



# Economic Contribution of Gum and Resin Resources to Household Livelihoods in Selected Regions and the National Economy of Ethiopia

Zenebe Mekonnen, Adefires Worku, Temsgen Yohannes, Tinsae Bahru, Trehas Mebratu, and Demel Teketay

## Research

### Abstract

Ethiopia has one of the largest dry forest and woodland resource bases in the Horn of Africa, predominated by diverse *Acacia*, *Boswellia*, *Commiphora*, and *Sterculia* species, with an estimated annual production potential of over 300,000 tonnes of commercial gums and resins. However, until recently, less than 1% of this potential has been tapped and traded while the resource bases are degrading fast. Shortage of locality-specific case studies typifying the state of gum and resin production and marketing systems and nationwide socio-economic significance of the resources has delayed development of value-added commercialization of the commodities and integrated management of the resource bases. A study aimed at exploring the value chain of traded gums and resins and their contribution to rural livelihood and national economy was conducted in 11 purposively selected localities in five National Regional States within the major gum-belts in Ethiopia. Two major cities, central for product processing and marketing, were also assessed. A questionnaire survey was administered to 135 randomly selected households, and key stakeholder interviews, group discussions, and field observations were carried out following the value chain (from producers to exporters). Results showed that one or more of the seven gums and resins (frankincense, myrrh, opopanax, hagar, gum arabic, gum talha, and gum gumero) were produced and traded at the studied districts. While frankincense marketing dominated the northern part, gum arabic, myrrh, and opopanax are most popular in the south and southeastern part of the country. About 93% of the interviewed households engaged in collecting, marketing, or both activities. Gums and resins contributed up to 14% of the average annual cash income of the households. However, a significant difference ( $P < 0.001$ )

was found in the amount collected and income generated per household and locality. Strong correlation was observed between cash income from gums and resins and off-farm activities ( $R = 0.74$ ) and other types of non-timber forest products like honey ( $R = 0.72$ ,  $\alpha = 0.01$ ). However, weak correlation was observed between incomes from gums and resins and crop and livestock production. Despite the observed inefficient value chain, the gum and resin resources have considerable contributions to the national economy. For instance, the annual average revenue from three districts in Tigray National Regional State was USD 882,000 in 2010. Between 2002 and 2010, about 2,306 tonnes of different gums and resins were traded and average revenue of USD 3,220,542 was obtained in one district in the same region. At the national level, between 1997 and 2010 about 6,174 tonnes of gum arabic and about 33,865 tonnes of other gums and resins were exported, and more than USD 72 million were gen-

### Correspondence

Zenebe Mekonnen, Wondo Genet Agricultural Research Center, P.O. Box 198, Shashemene, ETHIOPIA.

Adefires Worku, Dresden Technical University, Institute of International Forestry and Forest Products, Postfach 1117, 01735 Dresden, GERMANY.

Adefires Worku, Temsgen Yohannes, Tinsae Bahru, Forestry Research Center, P.O. Box 30708, Addis Ababa, ETHIOPIA.

Trehas Mebratu, Melkasa Agricultural Research Center, Adama, ETHIOPIA.

Demel Teketay, Botswana College of Agriculture, Department of Crop Science and Production, Private Bag 0027, Gaborone, BOTSWANA.

Ethnobotany Research & Applications 11:273–288 (2013)

Published: 19 December 2013

[www.ethnobotanyjournal.org/vol11/i1547-3465-11-273.pdf](http://www.ethnobotanyjournal.org/vol11/i1547-3465-11-273.pdf)

erated. Responding to what sort of institutional arrangement governs the value chain and use of gums and resins resources at the present situations, about 41% of the respondents asserted customary and national legal arrangements, while 56% mentioned alternative systems as means of conflict resolution. Key policy and development interventions that could enhance the socio-economic importance of the gum and resin value chain at the local and national levels, while also increasing responsibility and commitment towards long-term management of the resource bases, have been recommended.

## Introduction

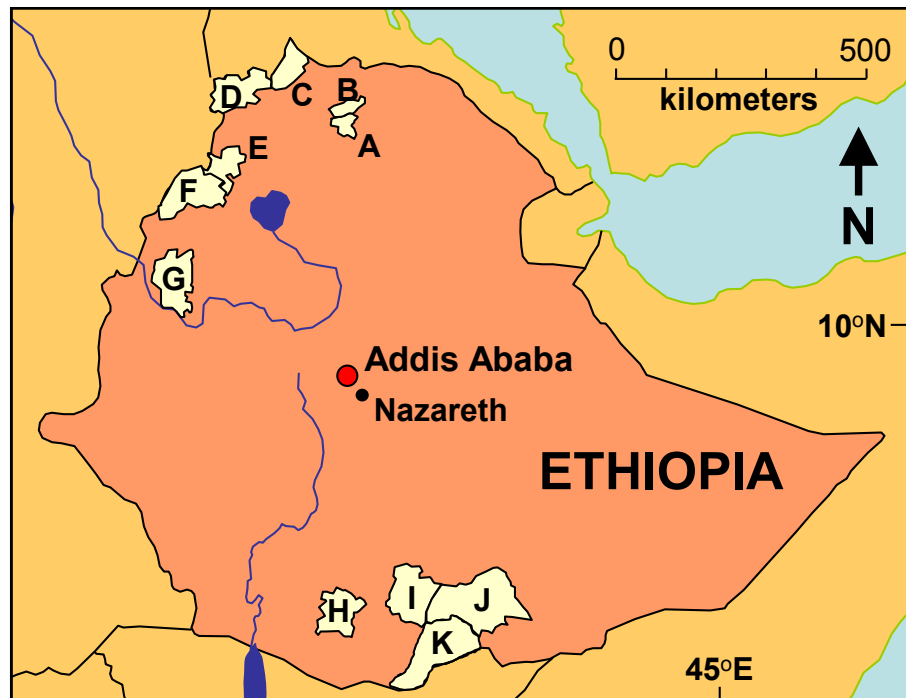
Multiple “pull” and or “push” factors motivate households in developing nations to engage in managing forest resources and products (Ambrose-Oji 2003, CIFOR 2005, Shiba & Michael 2011). In rural Ethiopia, a majority of the households make use of non-timber forest products (NTFPs) for different purposes, ranging from food, feed, energy, and medicine to income generation and cultural practices (Babulo *et al.* 2008, Tesfaye *et al.* 2011). Among the range of NTFPs, gums and resins are important trade commodities with a potential for spurring economic and social developments both at rural and urban areas in Ethiopia (Kassa *et al.* 2011, Lemenih & Kassa 2011, Worku *et al.* 2011a). Commercial gums and resins are produced in rural (remote) areas, traded in urban centers, and consumed by western countries and, hence, touch wide ranges of human lives and cross-sections (FAO 2010, ICRAF 2009, Lemenih & Teketay 2003). However, recent studies (e.g. Worku *et al.* 2011a) revealed poor linkage of rural producers to the market niches and, hence, lack of proper producers’ marketing system. Sound development of the value chain of gum and resin resources will, thus, have a huge impact on the larger population, especially the vulnerable rural poor dependent upon natural resources in the country (Gemtessa 2001, Worku *et al.* 2011b).

