienced collectors indicate that some harvesting practices affect the tree growth, especially making deep cuts on the tree's trunks and branches which allows for insect damage and ultimately death of the tree. The majority of the collectors stated that they take necessary precautions to avoid damage to trees. One of the measures they practice is to make slight cuts on the branches and trunks to avoid damage to sapwood in order not to disrupt the flow of water and nutrients that is essential for tree survival. Although community members are cautious not to damage trees during gum and resin exploitation, collectors are not knowledgeable on ways and practices of boosting the yield from trees. There is a prevalent shortage of trained researchers who can educate the community members on appropriate techniques of tapping gums and resins. Although

Table 2: Proportion of households involved in collection of different types of gums and resins

Gum and resin type	Percentage of households involved
Opoponax	69
Frankincense	37
Gum arabic	5

Figure 3. Monthly incomes from livestock and gums and resins



community members have a culture of collecting gums and resins, they have not yet adopted modern tapping practices. The community members are also aware of the environmental changes that are taking place in the area. They are of the opinion that trees are generally becoming scarcer, pastures are less abundant with seeds disappearing, temperature has increased and rainfall is rare without a particular pattern as before.

Respondents also indicated livestock damage as one of the factors that result in yield reduction. Opoponax yielding trees are damaged by camels mostly owned by Somali communities who frequently migrate into the Garba Tula area from Wajir, Mandera and Garissa. Camels browse on the trees, resulting in drying and ultimately death, thereby reducing the number of trees and production levels.

Planting of gum and resin trees is not currently practised in the area, and domestication is not an option the community members are currently considering. The majority of respondents still consider that there is substantial cover of the gum and resin yielding trees in the locality and in their own opinion there is no need to domesticate them. Other reasons given by respondents as to why the community has not taken up planting of gum and resin trees include lack of knowledge on methods of propagation; lack of financial capital; scarcity of water; and tendency of opoponax producing trees to grow less well in the homestead, as they prefer rocky and rough terrain.

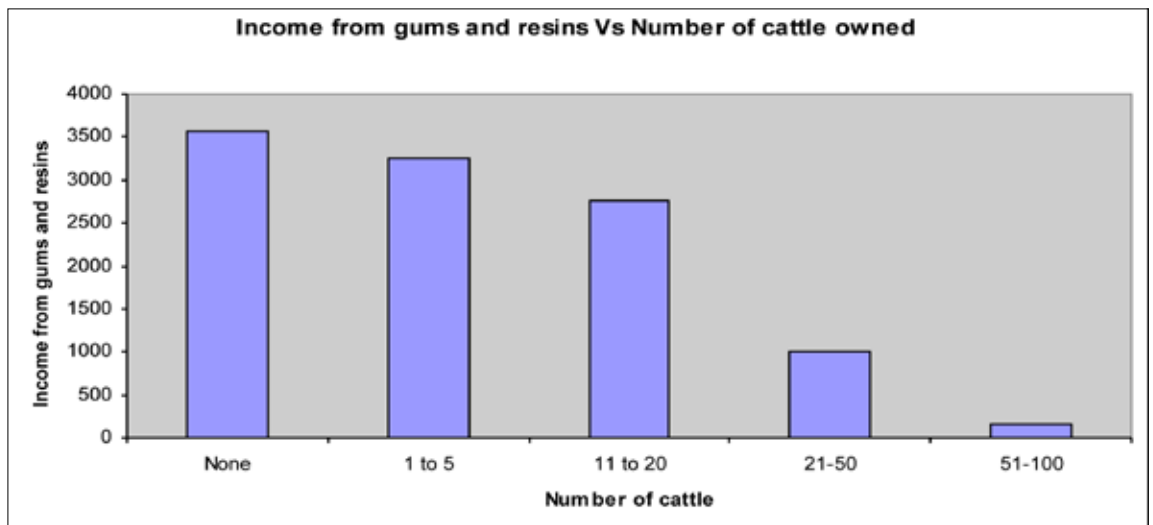
4.3. Income from gums and resins

The collection and selling of gums and resins in the Garba Tula area is widespread, and currently people of diverse social standing are embracing the practice. Average monthly income from gums and resins across the villages is estimated at Kshs 4,200, but this varied from village to village and household to household. Income from gums and resins for interviewed households ranged from Kshs 300 to 12,000. In some villages the dependence on earnings from gums and resins was equal to or higher than that from livestock. For example, in Belgesh the amount of income from opoponax was higher than income from livestock. Figure 3 indicates the amounts of monthly income derived from livestock and gums and resins (opoponax).

