

SOCIO-ECONOMIC IMPORTANCE OF GUM AND RESIN RESOURCES IN THE DRY WOODLANDS OF BORANA, SOUTHERN ETHIOPIA

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ABSTRACT

Drylands of Borana Zone, southern Ethiopia, are endowed with different woody species that produce commercial gums and resins, which support the livelihoods of pastoral and agro-pastoral communities. The objectives of this study were to: (i) assess the role of gum and resin production and marketing in the livelihoods of the pastoral and agro-pastoral communities; (ii) identify major challenges and constraints that hinder sustainable production; (iii) analyze the existing opportunities related to future gum and resin production and commercialization; and (iv) understand the perception of the local communities and the overall future prospects of sustainable gum and resin development, production and commercialization. A semi-structured questionnaire was administered to a total of 80 households, randomly selected from two representative Districts (Arero and Yabello) in the Borana Zone. Group discussions were also held with 12 key informants. Additional information was also collected from District and Zonal officials, local merchants and enterprises engaged in businesses involving gums and resins. The results revealed that the pastoral and agro-pastoral communities in Borana Zone have intimate attachments with the woody species that provide gums and resins, and that collection and marketing of gums and resins are among the three major sources of livelihoods of local communities, along with livestock and crop production. The average annual household income generated from the sale of gums and resins was estimated at about 2,674 and 2,403 Ethiopian Birr (about 311.00 and 279.00 USD) at Arero and Yabello, respectively. Collection and sale of gums and resins represented the sole source of income for the disadvantaged groups in the local communities, i.e. women, school children and poor households with neither livestock nor land resources. The majority of respondents identified the income generated from the sale of gums and resins as a safety-net safeguarding the communities during recurrent drought periods. Gums and resins are also sources of food, chewing gum, traditional medicine, fodder, traditional soap, insect repellents, fragrance for smoking houses and other cultural practices. Several challenges and constraints are discussed, which affect the sustainable use of the vast woodlands for enhanced livelihoods and reduced household vulnerability in Borana.

Key words: environmental constraints, indigenous knowledge, livelihoods, perception, local communities.

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INTRODUCTION

The drylands of Ethiopia, which constitute over 70% of the landmass, are endowed with rich diversity of woody species that produce different commercial gums and resins (EFAP 1994, Tadesse *et al.* 2003, Lemenih and Teketay 2003a,b, Eshete *et al.* 2005, Lemenih 2005, Lemenih *et al.* 2007). Gums and resins, e.g. frankincense and myrrh, are widely used in unprocessed form for fragrance in many religious rituals. They are also used as raw materials in many pharmacological industries and folk medicines, food industries, flavouring, beverage and liqueurs, cosmetics, detergents, creams and perfumery, adhesive and dye manufacturing and paints (FAO 1995, Lemenih and Teketay 2003a, b and references therein). They have been articles of great historical and current commerce in the Horn of Africa in general and Ethiopia in particular. For instance, Ethiopia and Somalia are the major producers and exporters of frankincense and myrrh in the world market (FAO 1995, Wahab *et al.* 1987, Lemenih and Teketay 2003a).

Despite their actual and potential socio-economic, religious, cultural and environmental importance, little attention has been given to the study and documentation of these valuable resources in Ethiopia. One of the most probable reasons for the inadequate attention by government and non-government organizations in the country and elsewhere is the lack of information on the actual and potential socio-economic and cultural importance of these valuable resources (Tadesse *et al.* 2003, Lemenih and Teketay 2003a, Lemenih *et al.* 2007, Tadesse *et al.* 2007). It has also been noted that because of the harsh environmental conditions, the drylands, which represent the habitats of gum and resin producing woody plants, have often been considered as lands of few livelihood options (Stiles 1988, Lemenih *et al.* 2007). This is associated with the facts that in about 22% of these drylands, cultivation is not possible even with the early maturing crops (NCSS 1993, Lemenih and Teketay 2003a). In the remaining parts, uneven and unpredictable distribution of rainfall has always been a severe constraint for agricultural performance.

Pastoralism and agro-pastoralism are the preoccupation of most of the communities in these areas. However, owing to low productivity, the pastoral and agropastoral households are limited to subsistence mode of production with either very little or no products left to generate income (Steen 1994). Another problem facing the pastoral and agropastoral communities is the extensive area required for animal husbandry per household. Hence, even at the present low population density, the pastoral and agropastoral economy in the country could not produce all the food the households require for basic subsistence, and food shortages are common even during normal dry seasons (Lemenih and Teketay 2003a). In addition, recurring droughts, frequent failures of crop and fodder production as well as problems associated with soil salinity have been threatening the pastoral economy and their overall socio-economic developments. With the continuous increase in human and livestock populations, shrinking land resources, advancing desertification and gloomy scenarios in connection with global climatic changes (World Agroforestry Center 2009, Anonymous 2006), the prognosis for these

marginal lands does not look good (Lemenih and Teketay 2003a, Lemenih 2005, Kassahun *et al.* 2008).