Lowlands of Ethiopia, including the arid and semi-arid regions, have one of the largest dry forest and woodland resource bases in the Horn of Africa, dominated by diverse gum- and resin-bearing species of the genera *Acacia*, *Boswellia*, *Commiphora*, and *Sterculia* (WBISPP 2004). According to Lemenih (2005), Ethiopia has an estimated 3.5 million ha of dry forests and woodlands with annual gum and resin production potential of 300,000 tonnes. Despite the fact that Ethiopia is one of the ancient producers and exporters of these commodities, until recently, less than 1% of the above-mentioned potential has been tapped and traded (Lemenih & Teketay 2004, Worku *et al.* 2011b). For instance, a survey of export statistics showed that Ethiopia exported only 16,019 tonnes of natural gums and resins worth USD 20,473,058 between 1996 and 2003 (Lemenih 2005). Similarly, in rural Ethiopia, despite the fact that gum and resin collection and sale is among the major livelihood activities, the existing limited case studies showed that the potential of gum and

resin resources to stimulate rural development in general and adaptation to the changing climate of the vulnerable pastoral, agro-pastoral, and farming communities in particular is not fully realized (Lemenih *et al.* 2003, Worku *et al.* 2011a).

Climate change is already happening in Ethiopia (IPCC 2007). The erratic and scanty rainfall pattern in highland parts of the country, for instance, has resulted in frequent failure of crop production (Ethiopian NAPA 2007, Georgis *et al.* 2010). Like the highland farmers, the pastoral and agro-pastoral communities in drylands of Ethiopia remain the primary victims of recurrent drought that has made the livestock sector (the major economic activity) and traditional coping mechanisms inadequate to support human life (ECA 2007, Ethiopian NAPA 2007). It is apparent that rural households in the country must look for alternative livelihood options that enhance adaptation. Value-added commercialization of the diverse gum and resin products could give additional opportunities to minimize the prevailing rural food insecurity due to crop and livestock failure, while also enhancing responsibility to sustainably manage the degrading dry forests, woodlands, and the dryland ecosystems (Eshete *et al.* 2005, Lemenih & Teketay 2004, Worku *et al.* 2011c). In addition to their rural socio-economic importance, gums and resins can also be an entry point to develop small- to medium-scale business ventures that will create employment opportunities and export options and, thereby, contribute to rural-urban linkages and growth of the national economy (Lemenih & Kassa 2011, Toure 2009). In this regard, although some companies and professionals are still questioning the sustainability and profitability of the gum and resin resources in Ethiopia, there are over 30 licensed companies and several cooperatives involved in the business (Worku *et al.* 2011c). According to AFC (2004) and FAO (2010), though multiple costs and other factors determine the profitability of various NTFP enterprises, the increasing demand for them and price in the international markets can compensate such costs and, hence, need to be promoted.

In Ethiopia, despite the above facts and professional support to promote value-added commercialization of the different gums and resins, there is little commitment in terms of enacting suitable policies and institutional arrangements that might facilitate the development of efficient value chain, in particular, and sustainable management of the fast-disappearing dry forest and woodland resource bases (Lemenih & Kassa 2011, Teketay 2004–5, Worku *et al.* 2011c). The existing reluctance to integrate and develop the valuable resource bases, both at federal and regional levels, is mainly due to lack of a clear image on the trends and socio-economic significance of the gum and resin production and marketing systems (Lemenih & Kassa 2011). Hence, there is a need to enhance national-level understanding, ensure the development of value-added commercialization of gums and resins in Ethiopia and lobby for sustainable management of dry forest and woodlands through minimizing their rampant conver-



**Figure 1.** Map of Ethiopia showing distribution and location of the study areas. **A.** Sheraro, **B.** Kola Tembien, **C.** Humera, **D.** Tanqua Abergele, **E.** Metemma, **F.** Qwara, **G.** Wenbera, **H.** Yabelo, **I.** Negele Borana, **J.** Filtu, **K.** Moyale.

sion to other land uses. To serve as a strong foundation for this initiative, we carried out nationwide research with the following objectives: (i) assess, describe, and evaluate the operational strategies of the existing gum and resin markets, stakeholders involved in the value chain, and their respective roles and benefits; (ii) determine the value addition gained as products move along the value chain; (iii) examine the impacts of product quality, quantity, and seasonality on marketability of the products; (iv) quantify the actual contribution of gums and resins to the livelihood of households in selected potential gum- and resin-producing areas and the national economy at large; and (v) assess the existing formal and informal institutional arrangements and means of conflict resolution in gum and resin resource uses. Advancing understanding on these objectives could enhance the development of an efficient gum and resin value chain in Ethiopia, which will be a pre-requisite to promote maintenance of forest cover on the fragile dryland ecosystems, a key step forward to combat desertification, encourage biodiversity conservation, and improve human welfare (Kassa *et al.* 2011, Worku *et al.* 2011a).