The collectors incur some operational costs, both in cash and kind, during gum and resin collection. An average of Ksh 990 is spent per month. The money is mainly used for buying subsistence like food, water, cigarettes, tobacco and khat (*miraa*). In some cases where the household doesn't have the tapping and collection equipment some initial costs are incurred. The operational costs that fall under in-kind are mainly the time spent in collecting gums and resins.

The dependence of households on gums and resins as an income generating activity is partly influenced by the number of livestock owned. The number of livestock

Figure 4. Income derived from gums and resins based on the number of cattle owned



owned and the amount of income the household gets from gums and resins was negatively correlated. Households with more than 50 head of cattle are 24 times less likely to collect gums and resins as compared to households with no livestock.

Collection and selling of gums and resins is currently considered the work of people who are less endowed with livestock wealth and rely on a commodity that is despised among well-to-do members of society due to the smell and staining of clothes and hands associated with the collection of gums and resins.

Knowledge on the importance of gums and resins as an income generating activity was also found to be a major determinant factor in gum and resin exploitation. This is evident in Belgesh village, for example, where the majority of the community members are returnees from Somalia who came back to Kenya after the start of the Somali Civil War in the 1990s. They learnt the art of collecting and selling gums and resins during their stay in Somalia and quickly tap into the existing markets in their locality after they resettled in northern Kenya.

Income generated from the sale of gums and resins is used for various purposes among people of different income brackets. The majority of households (70 percent), mostly the poor, use the income from gums and resins for buying sustenance – that is, food and other household items. Frequency of selling the collected gums and resins to buy sustenance depends on the need of the household. Some households sell all the gums and resins they collect on a single day to buy food the same day, but those who have options prefer to accumulate gums and resins and sell in bulk, which fetches a better price. A considerable number of households (24 percent) also indicated that the income they derive from gums and resins is used for paying school fees for their children.

Income from gums and resins also supports livestock keeping activities. About 22 percent of the respondents said that the money they get from the gums and resins is used to buy livestock. This was mainly small stock, but some, after accumulating the money over a longer period, had even used it to buy cattle. Apart from the restocking, money from gums and resins supports livestock wellbeing. A number of households (6 percent) use the money from gums and resins to buy salt for their livestock, and in some household money is also used to buy veterinary drugs.

Households mostly (73 percent) depend on income from gums and resins during the dry season when income from their livestock is diminished. Hence income from gums and resins serves as both a safety net and a complementary income source for both wealthy and poor pastoralists in Garba Tula area.

Apart from the financial gains, gums and resins play an important social role among the pastoralists in Garba Tula area. Gums and resins are used for various domestic purposes. Opoponax, the most abundant in the area, is mainly used for:

- Acaricide against ticks
- Treating snake and scorpion bites
- Treating foot rot and mange
- Treating chest congestion, common cold, amoeba and lymph node swelling in humans
- Appetiser

The main domestic uses of frankincense are as incense in homes and during religious ceremonies. It is also used as chewing gum. Gum arabic is eaten by community members during periods of drought.

Table 3: Main uses of income derived from gums and resins

Uses of income from gums and resins	% of people involved
Subsistence	70
School fees	24
Restocking	22
Support livestock keeping activities (drugs, salt)	6

4.4. Value chain and market structure

Currently the trade in gums and resins in Garba Tula area and northern Kenya in general is not well developed and there is no established market in place. Buying and selling is done at many levels ranging from the collection point up to trading centres in small and major towns, with Garba Tula being the major trading centre where the majority of the traders who buy the gums and resins in bulk are located. It takes a long time to market gums and resins and collectors lack sound market information to guide them on opportunities, trends and price mechanisms. The price of the gums and resins increases as the commodity heads to the end of the value chain. The number of traders buying gums and resin are few, mostly based in trading centres or enlisting agents who buy at collection points or small centres and in return sell to them. However, there is an emerging trend where traders are going around and buying gums and resins from the small towns where they have stationed their agents and also buying directly from collectors. This group of traders are those whose exclusive business is gums and resins, and they operate as cartels. They are the ones who do