Nevertheless, these drylands account for more than half of the land area in Ethiopia (NCSS 1993) and about 12% of the population (Lemenih and Teketay 2003a). It is therefore, urgent to seek for viable strategies that will make the vast arid and semiarid land resources, which have both actual and potential significance, contribute optimally to the wellbeing of communities, local, national and international economies as well as the environment, including biodiversity. In this regard, one of the promising solutions could be the integration of sustainable management and utilization of the vast gum and resin producing woody species as well as their habitats with other opportunities for dryland development to bring about accelerated socio-economic development and sustainable management of the environment (Vivero 2002, Lemenih *et al.* 2003, Lemenih and Teketay 2003a, b, Mesfin *et al.* 2007, Debela 2008).

The woody vegetation resources that produce gums and resins are declining both in terms of size (deforestation) and quality of stands (degradation) at an alarming rate associated with expansion of crop and livestock production as well as human settlement, overgrazing, fuelwood and charcoal production, anthropogenic fire and poor tapping practices (Gebrehiwot 2003, Lemenih *et al.* 2003, Lemenih and Teketay 2003a, Tadesse *et al.* 2003, Dalle 2004, Dalle *et al.* 2005, Eshete *et al.* 2005, Tadesse *et al.* 2007). Moreover, the production and marketing of gums and resins is further constrained by remoteness of the woodlands, lack of roads, and inadequate transport facilities to the potential production areas (Tadesse *et al.* 2007). As a result, mobilization of labour force, equipment and supplies, collection and transportation of harvested natural gums and resins through the rugged and undulating topography of these dryland habitats is extremely difficult. In addition, the gum and resin production areas lack facilities such as residential quarters, restaurants and potable water, making collection of gums and resins in particular and life in general very difficult.

Borana Zone, southern Ethiopia, where this study was carried out, is one of the richest areas in gum and resin producing woody species in the country (Dalle 2004, Dalle *et al.* 2005, Worku 2006). The woodlands of Borana are, however, under severe pressure due to their massive conversion to agriculture, bush encroachment and overgrazing with signs of rangeland deterioration and vulnerability to desertification (Woldu and Nemomssa 1998, Coppock 1994, Dalle 2004, Worku 2006). Therefore, sustainable management and development of the vast woodland resources with their versatile products have been repeatedly indicated to provide viable options not only for the rehabilitation of the degraded landscapes but also for securing local livelihoods and enhancing the socio-economic development of the country. However, information on the status of gum and resin producing woody vegetation resources, challenges and constraints for their sustainable management and utilization as well as perceptions of local communities about the resources in Borana Zone is either scanty or completely lacking.

Hence, the objectives of this study were to: (i) assess the role of gum and resin production and marketing in the livelihoods of the pastoral and agro-pastoral communities; (ii) identify major challenges and constraints that hinder sustainable production; (iii) analyze the existing opportunities related to future gum and resin production and commercialization; and (iv) understand the perception of the local communities and the overall future prospects of sustainable gum and resin development, production and commercialization.

MATERIALS AND METHODS

Study area

Borana Zone (hereafter referred to as Borana) lies at the most southern and southeastern edges of the Oromia National Regional State, southern Ethiopia (Dalle *et al.* 2005, Worku 2006), between $36^{\circ} 42' 38''$ to $39^{\circ} 45' 15''$ E and $3^{\circ} 31' 31''$ to $6^{\circ} 35' 37''$ N (Figure 1). The arid to semi-arid agro-climatic zones cover most (69.1%) of the landmass of Borana, implying that most of the area falls under the dry climatic regime with marginal or no agricultural potential. The study area receives a mean annual rainfall ranging between 400 and 600 mm (Coppock 1993). The rainfall distribution is bimodal with a short rainy