## Materials and Methods

### Site selection and description of the study areas

The assessment sites (Figure 1) were selected objectively by their potential of having sufficient gum- and resin-bearing tree resources and mostly characterized as dry forest and woodland ecosystems with low rainfall and high tem-

perature (Eshete *et al.* 2011, Worku *et al.* 2012). The vegetation types of the study sites in the northern (i.e. Tigray and Amhara National Regional States) and the northwestern (Benishangul Gumuz National Regional State) parts of Ethiopia were composed of more or less similar species characterized as *Combretum-Terminalia* forest type. Species of *Acacia*, *Boswellia*, and *Sterculia* are the major components of the vegetation (Eshete *et al.* 2011, WBISPP 2004). The vegetation in the southern and southeastern study localities was characterized as *Acacia-Commiphora* woodland predominated by various species of *Acacia*, *Boswellia*, and *Commiphora* (Dalle *et al.* 2005, WBISPP 2004). The livelihood of the communities in the northern region of the country is, mainly, composed of crop farming while livestock-based pastoralism and agro-pastoralism dominate the southern and southeastern regions of the country (Babulo *et al.* 2008, Dalle *et al.* 2005).

The uniqueness of this study was that, unlike most studies so far, it covers almost all the major gum- and resin-producing regions in the country. In total, 11 Districts from five National Regional States endowed with gum- and resin-bearing resources and two cities, which are the main destination of the products for final processing, grading, and marketing, were explored. The Districts include Metemma and Qwara in the Amhara National Regional State (ANRS); Yabelo and Negele Borana in Oromia National Regional State (ONRS); Filtu and Moyale in Somali National Regional State (SNRS); Humera, Kola Tembien, Sheraro, and Tanqua Abergele in the Tigray National Regional State (TNRS); and Wenbera in the Ben-

ishangul-Gumuz National Regional State (BGNRS). The two cities studied were Addis Ababa and Nazareth (Adama). Selection of all study sites was made purposively and based on previous experiences.

### Data collection

A reconnaissance survey was initially conducted to collect village-level information such as resource endowment, access to forest resources, credits, roads and education, major livelihood activities, major gums and resins collected and traded as well as enterprises engaged in the harvesting, processing, and marketing of businesses of gums and resins. At this phase, questionnaire pre-testing was also carried out after a verbal agreement was made with respondents on the purpose of the research and how the findings will be reported and benefit the local communities. Based on the information from such a rapid appraisal, sample respondent households, key informants, and companies and cooperatives engaged in gum and resin businesses were selected for the detailed study. In general, data collection involved a sequential exploratory strategy (Creswell 2009) where quantitative data collection and analyses were supplemented with qualitative information obtained through group and key informant discussions and field observations (Yin 2009).

For the quantitative analyses, a total of 135 households, 31 from southeastern Ethiopia (Yabelo, Moyale, and Filtu), 18 from northwestern Ethiopia (Wenbera), and 86 from northern Ethiopia (50 from Kola Tembien and 36 from Tanqua Abergele) districts were randomly selected. The number of households was determined based on the homogeneity of the population at each site using their livelihood strategies and wealth status as criteria. For other sites, such as Metemma, Qwara, Humera, and Sheraro, qualitative and quantitative data were collected based on group discussion with key stakeholders and secondary information, respectively. Among the wide range of selected study sites, the reasons for selecting such specific communities for household survey were: (i) community engagement in the gum and resin collection and marketing activities and relative dependence on income from gums and resins; (ii)

diversity and abundance of the gum- and resin-bearing resource base surrounding these communities; and (iii) existence of government and non-government organization (NGO) initiatives to develop gum and resin resources. In addition, focused group discussions were also made with these communities living at these gum and resin hot-spot areas. Key informant interviews and participatory discussions were made with managers and experts at government offices, NGOs, and companies engaged in gum and resin marketing following, mainly, the procedures described in Babulo *et al.* (2008), Campbell *et al.* (2002), and Lemenih *et al.* (2007).

Data were collected on whether or not the households were engaged in the gums and resins business, type and amount of gums and resins collected and traded, annual cash income generated from the sale of gums and resins, share of cash income from other livelihood activities, structure and function of gum and resin marketing value chain, actors involved, trend in the price of gums and resins, export and profitability in the case of the enterprises, royalty tax collected by local administration, and factors affecting engagement with and benefits from the gum and resin resources. Discussions were also held to understand the modalities by which access to forest resources and the sustainable management and market for the products could be governed. Various researchers followed more or less similar procedures to examine the socio-economic and marketing of various NTFPs and resource base management in Ethiopia and elsewhere in Africa (Babulo *et al.* 2008, Campbell *et al.* 2002, Lemenih *et al.* 2007, Tesfaye *et al.* 2011, Worku *et al.* 2011a).

### Data analyses

Data were encoded into Excel sheet and SPSS, checked and categorized into quantitative and qualitative. Quantitative data were statistically analyzed using SPSS Version 16. To explore the role that gums and resins play in rural livelihoods in comparison with other activities, various statistical analyses were carried out, including one-way ANOVA. Descriptive statistics, including calculating mean incomes and percentage ranking, were undertaken to

**Table 1.** Demographic characteristics of household respondents involved in gums and resins business in 13 study sites in Ethiopia ( $N = 135$ ).

Age of household head	Gender			Level of education				Family size			
	Male	Female	Total	Illiterate	Primary	Secondary	Total	≤ 4	4–7	≥ 8	Total
< 20	9	0	9	1	8	0	9	5	4	0	9
20–30	36	0	36	9	17	10	36	31	3	2	36
30–40	34	6	40	26	13	1	40	19	18	3	40
40–50	32	2	34	20	14	0	34	5	8	21	34
> 50	16	0	16	13	3	0	16	3	4	9	16
Total	127	8	135	69	55	11	135	62	37	36	135

compare the role of income from gums and resins to other incomes and understand how different socio-economic factors influence the extent and pattern of forest dependence. Once total income of households by different sources was computed separately, the relative dependence of households on income from gums and resins in particular was determined via calculating percentages (Babulo *et al.* 2008, Tesfaye *et al.* 2011). Qualitative data were analyzed using text analyses by way of condensing and summarizing information (Yin 2009).