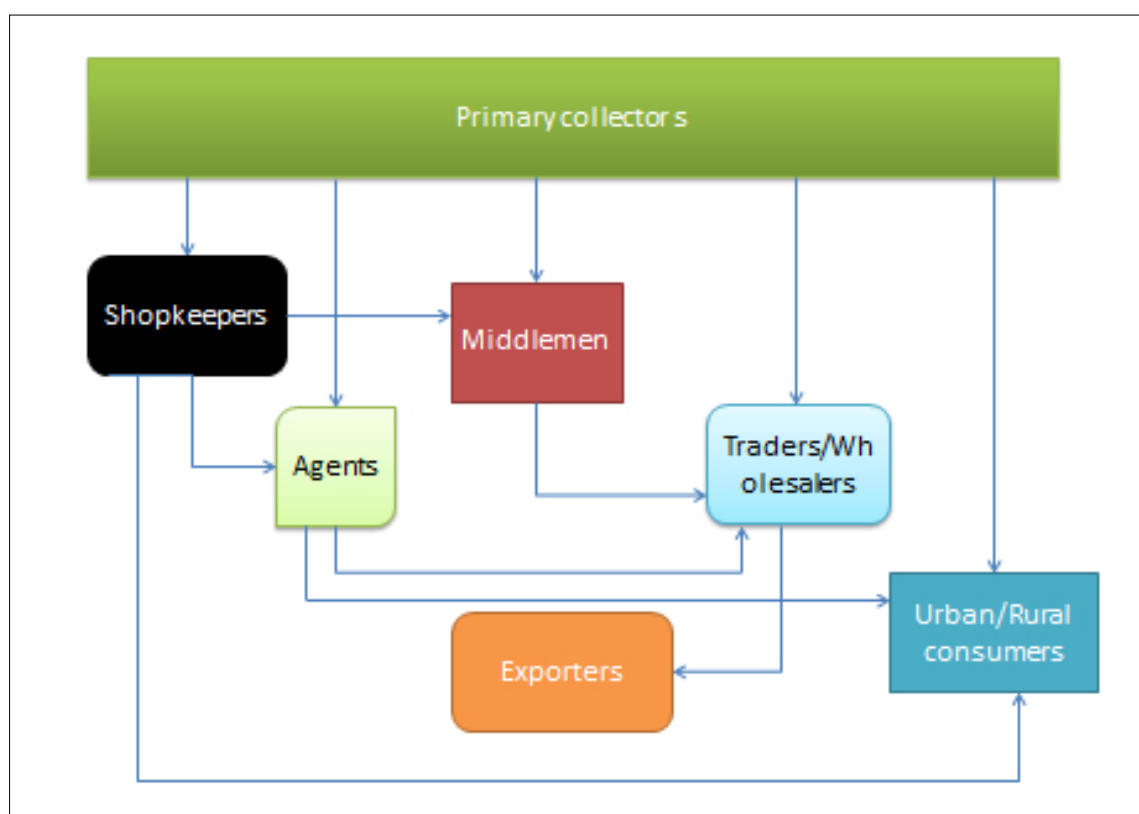
most of the buying and sell their consignment in bulk to exporters who are mainly based in Nairobi or Mombasa.

Collectors are paid Kshs 60-100 per kg for opoanax by both agents and traders. Agents mostly sell at Kshs 100-120 to the traders, while traders who transport the gums and resins to Nairobi or Mombasa get Kshs 180-250 from exporters. The bulk of opoanax is currently exported to the Chinese market and exporters get Kshs 300-450 per kg.

According to collectors, in recent years the price of opoanax has improved. In the span of 10-15 years the price had increased from Kshs 30 to 100 per kg, but it has stagnated at Kshs 100. The rise in price is attributed to rising demand for opoanax from the end market, mainly in China. Some collectors also attribute the increase in price to the new entry of traders into the gums and resins market, which has increased competition among the traders and caused a rise in price.

The amount of the gums and resins brought by collectors to the trading centres per each sale vary in quantity from 0.5kg to 20kg. According to some traders, the quantity brought to the market dictates the price at

Figure 5. Value chain map of key actors involved in gums and resins trade



which they buy gums and resins. They pay a higher price if the quantity is large compared to smaller quantities, the argument being that if they get the commodity in bulk they can quickly transport it to Nairobi for sale, resulting in higher stock turnover and more profit than collecting the gums and resins for a long period of time for less frequent sale. In the study area the survey established that there are currently no gum and resin collecting and selling associations in place. This results in uncoordinated practices which limit the full realisation of the benefits that can be derived from the gums and resins sector in the area.