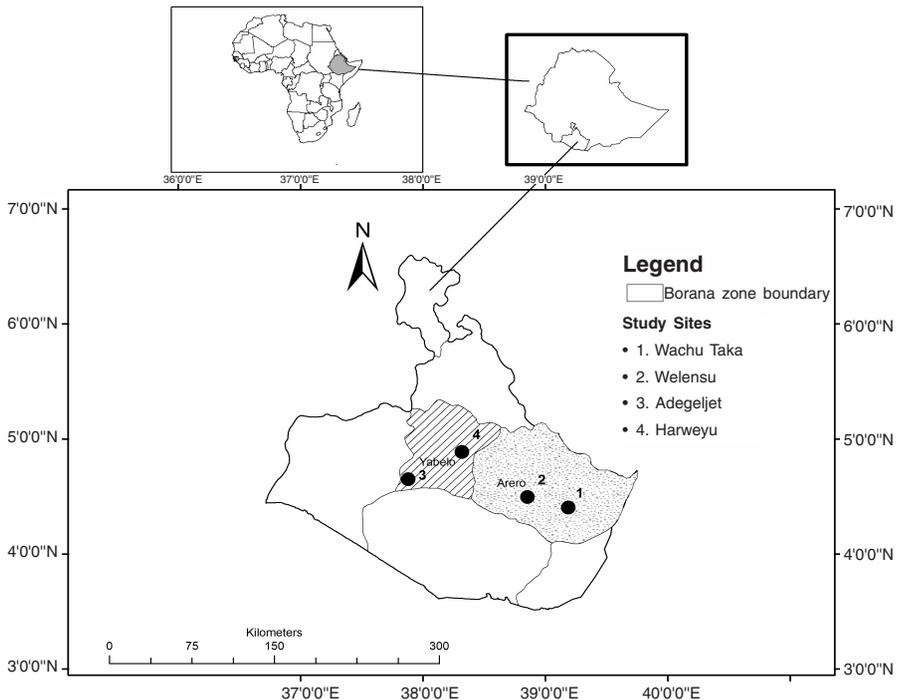


Figure 1. Map of Ethiopia showing location of the study area.

season occurring between April and May, and a major dry season occurring between December and February (Dalle 2004). The small monthly rainfall is associated with high evapo-transpiration rate, which makes the rainfall unable to sustain good livestock and agricultural production. The population of Borana is estimated at about 400,000 (Dalle *et al.* 2005). The people of the study area are called Borana, the eldest branch of the Oromo ethnic group in Ethiopia and derive their subsistence from livestock husbandry and small scale traditional farming practices (Dalle *et al.* 2005). Most communities are dependent on the collection of various non-timber forest products, including gums and resins, to generate income.

The vegetation in the study area is characterized by highly multi-purpose species such as various *Acacia*, *Boscia mossambicensis* Klotzsch, *Delonix elata* (L.) Gamble, *Balanites aegyptiaca* (L.) Del., *Dalbergia microphylla* Chiov., *Euclea divinorum* Hiern., *Olea europaea* subsp. *cuspidata* (Wall. ex G. Don) Cif., etc. (Dalle *et al.* 2005).

Data collection and analyses

Four villages were selected in two Districts, namely Arero (Wachu Taka and Welensu Villages) and Yabelo (Adegeljet and Harweyu Villages) (Figure 1), known to contain woodlands with gum and resin bearing woody species. A semi-structured questionnaire was developed in the local language (Afaan Oromo) and pre-tested. Then, a total of 80 households, 20 from each village, were randomly selected from the list prepared by the Peasant Associations (PAs). The semi-structured questionnaire was administered to interview household respondents. 12 key informants were also selected and invited for focus group discussions in each District. Further, the discussions with the Zonal and District Experts, local merchants and enterprises engaged in gum collection and marketing were used as source of information. Information was collected on the type of gums and resins collected, species from which they are tapped, the collection season, collection method, estimated annual income generated from the sale of gums and resins, the percentage share of the income generated in the household subsistence, local or household uses, medicinal values and other relevant socio-economic information (Lemenih *et al.* 2003, Eshete *et al.* 2005). The content of the interviews, group discussions and other secondary data were checked, refined and analyzed for descriptive statistics using SPSS version 13.

RESULTS

Socio-economic characteristics and major livelihood occupations of local communities

From the total selected respondents, males and females accounted for 60 and 40%, respectively. The respondents had an average family size of seven. The

interviewed respondents who can write and read were only 17%, indicating that a large proportion of the community did not receive formal education.

Most people in the rural areas of Borana are typical examples of subsistent pastoralists (first group: 61% of the interviewed households) and agro-pastoralists (second group: 27% of the interviewed households). The remaining 12% (third group) depended totally on the sale of wood and non-wood forest products, mainly collection and sale of gums and resins. The first group owned, on the average per household, 89 heads of livestock, i.e. cattle, goats, donkeys, sheep and camels. The second group owned 32 livestock heads and about 0.35 ha of farmland. The key informants identified livestock production, collection and sale of gums and resins as well as farming as the major livelihood occupations in Arero District in their descending order of importance. For Yabello District, farming is second before the collection and sale of gums and resins. They further emphasized that collection and sale of gums and resins represent a significant portion of the day-to-day subsistence activities of the communities in both districts. Only a few people got other employment opportunities, such as craft making and mini-trade.

Gums and resins collected from different woody species and their uses

Different types of gums and resins were collected either for local use or commercial purposes from different woody plants in Borana lowlands (Table 1). Whenever high demand and attractive price arise, gums from *Acacia drepanolobium*, *A. oerfota*, *Sterculia stenocarpa* and *Lannea rivae*, are collected and mixed with gum obtained from the major *Acacia* species.