**Results**

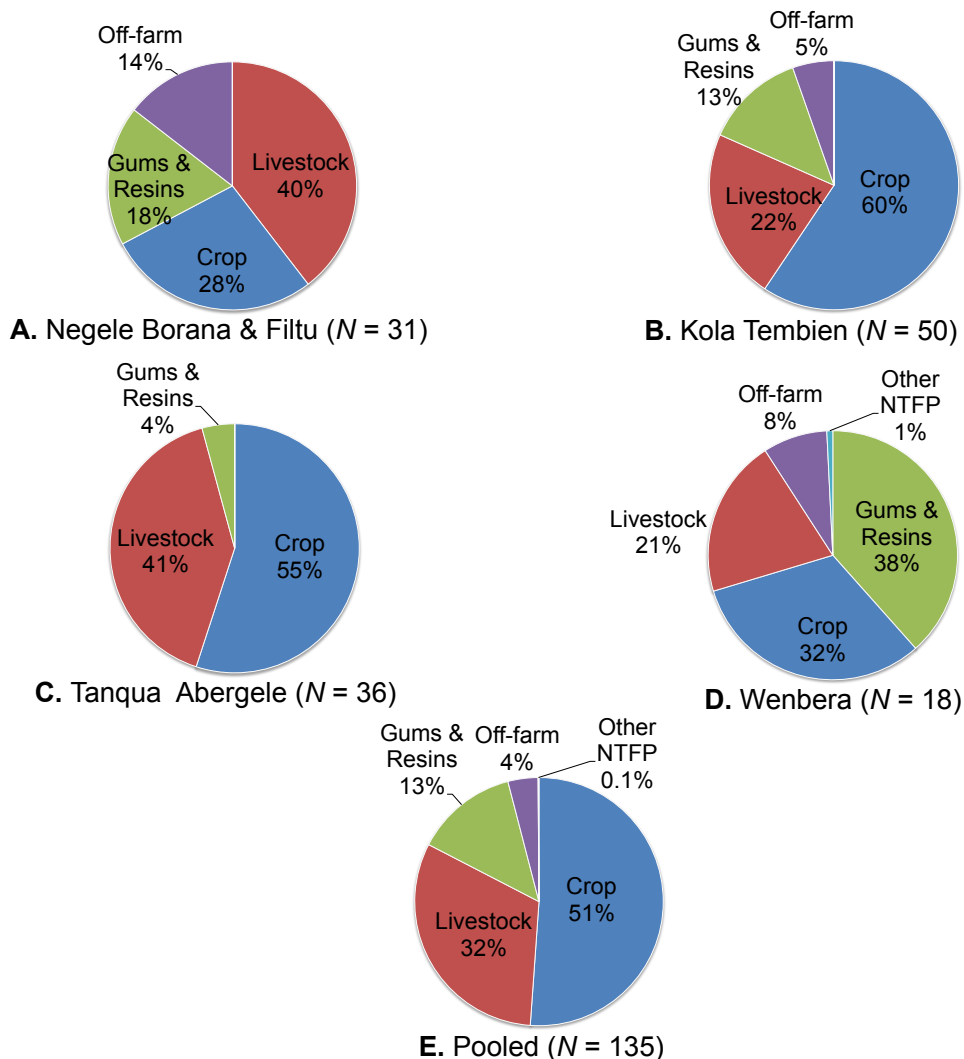
**Socio-economic characteristics of the respondent households**

A majority of the respondent households are between 20 and 50 years old and male-headed (Table 1). In rural Ethiopia, due to cultural influence, it is common to find few

male-headed households. Illiteracy is prevalent, and only 8% of the respondent households completed secondary school. In contrast to government reports that indicate significant improvement in educational access for children and youth (MoFED 2010), none of the family heads below 20 years of age had completed even primary school.

**Income sources of households and the relative contribution of gums and resins**

The survey identified crop and livestock production, gum and resin harvesting and trade, collection of honey, and off-farm activities such as causal labor as major income sources of the studied households (Figure 2). Although not common, aid and remittance are mentioned as sources of livelihoods. While in the northern and northwestern part of the country crop production is the major source of subsistence and cash income followed by livestock and gum and resin collection and marketing, southern and



**Figure 2.** Share of the different livelihood activities in the 2010 annual cash incomes of households at individual gum- and resin-growing localities within 4 districts in Ethiopia as well as the pooled values of those districts.

southeastern Ethiopia reported livestock production followed by gum and resin collection and marketing as the most important source of cash income. Despite the observed significant difference in amount of gum and resin collected per annum and per household and the level of income generated (Table 2), about 93% of the studied households are engaging in gum and resin activities, i.e. either in tapping/collection, marketing, or both activities to generate cash income. The highest income from gums and resins is recorded at Metekel Zone (Wenbera District) in BGNRS region (38.4%) and Borana Zone (Yabelo and Moyale Districts) (18.2%) in Oromia National Regional State. On the other hand the lowest cash income (4.2%) is recorded in Tanqua Abergele District in TNRS (Figure 2). The pooled average annual household income contribution of gum and resin resources is 14%. According to the group discussion, subsistence use of frankincense and gum arabic as sources of fumigation and as famine food, respectively, are mentioned.

Gums and resins have also contributed considerably in providing local employment opportunities. For example,

the data obtained from Natural Gum Processing and Marketing Enterprise (NGPME) showed that, in 2010 alone, the enterprise employed more than 2,000 casual workers, mainly women, for separating and grading the products. The workers are paid USD 3 day<sup>-1</sup> for processing up to 20 kg gums and resins in a day. The enterprise itself has also 300 permanent staff members, including technicians and high-level managers. Further, during the field study, it was observed that the number of casually employed workers by other companies engaged in businesses associated with gums and resins at each collection site is in the thousands.

Analysis of relations between various income sources indicates a highly significant correlation at  $\alpha = 0.01$  between income generated from gums and resins and income from off-farm activities (0.74) and honey production (0.72). There is also a significant correlation between gum and resin income and income from crop and livestock at  $\alpha = 0.05$  (Table 3).