The amount of gums and resins bought and sold by traders differs. The cartels take the lion's share of the market due to networks of agents they have at different localities and their good information on the prevailing demand and market prices in Nairobi where the bulk of the gums and resins are taken by the cartels. According to buyers who are stationed at major market centres, the majority of the sellers of gums and resins are male and mostly middle aged (21-45 years), although currently there is a significant increase in the number of women and teenage boys involved. The majority (90 percent) of the traders buy gums and resins the way the collectors bring them, without assigning grades, and subsequently sell the same products to other traders, mostly those who go around buying the stocks. Traders who sell the gums and resins to the exporters do grading before they sell to them and get different prices for different grades presented. Currently there are no value addition practices in place anywhere from the collection point up to the export stage, where the gums and resins are shipped overseas or sold to industries in Kenya which use gums and resins for industrial purposes.

There are a number of challenges faced by the traders involved in gums and resins in Garba Tula area. The primary ones are:

- There is no established market where gums and resins are sold. The cartels operating in the area are taking advantage of this loophole and exploit other traders.
- The supply of the gums and resins does not meet the current demand. Gum and resin tree species grow in remote areas with rugged topography where there is a lack of access roads and other infrastructural facilities. Reaching those areas takes a lot of effort and time. Transporting the collected gums and resins to the market is extremely difficult, especially when a large quantity is collected – bearing in mind that the common means of transport is human (i.e. the collectors themselves). Due to lack of transport, collectors cannot reach areas located far from their abodes where there are abundant gum and resin resources. One trader stated that with good organisational structure the supply can be boosted.

- Lack of operational capital to invest in the gums and resins trade.
- Lack of storage facility, which in most cases results in gums and resins losing weight because the traders cannot get the supply in bulk and are forced to keep the portions they get while waiting for further supply.
- For traders who transport the consignment to Nairobi additional challenges exist:
 - Kenya Forest Service personnel ask for certificate of origin during transportation, and if traders don't have this they request bribes from traders. The officers do not issue certificates of origin if these are requested prior to transportation of gums and resins.
 - Police officers are not aware of the gums and resins business and most of the time they identify gums and resins as materials for manufacturing explosives. Therefore, they always ask for bribes.
 - There is no NEMA office in Garba Tula area, hence traders have difficulty in obtaining permits.

5. Discussion

Recurrent drought, which is increasing in frequency and magnitude in northern Kenya, is resulting in a dwindling of income from the livestock sector, prompting communities to venture into other complimentary livelihood strategies. Exploitation of natural products, mainly gums and resins, as an income generating activity is gaining momentum among pastoral communities in northern Kenya. The current study indicates an increasing trend of gum and resin exploitation among both poor and well-off pastoralist households, although the former are more dependent on gum and resin exploitation as a survival strategy.

While a transition to other forms of livelihood is currently in progress, people's livelihoods in the area are intertwined with the livestock sector and pastoralism is likely to remain an important income generating activity for the foreseeable future. Respondents feel that shifting to another lifestyle or livelihood strategy requires a long process of learning and adjustment. Some also expressed the sentiment that owning livestock is a sign of wealth and prestige in pastoral society, and hence forfeiting it will relegate them to low social standing in their community. The bulk of the people who felt such a strong imperative to remain in the pastoral lifestyle belonged to the wealthy households who are benefiting from livestock keeping activities.

The involvement of the members of household in gum and resin collection and selling cut across all gender and age groups in Garba Tula area. The study indicates that collection is undertaken by the husbands (65 percent), wives (34 percent) and young boys (22 percent) in sampled households. The diverse collector base for gums and resins affords an opportunity for the bulk of the population to actively engage in an employment activity that can contribute to boosting the income level and wellbeing of communities in the area. There is a need to realise the potential that gum and resin exploitation can bring to communities in northern Kenya in terms of employment creation and enhancing livelihood strategies across social and gender divides, especially among poor households with limited access to cash income. In fact, non-wood forest products in many studies have been found to contribute a greater proportion to total income of poor households than they do for wealthy households (Shackleton and Shackleton 2004).