Pastoralism is the dominant mode of life in Borana, and the woodland vegetation resources play key roles as the major support of livestock in the area. According to the local communities, gum and resin bearing species are known for their provision of nutritious fodder. The local communities had also stressed their long-standing tradition of using plant species as their main sources of medicine for both human and livestock diseases since there are no modern health centers in rural areas. The traditional healers are able to treat different ailments such as eye infection, bleeding, wounds, ulcer, stomach-ache, gastro-intestinal infections, skin infections, etc. for which gum and resin bearing species are the most commonly used ingredients (Table 1).

Besides treating infectious diseases, the pastoralists use the aroma of frankincense and myrrh, e.g. as fumigants during religious and cultural occasions. The resin from *Commiphora kua* is used as ordinary soap to wash human body, cloths and other vessels. Its suspension is used to dispel bad smell, and keep flies, snake and mosquitoes away. Incense obtained from *Commiphora myrrha* and *C. kua* are locally used as candle in ritual ceremonies and festivals. Respondents also acknowledged the role of gum Arabic as famine food and the different types of gums collected from woody species as ordinary chewing gum. Elderly persons prepare writing ink and dyes from the resin of *Commiphora africana*,

TABLE 1

List of gum and resin bearing species, product type, medicinal and other uses by local communities in Borana and their international application

Species	Habit*	Product	Medicinal Use	Other Uses**						
				FF	CG	FO	SA	FU	SC	IA
<i>Acacia drepanolobium</i>	S/ST	Gum	Gum used to kill ticks	No	No	Yes	No	No	Yes	–
<i>Acacia mellifera</i> (Vahl) Benth. ^a	S/T	Gum	Gum used to enhance blood clotting	No	Yes	Yes	No	No	Yes	NFI
<i>Acacia oerfota</i> (Forsk.) Schweinf. ^a	S	Gum	–	No	No	Yes	No	No	Yes	–
<i>Acacia senegal</i> (L.) Willd. ^a	S/T	Gum Arabic	Gum used to treat gastro-intestinal and stomach pains	Yes	No	Yes	No	No	Yes	F/B/P/T/PA/A
<i>Acacia seyal</i> Del. ^a	T	Gum Talha	Gum used to treat dysentery	No	No	Yes	No	No	Yes	NFI
<i>Boswellia microphylla</i> Chiov. ^b	S/T	Black and White Incense	Incense anti tick and pain killer for stomachache, disinfectant in mouth/teeth when chewed	No	No	Yes	No	No	Yes	NFI
<i>Boswellia neglecta</i> S. Moore ^b	S/T	Borana Type	Incense fumigation heal headache	No	Yes	Yes	No	Yes	Yes	P/FM/PE/I
<i>Commiphora africana</i> (A. Rich.) Engl. ^b	S/T	Frankincense Hagar	Bark, resin and leaves used to treat snakebite, skin wound, tumor and stomachache, and as anti-ticks	No	Yes	Yes	No	Yes	Yes	P/FM/PE/I
<i>Commiphora erythraea</i> (Ehrentb.) Engl. ^b	T	Hagar	Resin used as an insecticide (against cattle fleas), anti-ticks and to treat snakebite	No	No	Yes	No	No	Yes	P/FM/PE/I
<i>Commiphora boranensis</i> Vollesen ^b	S/T	Myrrh	Resin used as body lotion to repel mosquito	No	Yes	Yes	No	Yes	Yes	P/FM/PE/I
<i>Commiphora confusa</i> Vollesen ^b	T	Myrrh	Resin used to reduce swollen body and heal wound	No	Yes	Yes	No	Yes	Yes	P
<i>Commiphora corrugata</i> Gillett & Vollesen ^b	S/T	Myrrh	Resin used to heal wound	No	Yes	Yes	No	Yes	Yes	P/FM/PE/I
<i>Commiphora habessinica</i> (Berg) Engl. ^b	S	Myrrh	Resin used to treat skin wound	No	Yes	Yes	No	Yes	Yes	P/FM/PE/I
<i>Commiphora kua</i> (R. Br. ex Royle) Vollesen ^b	S/T	Myrrh	Resin used to treat wound and as fungal infections	No	Yes	Yes	No	Yes	Yes	P/FM/PE/I
<i>Commiphora myrrha</i> (Nees) Engl. ^b	S/T	True Myrrh	Resin used to treat stomach-ache, avoid erection of male genital organ and as anti dandruff	No	Yes	Yes	Yes	Yes	Yes	P
<i>Commiphora schimperii</i> (Berg) Engl. ^b	S/T	Myrrh	Resin used to treat wound/ulcer and repelling calves from breast feeding	No	No	Yes	No	Yes	Yes	–
<i>Commiphora terebinthina</i> Vollesen ^b	T	Myrrh	Repelling calves from breast feeding and also disinfectant	No	No	Yes	No	Yes	Yes	P/FM/PE/I
<i>Lannea rivae</i> (Chiov.) Sacl. ^c	S/ST	Gum	Gum used to remove unwanted hair from children body	No	No	Yes	No	No	Yes	–
<i>Sterculia stenocarpa</i> H. Winkler ^d	T	Gum	–	No	No	Yes	No	No	No	–