**Table 2.** Results from the ANOVA showing variation of cash income and annual harvest of gums and resins by households at Negele Borana, Filtu, Wenbera, Tanqua Abergele, and Kola Tembien districts in Ethiopia.

	Source	Sum of Squares	df	Mean Square	F	Sig.
Gum & resin harvest / year (kg)	Between groups	1,410,123	3	470,041	25.493	<b>0.0001</b>
	Within groups	2,230,993	121	18,437		
	Total	3,641,116	124			
Gum & resin cash income	Between groups	475,536,052	3	158,512,017	33.277	<b>0.0001</b>
	Within groups	581,136,952	122	4,763,417		
	Total	1,056,673,004	125			
Crop cash income	Between groups	2,703,964,357	3	901,321,452	7.563	<b>0.0001</b>
	Within groups	14,897,540,146	125	119,180,321		
	Total	17,601,504,503	128			
Livestock cash income	Between groups	1,728,782,666	3	576,260,888	3.893	<b>0.011</b>
	Within groups	17,615,220,481	119	148,027,062		
	Total	19,344,003,148	122			
Off-farm cash income	Between groups	19,129,447	2	9,564,723	2.103	0.134
	Within groups	200,148,903	44	4,548,838		
	Total	219,278,350	46			

**Table 3.** Correlation between household's cash income in gum and resin growing sites in 13 study sites in Ethiopia. Values are correlation coefficients. \*\*Significant at  $\alpha = 0.01$ ; \*Significant at  $\alpha = 0.05$ .

	Crop	Livestock	Gum-resin	Off-farm activity	Other NTFP
Crop	1.000				
Livestock	0.399*	1.000			
Gum-resin	<b>0.364**</b>	<b>0.229*</b>	1.000		
Off farm activity	0.911**	0.330*	<b>0.739**</b>	1.000	
Other NTFP	0.717**	0.717**	<b>0.717**</b>	0.710**	1.000

**Factors hindering engagement in and benefit from gum and resin business**

Responding to what key factors affect engagement in and benefit from gum and resin businesses, results from household respondents and key informants representing the private sector, cooperatives, experts from government and NGO offices, and farmers and pastoralists mentioned several bottlenecks determining involvement and benefit share of actors, starting from tapping/collection up to export market. In the northern and northwestern part of the country, the following are mentioned as most important challenges and constraints: absence of modern tapping methods for various gum-bearing species (there is only one traditional tapping method for *Boswellia papyrifera* (Del.) Hochst., a tedious job according to the respondents), requirement of intensive labor to collect and transport products, high temperature during collection seasons, lack of product quality standard specification, unstable production and market plus low price, lack of market regulation, government restriction regarding gum and resin collection and marketing (e.g. farmers must be organized in cooperative before they will be allowed to collect in TNRS, and in the ANRS, the involvement of only one cooperative is allowed in gum and resin business per District), confiscation of products at storage and processing sites, and resource depletion. Secondary but important factors determining decision to engage and benefits include inaccessibility or lack of markets, credit, transport and information (mainly at the local producers' level), seasonality of low yield, shortage or lack of warehouse and other inputs (e.g. bags/sacks and weighing balance), and technical problems during tapping. In the southern and southeastern parts of the country, all these above-mentioned issues are also equally critical. In addition, low-level of awareness on the livelihood importance of gums and resins and the escalating conflicts over scarce resources are mentioned as constraints to engage in and develop pro-poor producer's gums and resins marketing chain.

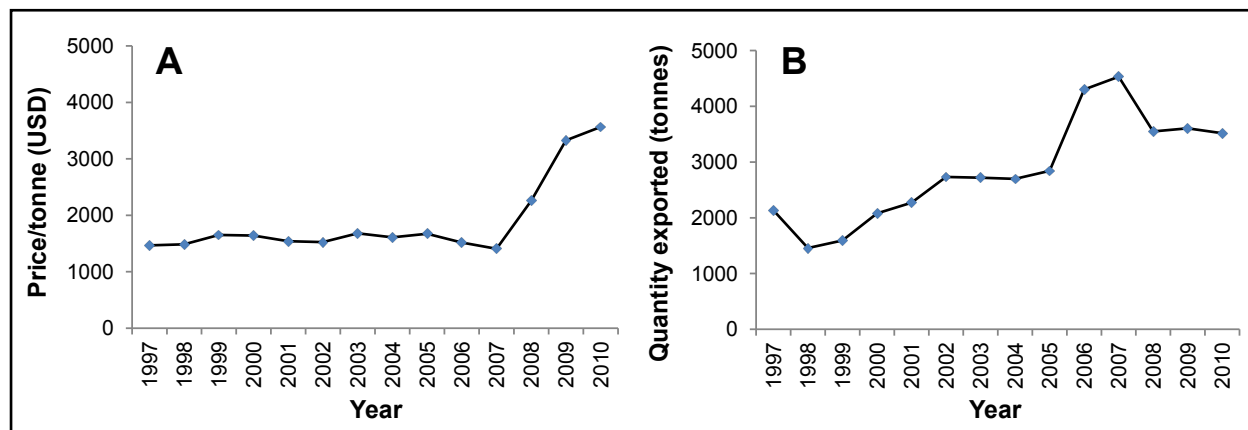
Similar to reports from various other studies (e.g. Babulo *et al.* 2008, Shiba & Michael 2012), the field survey revealed that demographic factors such as age, gender, level of education of the head, whether children go to school or not, and family size affect a household's choice of livelihood strategy and, hence, decision to engage in the gum and resin business. For instance, in the northern part of the country where a tapping technique is used to produce incense from *B. papyrifera*, children and women are not encouraged to participate in the production step, while in the southern and southeastern part of the country where collection of various gum and resin products is made from natural oozing, women and children are key participants. Similarly, gum and resin collection volume and, hence, income are affected by family size as households with relatively larger active force are able involve more labor.