The promise of gums and resins to contribute to enhancement of livelihoods in the drylands of northern Kenya is supported by the current study, which found that gums and resins contributed an average of Kshs 4,200 to household monthly income. There are some bottlenecks, however, that hamper this potential. The gum and resin sector attracts less attention in developmental corridors compared to other agricultural crops produced in the Kenyan highlands like tea, coffee and pyrethrum, which enjoy government support in terms of finance and policy development. High poverty levels and lack of infrastructure characterise northern Kenya, emanating mainly from laxity and lack of will by the government to develop the area. There is no formal market structure in place and the market is dictated by a few cartels setting prices. There is a knowledge gap on the importance of gums and resins to end users among collectors and traders which has resulted in acceptance of prices offered by the immediate buyer with little option of bargaining.

The study shows that there are possibilities for up-scaling this trade and developing the gums and resins sector in northern Kenya. The vast land area of northern Kenya is populated with a variety of gum and resin yielding tree species including *Acacia*, *Commiphora* and *Boswellia* which are naturally occurring. The trees currently produce adequate amounts of gums and resins, which in most cases go to waste due to lack of adequate collection efforts. The tree species are adapted to the harsh climatic conditions prevailing in the areas and will definitely survive the vagaries of climate change anticipated in the future. The inherent ability of these species to survive climate change accords them importance as a resource that will continue to contribute to livelihood security in northern Kenya. Nevertheless, the recurrent drought in northern Kenya has impacted the production of gums and resins due to lack of sufficient water necessary for tree growth and sap production. Drought incidence has been noted as a factor that affects gum Arabic production in Sudan (Seif el Din 1995 cited in Seif el Din and Zarroug undated). Provision of water through irrigation is an option that can be explored

to counter the drought effects, especially in situations where plantation establishment is considered.

Communities in northern Kenya already have a culture of collecting gums and resins for domestic use and commercial purposes. The majority of the population are of Somali and Oromo origin and are Muslims with strong cultural attachment to gums and resins used for religious rituals and as incense in the homestead. Religious and cultural attachment to gums and resins in northern Kenya is an incentive and platform to lure and bring on board a considerable number of people in exploitation of the gums and resins with minimal effort in sensitization and advocacy aspects. Policy interventions need to take cognisance of the existing tradition and aim to build on the practices already in place. Xu et al. (2005) note that policies that promote economic development that is rooted in cultural revival hold potential to strengthen and revive cultural practices and indigenous knowledge on resource management and exploitation of non-timber forest products. This is a strategy that fits well with the gums and resins sector in northern Kenya and that can be capitalised or made feasible through devolved system of government. Planting of trees is encouraged within both the Somali and Oromo tribes and is compatible with the prospect of establishing gum and resin plantations in the area once the sector stands on its feet and fosters large scale commercial enterprises.

Historically, trade in gums and resins in northern Kenya have transcended borders. The Somali communities used to trade these products throughout the former Somali Republic (Gachathi and Eriksen 2011). The outbreak of the Somali Civil War in the 1990s forced most dealers based in Somalia to relocate to major cities like Nairobi and Mombasa, creating new and accessible markets for gums and resins collected in northern Kenya. The growing participation of these traders in the local gum and resin business adds impetus to trade and general operation of the sector due to their rich history and knowledge of gums and resins, and is reinvigorating the sector.

The recurrent drought has brought to the fore the importance of gums and resins as an income generating activity. The number of the people who have taken up collection and trading of gums and resins as a complimentary or alternative livelihood strategy was on the rise in the current study. In some instances community members organised themselves as groups to jointly go for gum and resin collection, especially in instances where they had to travel long distances to locate areas with abundant gum and resin resources. Formation of such groups at the micro level and coming into existence of such structure can be used as a launch pad for community mobilisation in the gums and resins sector.

Gum and resin tree species also play an important role in carbon sequestration and provide other ecosystem services like controlling soil erosion and providing feed for livestock and shade, among others. Collection of gums and resins doesn't entail cutting down trees; hence, trees are maintained in their natural habitat where they continue to sequester and capture carbon, playing an

important role in climate change mitigation. Globally, different initiatives are under development to reward activities that enhance climate change mitigation both in compliance (Kyoto Protocol inclined) with Clean Development Mechanisms, specifically afforestation and reforestation in the forest sector, and in voluntary mechanisms like Reducing Emissions from Deforestation and Forest Degradation (REDD). Linking gum and resin operations to these initiatives will form a platform where additional benefits can be obtained, mainly through generation of carbon credit, boosting the income levels of the households or communities. Development of the gums and resins sector also needs to inculcate certification of the products. Putting in place certification procedures and standards will give the sector due consideration by external buyers, especially in the developed world, who are keen on knowing the origin, safety standard and risks/impacts on the natural environment the product has generated during its production. Kenya, and by extension Africa, can harness competitive advantages in the gums and resins trade due to sourcing of materials from pure and unpolluted sources, low cost of production, and positive scores on ethical trade due to participation of women in collection and their empowerment through income generated.