Plant Families: ^aFabaceae, ^bBurseraceae, ^cAnacardiaceae and ^dSterculiaceae; *Habit: S = shrub; ST = small tree; and T = tree; **Other Uses: FF = famine food; CG = chewing gum; FO = fodder; SA = sanitation; FU = fumigation; SC = source of cash; and IA = international application; A = adhesives; B = beverages; F = folk medicine; I = incense;

C. habessinica and *C. erythraea*, mainly in Kuran schools. Furthermore, they prepare tea from the bark of *C. africana*. More importantly, gum and resin bearing species serve the communities as shade trees and windbreaks, and for protecting the soil from the prevailing wind and water erosion, thereby, maintaining properly functioning ecosystems.

Production and marketing processes of gums and resins

Collection of gums and resins in Borana is performed mostly on communal natural stands indicating that gum and resin trees are not domesticated and individually owned. Collection is made after trees ooze out the gums and resins naturally, and the communities did not practice any specific tapping technique even though tapping is important for effective harvesting. However, the group discussion revealed that the communities are interested in improved tapping technologies that enhance production. They indicated that since collection of natural exudates is a tedious and ineffective method, they would adopt any improved tapping techniques if and when available.

Children and women were the key actors in collecting, transporting and marketing the gums and resins in Borana. However, the group discussion revealed that during slack periods, times of scarce livestock and farm products, and high demand for gums and resins in the market, collection was made by all members of households without any discrimination of either age or sex. Also, gum and resin collection is a major family occupation among those poor households with no farmlands and either few or no livestock. The main actors in marketing gums and resins were wealthier households since they have better capital to buy the products from collectors. The poorer members of the local communities are heavily involved in the production of gums and resins. They also collect and accumulate substantial amount of gums and resins, transport them to markets and sale them to intermediate traders for better prices. Collection is made piece-by-piece, and the products are either transported to available markets or sold to occasionally visiting buyers at village level. In most cases, buyers fix the price, and, hence, collectors have only little bargaining power for increased price. According to the respondents, quantity and consistency of collection was affected by social status, family size, market price, distances of the resources from villages and awareness of household members.

Collection schedules and factors affecting yield and quality of gums and resins

Collection of gums and resins is performed during the dry seasons when the trees have shed their leaves. Good collection is often made between December and February as well as June and August. These months are not only periods for

better yield but also time for obtaining good quality gums and resins. Although the quality and quantity of the collected products are low, poor families are engaged in the collection throughout the year. The respondents indicated that high temperatures are factors conducive for both good gum flow and increased quality, although extended drought reduces gum quantity. Prolonged rainfall was reported to affect both the quality and quantity of gums and resins by shortening the production period. The respondents also indicated altitude, post harvest handling, adulteration as well as storage time, materials and sites as determinants of the quality of gums and resins.

Contribution of gums and resins to household livelihoods

According to the key informants, the subsistence farming practiced in Borana could not enable households to produce enough food for all members of families, and food shortage has become a common feature even in normal dry seasons. Consequently, households are obliged to sale their cattle at low prices and buy cereals at relatively high cost. Our assessment revealed the significant contribution of the sale of gums and resins to households food items purchase. Hence, gum and resin resources served both as safety-net during difficult times and regular means for generating cash income for households.

Based on the size of household members and number of active collection months, the annual income generated from the sale of gums and resins was estimated at about 2,674.00 and 2,403.00 Ethiopian Birr (about 311.00 and 279.00 USD, respectively, with exchange rate of 1 USD to 8.6 Ethiopian Birr) per household at Arero and Yabello, respectively (Table 2). Key informants indicated that, although the amount of money obtained seems little, the time at which it is obtained makes it so critical. The respondents also emphasized that the annual income would have far exceeded the current amount if the various problems associated with collection, processing and marketing of the products were solved since there is a huge resource potential for increasing the volume and quality of the collected gum and resin.

Respondents noted that gums and resins have several peculiar advantages. One of the major advantages is the opportunity to access income during dry seasons when other livelihood options either decline or are not available. Most respondents (about 87%) identified gum and resin collection as the first, quickest and most sustainable means of getting income. The sale of livestock is almost a taboo in Borana since the number of livestock is a reflection of family social status. Hence, even when members of a household need money, sale of cattle is hardly possible. Collection and sale of gums and resins is also reported as the sole means of getting cash for women and school children since they are not allowed to sale cattle or other agricultural products.

TABLE 2

Mean annual income generated from sale of gums and resins per household in Borana. The calculation was based on six months/year active collection time and participation of three household members, each engaged in collection for an average 10 days/month for each product type.