**Seasonal variation of income from gum and resin business**

Seasonal variation is found to affect production, price, quality, and marketability of gum and resin products. According to the group discussion held with producers and sellers, gum and resin production is a more or less seasonal activity. During dry seasons, for instance, there is a significant increase in quantity and quality of production and, hence, an increase in the income of households. Respondents also indicated that dry seasons make the tapping and collection process easy, and, hence, increase in the amount of gums and resins collected. About 33 and 29% of the collectors in the northern part of the country mentioned March–May and September–November, respectively, as the best seasons for the collection of gums and resins. Nevertheless, a considerable number of respondents (58 and 27%) mentioned March–May and June–August as the best season for the collection of gums and resins. In southern Ethiopia in Borana and Filtu, January–March is mentioned as the season for primary gum and resin collection and June–July as secondary. However, both tappers and those who collect from natural oozing trees noted that collection of quality gums and resins depends on the optimum temperature of the collection year and rainfall amount and distribution of the earlier year. Field observations at Humera in northern Ethiopia also showed that upon longer storage, frankincense would turn from white to yellow due to high temperature, reducing its international market demand and market price. Such a seasonal nature of gum and resin business is mentioned as relevant to household decisions, contributing to a switch from such an activity to other more consistent livelihood options. On the other hand, specialized market niche for each of the different products that can be collected at different seasons is mentioned as the means to protect the substitution of the activity by an alternative one.

**Contribution of gum and resin collection and trade to local economies**

Gum and resin collection and marketing contribute greatly to the local economies in Ethiopia. For instance, in 2010, the total average annual revenue from gums and resins in Kola Tembien, Tahitay Adiyabo, and Humera Districts, TNRS, was USD 882,000 (ERCA 2010). Analysis of secondary data obtained from seven gum- and resin-based cooperatives (with 445 members) and Ethiopian Natural Gum Processing and Marketing Enterprise (ENGPME) showed that they collected about 2306 tonnes of gum and resins in Humera District and generated average revenue of USD 3,220,542 between 2002 and 2010. In the south and southeastern Ethiopia (Guji and Liben Districts), ENGPME alone collected about 930 tonnes of gums and resins and generated a revenue of more than USD 2 million between 2008 and 2010. At the same time, the Moyale District Trade and Industry Bureau of the Somali National Regional State (SNRS) collected tax valued



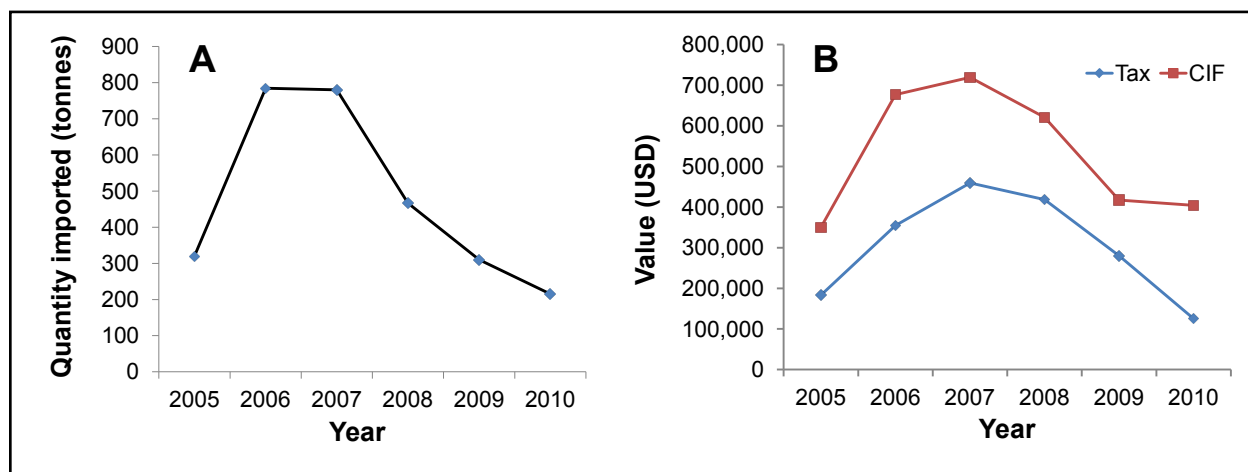
**Figure 3.** Price trend (A) and export quantity (B) of the gum and resin export market in Ethiopia (ERCA 2010).

at USD 16,281 from gum and resin traders during the period 2005–2009.

The assessments of seven gum- and resin-based cooperatives in Liben and Guji Districts (southeast Ethiopia) who had 320 members have shown that they were established with average initial capital of USD 418 per cooperative in 2005. In 2010, they had up to an average capital of USD 3,044. During those years, the average price of gums and resins was USD 1,546  $\text{tonne}^{-1}$  at the conventional market while the cooperatives sold the same amount at USD 1,910, which enabled them to get a premium profit of USD 364  $\text{tonne}^{-1}$ . In Metemma District, the Trade and Industry Bureau collected a royalty fee of USD 89,065 during the period 2004–2009 from the gum and resin trading companies which generated an average annual harvesting capacity of 19 tonnes in the indicated period. In Qwara District, too, a single cooperative having an annual average production capacity of 20 tonnes had paid an annual royalty fee of USD 15,000 in 2009.

#### **Contribution of gum and resin collection and trade to the national economy**

Gum and resin products contribute considerably to the national economy of Ethiopia. For instance, during 2001–2010 the country exported about 11,247 tonnes of gums and resins through ENGPME and generated USD 72 million (ERCA 2010). The data obtained from Ethiopian Revenues and Customs Authority (ERCA) has shown that the country has exported about 6,174 tonnes of gum arabic and 33,865 tonnes of other gums and resins in the period 1997–2010 and generated an FOB value of USD 72 million (ERCA 2010). Main importers included China and United Arab Emirates with the share of about 20 and 19%, respectively. At the same time Ethiopia also imported about 170 tonnes of gum arabic and 2,599 tonnes of other gums and resins in the period 2005–2010 and paid a CIF value of USD 3,373,573 and collected total tax of USD 2,071,091 (ERCA 2010).



**Figure 4.** Quantity imported (A) and CIF (Cost, Insurance, & Freight) and tax trends (B) of gum and resins products in Ethiopia (ERCA 2010).