After assuming power the National Rainbow Coalition (2003–2007) and Coalition government (2007–2012) had shown interest in developing northern Kenya and other marginalised dryland areas in Kenya. The Government of Kenya has established the Ministry of State for Development of Northern Kenya and Other Arid Lands to facilitate development in the previously marginalised areas to bridge the gap and bring them to the same level in terms of infrastructural and human development with the rest of the regions. Gum and resin collection as a livelihood enhancement strategy, and its further development, is in accordance with the government's intentions in setting up such a ministry and other policy goals that aim to develop arid lands in Kenya. However, there is currently no policy in place that is directed toward developing the gums and resins sector in northern Kenya. The only instrument that touches on non-wood forest products is the Forest Policy of 2005, although it does not elaborate on mechanisms that need to be put in place to promote the sector. Furthermore, proper and effective implementation of previous policies in the drylands of Kenya is wanting. There is also a highly likelihood that the new Ministry will be axed in the coming years, which will serve as a disincentive to struggling sectors in the region like gums and resins.

The gums and resins sector currently contributes to the economy at the individual, household, community and even national level and has inherent potential to contribute more at all of these levels. For the sector to effectively contribute to the livelihoods of northern Kenya and the country's economy at large, a number of interventions are required to enhance its development. Capacity building of the local communities is of paramount importance. Sensitizing the communities on the economic importance of the gums and resins needs to be given due consideration. Currently there is

disparity in the level of engagement in the gums and resins trade among different communities in northern Kenya. Somali communities are more active and well informed about the economic benefits of gums and resins than their Borana counterparts. This sentiment was expressed by many traders interviewed in Garba Tula area in the current study.

The quantity of gums and resins harvested in northern Kenya is currently below their potential. The communities are not knowledgeable on tapping methods that can result in better yield. In most cases tapping is rarely practised, and in areas where the practice is exercised it is not done in the most efficient way. Moreover, the communities are ill-equipped in terms of the accessories used in collecting and transporting the gums and resins. Collection of gums and resins also has detrimental effects on collectors' skin, hence provision of gloves and other protective equipment is required.

The market for gums and resins in northern Kenya is currently not well developed. The collectors have little ability or knowledge to seek new markets, specifically wider national and international markets. It is unlikely that the trade will be able to grow and blossom without at least some external intervention. Measures to develop the market structure need to be explored and implemented in order to realise the full benefit of trading in gums and resins. Areas that require special attention include exploring ways of breaking the cartel culture in the sector, and of disseminating information on price trends and demands for the gums and resins locally and internationally. Closely related to marketing is the putting in place of infrastructure such as roads, harvesting and transportation materials and storage facilities required to facilitate the enhancement of the gums and resin sector. Informal sectors, especially in the rural setup, do not have access to credit facilities which are an essential component for business expansion. Promotion of microenterprise through financing, value addition and putting in place of certification measures are also required. All of these aspects are pegged to the policy process in the northern Kenya, hence putting in place gums and resins policy will help in facilitating and speedy implementation of interventions that will accelerate the development of the gum and resin sector in northern Kenya.

Community members who are involved in collection of the gums and resins, and those willing to take up the practice, are normally faced with financial difficulties in buying sustenance and necessary equipment; therefore, advancing finances to fund operation of the collectors will be helpful in developing the sector.

There is a dearth of knowledge in the gums and resins sector due to inadequate research. Gachathi and Ericksen 2011; Chikamai and Gachathi 1994; Chikamai 2002; and Chikamai and Odera 2002 are a few studies undertaken in the country. Up-scaling of the research activities in the sector is required to assess resource availability, identify issues that affect productivity and proper functioning,

and critically analyse potentials that exist in the gums and resins sector in northern Kenya.

6. Conclusions and recommendations

This paper has addressed the interplay and linkages between occurrence of drought in pastoralist areas and emergence and strengthening of complimentary livelihood strategies at play in the pastoralist area of Garba Tula in Kenya. The recurrent droughts which have been increasing in magnitude in northern Kenya are putting more strain on pastoral communities, leading them to explore additional sources of income alongside livestock keeping.