Commodity	Mean daily collection (kg/individual \pm SD)		Annual collection (kg/individual)		Local price (Birr/kg)		Estimated average annual income (Eth. Birr)	
	Arero	Yabello	Arero	Yabello	Arero	Yabello	Arero	Yabello
Gum Arabic	1.67 \pm 0.36	2.67 \pm 0.23	300.6	480.6	3.00	2.00	901.80	961.20
Frankincense	2.00 \pm 0.28	2.00 \pm 0.23	360.0	360.0	2.00	1.50	720.00	540.00
Myrrh	1.67 \pm 0.26	1.67 \pm 36	300.6	300.6	3.50	3.00	1052.10	901.80
						Total	2673.90	2403.00

Income allocation

Household assessment of the income allocation shows that households use the income generated from the sale of gums and resins for various purposes. Households use the income for subsistence, i.e. to satisfy the daily needs of their families. The pastoralists in Borana consume maize flour and sugar with milk. Hence they exchange gums and resins with flour and sugar in the local markets. The other identified use of the income was supplementary to other livelihood activities, for instance buying inputs for crop production. Particularly, women save their incomes for occasional events, e.g. to buy clothes for their children at school time. Almost all the respondents underlined the buffering role of gums and resins, mainly, during slack-periods. In such periods, most households are actively engaged in the collection of gums and resins to generate income, and safeguard their families. There are many social and cultural events in Borana where households are expected to visit others and also participate in the different festivals. The role of the income generated from the sale of gums and resins in maintaining the social integrity of households, e.g. to buy gifts, was very well acknowledged by the respondents. In addition, although not well known as such, the income from the sale of gums and resins is used as a means of insurance whereby households borrow money from local traders to pay back in cash or kind when the next harvests are available.

Indigenous knowledge

Most respondents (89%) had knowledge about the diversity and current regeneration conditions of the gum and resin bearing species in their vicinities (Table 3). This group was able to list and identify the species, type of gum and incense they produce, harvesting seasons, factors affecting quality and quantity of the products, collection sites and associated challenges and constraints. Most of the respondents, mainly the elders, were knowledgeable on the different use and values of the gum and resin bearing species (Table 1 & 2). Responding to factors affecting gum and resin bearing resources, they identified recurrent drought, increased human population and associated change in life style, overdomination of few species (i.e. bush encroachment) and overgrazing as the main factors affecting the natural regeneration of some of the study species.

However, most respondents (about 93%) had very little knowledge on the economic value of gum and resin resources on national and international markets as well as on the use of gums and resins in advanced industries. These knowledge gaps, in association with the existing poor link to market, prevent stronger engagement of the households in the production of gums and resins.

TABLE 3
Respondent's awareness, participation in collection and attitude towards future commercialization of gums and resins in Borana lowlands.

Question	Yes (%)	No (%)
Do you know the diversity and the current regeneration conditions of gum and resin bearing species in your area?	89	11
Do you collect gums and resins?	57	43
If you collect gums and resins, do you collect them for sale?	87	13
Are you a member of any gum and resin collectors association/cooperative?	35	65
Do you want to be a member of gum and resin collection and trade association/cooperative?	94	6
Do you have any idea about the role of gums and resins in the national economy and their applications in industries?	7	93

Environmental constraints

In Borana, a majority of communities are prone to the severe and combined impacts of the global climate change and expanding desertification, and, hence, are vulnerable. About 91% of the respondents were able to identify the three major factors leading pastoralist livelihoods to their breaking point: climate change, desertification and weak institutional/infrastructural capacity. Few respondents (14%) considered population growth as one of the major reasons for enhancing vulnerability of households. The respondents also identified recurrent drought, range deterioration, continuing inter/intra community conflicts and weak resilience as the second level factors affecting sustainable pastoralism and agro-pastoralism in Borana. According to them the Borana elders used to predict seasonal climatic fluctuations, but current climatic variability was getting so unpredictable that it was now too hard to forecast.

The key informants mentioned that for the last two decades both the extent and frequency of drought had severely increased, covering more areas and killing more livestock. The average seven years interval between droughts (e.g. Coppock 1994) had significantly shortened, to two to three years. In comparing the nature of previous and current droughts, respondents indicated that current droughts not only expanded in the area they affected but also lasted for several consecutive years. Such extended drought periods are a major factor for the significant reduction in productivity of rangelands and, hence, declined meat and milk production. The sporadic agriculture was also victim of such extended dry seasons leading to chronic hunger. Inter/intra seasonal community conflicts were also escalating from time to time, further complicating the issues, and exerting more pressure on natural resources and, hence, leading to repeated economic and social shocks.

Existing opportunities for future gum and resin production and commercialization

The most important opportunity is associated with the current status of the resources base, i.e. the presence of diverse and abundant gum and resin producing species with wider distribution and good regeneration for the majority of the species. Some of these resources have not even been tapped. As a result, Borana has a unique opportunity for promoting sustainable management of this resource base and commercialization of gum and resin resources. Furthermore, this can be achieved simultaneously with livestock production.