**Trend of price and export-import**

The analyses of export data from ERCA show that the price of gums and resins both in domestic and international markets is at an increasing trend, particularly in the last three to four years (Figure 3A). From the same analyses, even though the trade balances for export and import market of gums and resins indicated surpluses, there is a general trend of decrease in the quantity of gums and resins exported (Figure 3B) and imported as well as associated tax values (Figures 4A & B).

**Value adding system**

There are two types of gum and resin collection systems at the study areas, i.e., wounding the tree stem and expanding the wound periodically (e.g., up to nine times for *B. papyrifera*) and collecting from natural oozing of trees. Hence, the major steps in the collection and marketing value chain of gums and resins can be grouped as in Figure 5.

As the collected gums and resins move through this chain, the relative weight of value addition increases (Figure 6, ENGPME 2010). The management cost (processing, storage, transport, labor, etc.) to supply one tonne of gums

and resins to export markets through such a chain is about 75% of the selling price. For Tigray-type frankincense, the marketing margin between local and export marketing is USD 341 tonne<sup>-1</sup> in 2010 (Table 4, ERCA 2010).

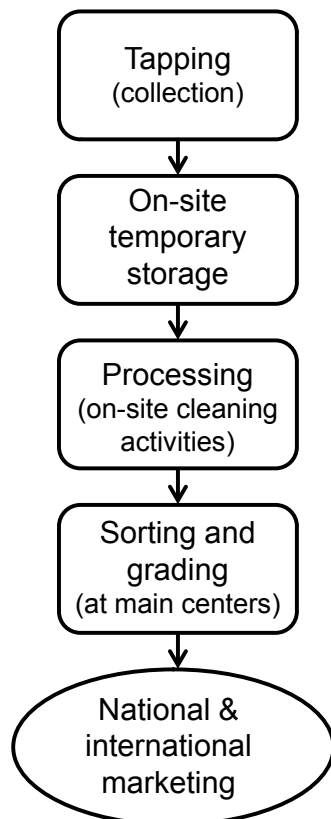
**Grading criteria**

Various types of gum and resin grading systems are in use at the visited study localities. These included mechanical, manual, and physical grading systems. Mechanical and manual grading involves selecting the products according to color and size by using simple cultural tools and sieves of different mesh sizes. There is no approval for the grades by relevant authority, namely the Ethiopian Quality and Standard Authority, and, hence, the grading system is simply an agreement between the sellers and the buyers. Physical grading systems use criteria to classify gums, resins, and incenses. The criteria include size, quality, and color of the products. For example, the red and coarse-sized myrrh is classified as first grade A and B, while the inferior quality and small-sized myrrh is classified from third to fifth grades. White and coarse-sized incense is also graded by following similar procedures. Despite the recently initiated preliminary research to introduce a robust grading system, including the chemical grading system, there is no recognized alternative grading system either locally or at a national level.

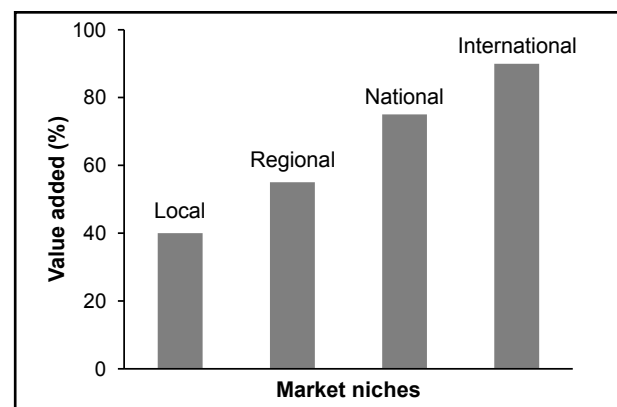
**Market chain**

By combining the observations from all the study localities, three main gum and resin marketing channels were identified (Figure 7).

- Channel 1—This channel is followed by those organized as cooperatives. These groups collect their products from the resource base in their vicinity, store products in their own stores at the nearby town, and sell them to local trading companies. Since they are able to



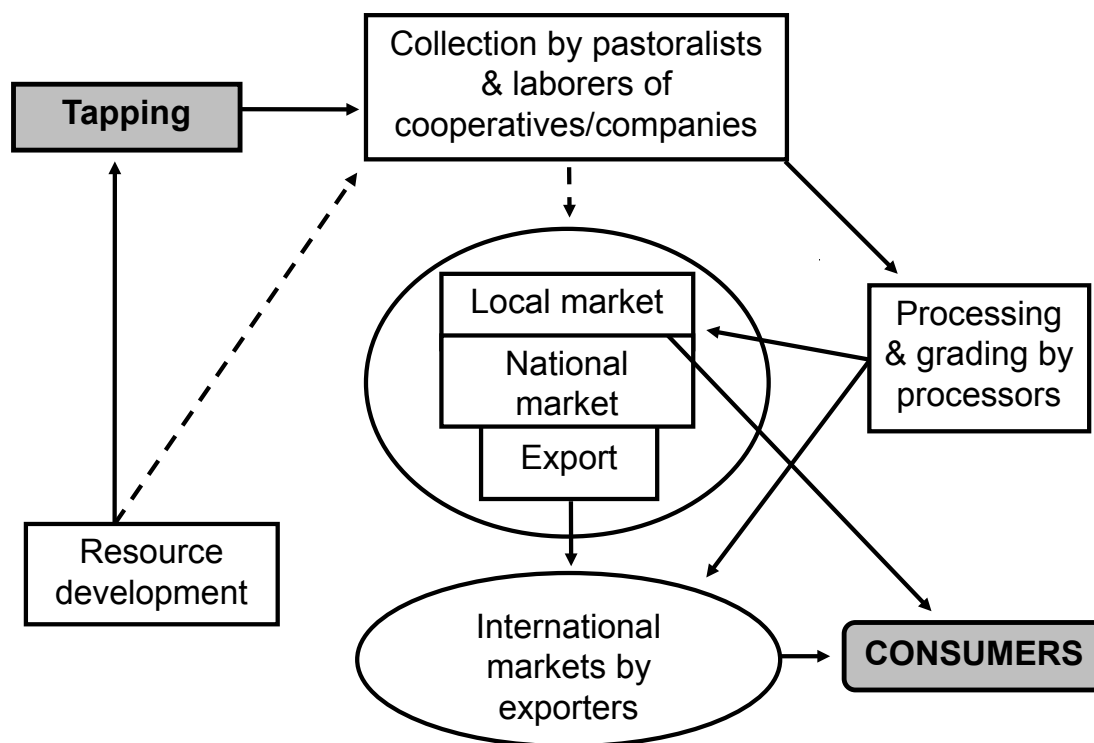
**Figure 5.** Major steps in collection and marketing value chain of gums and resins in Ethiopia.