Findings from the case study in Garba Tula, northern Kenya show that exploitation of gums and resins is one of the complementary activities undertaken by pastoralists to supplement their income. The use of gums and resins as a supplementary income activity has gained prominence in recent years as a result of amplified drought conditions, serving as a safety net and an adaptation strategy.

The case study also suggest that income generated from sale of gums and resins helps in meeting household needs like paying school fees, purchasing food and supporting livestock keeping activities. When the amount generated from gums and resins reaches a level where it can purchase livestock, priority is given to restocking, which underpins the importance given to livestock keeping. Improving livestock production remains a priority area of intervention as options of developing complimentary or alternative livelihoods are being considered.

Market structures for selling gums and resins are poorly developed in northern Kenya and the country in general. Although poor households depend on collection of gums and resins, they are particularly disadvantaged in the trade. Cartels dictate the price of the gums and resins, and they are the main beneficiaries in the value chain. Gum and resin collectors are ill equipped to do effective collection due to lack of basic skills and equipment.

For the gums and resins sector to sustainably contribute to the income of pastoral communities, a number of interventions are required from different quarters to make the gums and resins sector successful and to realise its full potential as an income generating activity and climate change adaptation strategy:

- Financing the collectors will facilitate their operational activities and buying of necessary equipment, materials and alimentation required during gum and resin collection. Operating capital needs to be advanced to traders in the form of grants or microenterprise loans, similar to other sectors in the country. Market and value chain development is an

essential component to advance gums and resins enterprise in the area. There is a need to provide reliable information on market trends and prices to enable communities to understand benefits associated with the enterprise. Furthermore, the inculcation of practices that are compliant with statutory standards in the international markets needs to be given proper consideration to maximise benefits accruing from gum and resin collection and trade.

- Collectors can benefit from capacity building, especially training on tapping methods and proper storage techniques that do not encourage adulteration or loss of quality or quantity due to unfavourable weather conditions. Trainers and extension officers need to be deployed to capacitate the collectors.
- Investment in the ASALs is unattractive, especially to private sector actors who are driven by motive of profit and prefer to operate in areas with good infrastructural facilities. Hence it is necessary for initial development and assistance of gums and resins enterprises to raise their business potential sufficiently to attract private sector involvement and create avenues for partnerships.
- Formation of collector groups, associations or cooperatives is needed to foster cooperation and coordination of the collection and sale of gums and resins. Pooling resources will enhance economies of scale in production and foster bargaining power for better prices. Storage facilities and quality assurance can easily be enhanced if the concerned parties organise themselves in formal groups. Sensitizing community members on the economic value of the gums and resins sector as an alternative or complimentary enterprise to existing income generating activity, mainly livestock, is an area that requires attention.
- Maintaining peace and putting in place appropriate conflict resolution mechanisms in areas prone to conflict will allow communities to move freely across ethnic boundaries in search of gums and resins.
- The above recommendations are cross-cutting and applicable to livestock and other sectors in the northern Kenya. Hence there is need to initiative dialogues through forums like ASAL stakeholder forum and county development platforms/forums that can add impetus for advocacy for greater policy attention for northern Kenya.

END NOTES

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Annex 1: Data collection methods

Technique	Number	Topics/themes covered
Household survey	100	<ul style="list-style-type: none"> • Types of gums and resins collected and traded • Amount traded and level of income from gums and resins • Income from livestock keeping activities • Level of dependence on gums and resins among the poor and wealthy pastoralists • Household members involved in collection and trade of gums and resins • Value chain and market structure • Major actors in gums and resins trade • Domestic uses and utilization of gums and resins at local level • Constraints faced by collectors and traders • Government, NGOs, CBOs and other development agencies involvement • Market and prices trend • Gums and resins resource availability and tapping techniques • Community's perception on the effect of gum and resin exploitation on the environment
Focus Group Discussions	4	<ul style="list-style-type: none"> • Constraints facing gums and resins sector • Assessment of the existing potential • Constraints facing pastoral communities in the study area and challenges encountered • Constraints encountered in changing livelihood strategies
Traders survey	5	<ul style="list-style-type: none"> • Market trends • Supply and demand • Quantity traded and prices • Challenges facing traders • Opportunities for up-scaling gums and resins trade in the area
NGOs and CBOs survey	2	<ul style="list-style-type: none"> • Assistance accorded to collectors and traders • Sensitization on conservation and sustainable utilization of gums and resins

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