Both Federal and National Regional Governments have started giving due attention to the sustainable management and commercialization of gum and resin producing resources as well as pastoralists. Some examples include putting in place various policies to support development of pastoralists, efforts to improve infrastructure, establishment of a Standing Committee responsible for pastoralists in parliaments and inclusion of pastoralism in the Government

Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) (PASDEP 2005).

Many NGOs work in Borana, and some of them are trying to promote integration of gum and resin resources as a means for both adaptation and mitigation of climate change as well as controlling desertification. Typically, production of gums and resins is less destructive than grazing, farming as well as timber and fuelwood/charcoal production. Moreover, if communities could be linked to good markets, responsibility and accountability for the management of gum and resin producing resources would improve.

Production of gums and resins is increasing in the country since the early 1990s due to market reforms. Before 1991, the sub-sector was monopolized by one government agency, namely Natural Gum Processing and Marketing Enterprise (NGPME). Following the changes in the political environment and subsequent market reforms, 34 licensed private companies have become engaged, with the subsequent significant increment in production and marketing of the resources (Teketay *et al.* 2010).

Despite the fact that local communities are not well aware of the global importance and, hence, potential international markets, of the resources, the existence of established indigenous knowledge of the pastoral communities on gum and resin collection, use and marketing is another opportunity.

Perceptions of respondents on the future management and commercialization of gums and resins

Most (about 94%) showed their keen interest to make collection of gums and resins as one of their future major livelihood activities, and wish to integrate it with other livelihood occupations such as livestock production. This group acknowledged the significant contribution of gum and resin bearing species in their livelihoods and cultural practices and the role of the woodlands as a means to protect their surroundings. Some of the respondents wish to own the woodlands as private resources and manage them partly for gum and resin production. Very few (about 6%) showed no interest in relying on income generated from gums and resins – instead, they were keen to rely on livestock production and farming (Table 2). In general, those households with very large number of livestock and other possessions were less interested in the gum and resin business than those with intermediate wealth and poorer households. The wealthy households consider gum collection as poor men's business.

Responding to the issue of managing the woodlands either for range or gum and resin production, a considerable proportion (about 51%) prioritized the woodlands for use as rangeland while some respondents (about 39%) wanted the woodlands to serve as both rangeland and source of gums and resins. Few respondents (10%) recommended delineation of some parts of the woodlands particularly to be managed for better production of gums and resins only. This group was composed of poorer families with no livestock and farmlands. About

92 and 96% of the respondents from Arero and Yabello, respectively, were in favor of establishing collectors' cooperatives, and wanted to fully participate in gum and resin business.

Challenges and constraints affecting production and commercialization of gums and resins

Despite the big potential of gums and resins to contribute to the development and conservation of drylands, there are several constraints that affect their full utilization in the Borana lowlands. The major identified constraints were:

- a lack of:
 - appropriate institutions and capacity,
 - infrastructure facilities,
 - appropriate tapping knowledge/technologies,
 - access to market, market information and fair markets prices,
 - or scarcity of capital,
 - established cooperatives
 - awareness by local communities about the sustainable management and utilization of woodlands containing gum and resin resources;
- conversion of the woodlands to farmlands;
- overgrazing;
- recurrent drought;
- bush encroachment;
- termites attacking woody species;
- traditional taboo, which considers collection of gums and resins to be business of the poor.

Most of the large populations of gum and resin bearing species are located far from residence centers and usually off roads, on sites characterized by a lack of potable water, high temperatures, and disease prevalence such as malaria. Gums and resins have thus to be transported several kilometers to access the available markets, usually carried by humans since there are no other means of transportation.

The current low prices associated to such a tedious production activity are discouraging not only local harvesters but also the private sector. A significant number of respondents (about 61%) complained about the lack of appropriate technologies that increase efficiency and quality of products collected from the woodlands.

Key informants considered the increasing human population as a threat to sustainable commercialization of gums and resins. Another of the human induced threats was overgrazing, which is leading to hampered regeneration of economically important species. The pastoralists in Borana want to keep more cattle since, as stated above, having many heads of cattle is an indication of social

status. More importantly, the current traditional system of range management is abused in that domestic animals are allowed to graze continuously at a given site, mainly at water points. Heavy grazing resulted in bush encroachment by native acacias, e.g. *Acacia drepanolobium*, *A. oerfota*, *A. mellifera* and others, rampantly replacing some of the valuable species at the study areas.

DISCUSSION

The livelihoods of communities in Borana are dependent, to a larger extent, on animal husbandry, which has also been thoroughly discussed by Dalle *et al.* (2005). Although livestock husbandry was the predominant livelihood occupation, collection and sale of tree derived products, mainly, in the form of gums and resins was found to play significant roles in the overall socio-economic conditions of the inhabitants in most places. A total of 15 woody species (14 at Arero and 11 at Yabello) were identified as important sources of commercial gums and resins (Worku *et al.* in preparation). Gum and resin bearing woody species contributed to 34 and 48% of all the species encountered at Arero (41 species) and Yabello (23 species), respectively. Shrub and tree densities were 2,098 and 1,307 stems ha⁻¹ at Arero and Yabello, respectively, with gum and resin bearing woody species contributing to about 48 and 67% respectively (Worku *et al.* in preparation).

Lemenih *et al.* (2003) also reported that livestock husbandry, collection of gums and resins and farming were the three major sources of livelihoods at Liben Zone, Somali National Regional State, Ethiopia, which is adjacent to Borana Zone.

Similar to communities in Borana, communities living in the arid and semi-arid parts of Tigray (Tadesse *et al.* 2003) and Amhara (Eshete *et al.* 2005) National Regional States, northern Ethiopia, produce gums and resins for both domestic consumption and sale. The production processes in Borana differ from those practiced in the northern parts of Ethiopia: the communities in Borana have never exercised artificial tapping unlike those in the northern parts of Ethiopia. They collect only what the woody species exude naturally. In addition, the collection efforts are not as well organized as in the northern parts of the country, since collections are individualistic and/or fragmented. The respondents associated the lack of coordinated and organized collection with the lack of appropriate tapping and post harvest technologies as well as attractive markets. Finally, in the northern part of the country, collection of gums and resins, e.g. incense, involves a single species, namely *Boswellia papyrifera* (Del.) Hochst. In Borana, collectors mix up products from different species to increase the volume of harvest and, hence, income. This results in poor quality of the products due to adulteration, leading to low market prices. The collection processes in Borana are similar with those in the southern and southeastern lowlands of the country (Lemenih *et al.* 2003).

As in most gum and resin producing areas of Ethiopia, e.g. Metema in North

Gonder Zone (Eshete *et al.* 2005) and Liban Zone in southeastern Ethiopia (Lemenih *et al.* 2003), the communities in Borana utilize the products of gum and resin bearing species for multiple purposes. Beside their use as source of fodder and income, the species are used as sources of traditional medicine, hygienic materials and many other cultural practices, indicating the deep ethno-botanical attachment of the pastoral and agro-pastoral communities with these species.

Despite the huge gum and resin production potential of the woodlands in the area, most members of the communities in Borana, especially wealthier households, would prefer to use them as rangelands for livestock husbandry. Lemenih *et al.* (2003) also reported a similar case for communities in the Liban Zone of southeastern Ethiopia. However, considerable proportions of the respondents, including the poorer households, wish the woodlands to be used both as rangelands and areas of sustainable gum and resin production, reflecting the multiple roles of the woodlands in the livelihoods of the communities.

The group discussion also revealed that farmers who are not members of any cooperatives wished to become members of cooperatives for the sustainable management and utilization of gum and resin producing vegetation resources. Working in properly organized cooperatives is a good opportunity for enhancing the quality and quantity of production of gums and resins without compromising the sustainable productive ability of the vegetation resource base. This opportunity could be further exploited to develop future scenarios on how to enhance the capacity of the communities to adapt to the cumulative actual and potential impacts of climate change and the prevailing desertification. In this regard, the attitude of the majority of the respondents to keep the woodland as rangeland can be skillfully exploited to integrate organized gum-resin production system in Borana.

Gum and incense resources are among the few forest-based export articles in Ethiopia, and Borana is one of the richest in the diversity of gum-resin bearing species (Worku 2006). Given the world-wide demand for gums and resins as important trade commodities, the huge untapped potential of gum and resin producing vegetation resources in Borana could not only support local communities as a source of income but also generate significant amount of foreign currency for the country. However, various anthropogenic and natural factors are threatening the gum and resin producing vegetation resources, especially overgrazing, expansion of settlement, drought, and bush encroachment.

CONCLUSIONS

The erratic and scanty rainfall pattern in Borana has resulted in poor socio-economic performance of the area. The situation is even worsening, making the former coping mechanisms inadequate. Generally, as the prevailing climate change and expansion of desertification had their adverse consequences on the livestock and agricultural sectors, the alternative role of gum and resin production in the

household livelihoods of communities in Borana cannot be overlooked. Our results have underlined the crucial role of gum and resin bearing woody species in the livelihoods of Borana local pastoral and agro-pastoral communities, which have deep attachment with gum and resin bearing species in particular in their day-to-day livelihoods. The positive attitude of the residents to participate in gum and resin production and marketing cooperatives could be a good opportunity to integrate the gum and resin production with other livelihood activities such as livestock husbandry and crop cultivation. In addition to their economic incentive, gum and resin producing vegetation resources have been proved to contribute to the sustainability of the delicate ecosystems of drylands in Borana. Hence, their sustainable management and utilization should be actively encouraged and promoted.

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