**Figure 6.** Relative weight of value addition in the gum and resin marketing along the market chain in Ethiopia (ENGPME 2010).

**Table 4.** Marketing margin of Tigray-type frankincense from *Boswellia papyrifera* (Del.) Hochst. in 2010 in Ethiopia (currency = USD) (ENGPME 2010, ERCA 2010).

Market type	Selling price/tonne	Total cost/tonne	Net profit/tonne	Margin
Local	1,364	1,023	341	
National	2,000	1,500	500	159
Export	2,728	2,046	682	182
<b>Total marketing margin</b>				<b>341</b>



**Figure 7.** The value chain of gum and resin resources within the major gum-belt in Ethiopia.

store their products for some time, they have a better chance of obtaining better prices. Once they buy the products from local cooperatives and accumulate products, these companies sell their products to the national and international markets.

- Channel 2—This channel is followed by the ENGPME. This company was the main shareholder in the gum and resin business in Ethiopia. It has its own production areas in the different localities, mainly, in the northern and northwestern parts of the country. The company is engaged in harvesting gums and resins from the woodlands assigned to it from the National Regional States. It stores the products in its own warehouses located at nearby towns and later transports the products from each local warehouse to the main warehouses at the major towns. Finally, the products are transported to the Nazareth main depot where final processing, grading, and export to international markets takes place. In the

south and southeastern parts of the country, however, the enterprise does not own woodlands. Thus, it buys gums and resins from individual rural collectors, cooperatives, or middle men. Hence, compared to the cooperatives, ENGPME has better options to look for improved prices and returns.

- Channel 3—This channel represents trade of the lower grade gums and resins that are sold outside of the above two chains in the local market for local consumption. The main actors in this market chain include farmers and pastoralists who are, mainly, involved in tapping, collecting, and selling their products to local traders, cooperatives, or enterprises and get about 22% of the profit. The second category of actors involved in this chain are the middle men, cooperatives, and traders who sell the products to companies that come to do business with them and/or supply the products to the national markets directly and get about 33% of the prof-

it. The third category of actors include enterprises and very well organized cooperatives and individual exporters who take nearly 45% of the profit in the value chain.

Examining the various channels, a direct link between producers and consumers may result in a relative increase of producers' gain due to increased price, but may also lead to cost reduction for consumers as these could be free of the further value additions due to the presence of actors at the middle stages. However, such a link could also lead to poor quality product as it has been observed increasing product quality as the product moves along the chains. The essence of the term consumers in the final end of the value chain is to mean the heterogeneous consumers types (households, churches, factories, etc.). Households and churches are consumers from the local and national markets, while sophisticated industries utilize processed products from the international markets.

The overall value chain of gum and resin resources in Ethiopia is inefficient and needs integration and value addition. Only few upgrading efforts, which are discussed below, were observed during field data collection missions.

- Production upgrading: Forestry Research Center (FRC) has experimented and introduced new tapping techniques for *B. papyrifera*, which were efficient both in terms of productivity and maintaining the health of the standing tree. However, there are efforts by producers to replace or mix the new with the traditional techniques. There were also some efforts by COOPI, an Italian NGO, to introduce the Sudanese **sunki** (tool) for tapping of *Acacia senegal* (L.) Willd. There are few ongoing experiments by FRC to develop tapping techniques for species of *Commiphora* and *Sterculia*.
- Product upgrading: examples of product upgrading observed during field surveys include efforts made to pack and label incense in the Somali region. The products were labelled as “**incenso nero**” (black incense from *Boswellia neglecta* S. Moore) and “**incenso del deserto**” (desert incense from various other species of *Boswellia*) and, as a result, obtained good market niches. The initiative was taken by COOPI, which also mobilized companies to focus in southern and southeastern parts of the country.
- Functional upgrading: producer cooperatives of gums and resins in TNRS and Guji and Liben districts, for example, took up new functions, such as export marketing or more lucrative roles within the value chain.
- Chain upgrading: there are some new initiatives to produce new products, such as improved quality incense for marketing, by establishing a new value chain. Some research efforts being carried out by researchers at FRC and other institutions on how to produce quality incense by proper tapping methods could also play a significant role in chain upgrading.

#### **Use rights and conflict resolution**

The survey showed that nearly 52% of the respondents have claimed that there are customary user rights to collect and market gum and resin products while the rest have claimed there are no defined user rights. About 29% of the respondents replied that there is no institutional means to assure use rights to gum and resin resources. However, 52, 15, and 4% of the respondents, respectively, have specified local bylaws, national-regional policies, and land certification, respectively, as possible institutional arrangements that could enable the assertion of use rights for gums and resins resources at the current condition. Regarding the occurrence of conflict in the use of the gum and resin resources, 39% of the respondents replied that the observed conflicts were negligible while 29, 24, and 7% of the respondents mentioned occurrence of conflicts at low, high, and medium levels, respectively. About 41, 4, and 56% of the respondent households asserted that customary, national legal, and alternative systems of institutional arrangements, respectively, are the means of conflict resolution in the use of gum and resin resources at their respective localities.

#### **Resources management, utilization, and depletion**

With regard to resource management and its utilization, respondents replied that the frequency of tapping gum- and resin-bearing species is intensive, and the rate of resource depletion varies from moderate to very high levels. About 32% of the interviewed respondents agreed that annual tapping of gum- and resin-bearing species, particularly *B. papyrifera*, is carried out from once up to three times per annum while 68% of them agreed that the tapping is made more than three times a year. About 53, 45, and 2% of the respondents agreed that there is high to very high, low to moderate, and negligible rate of depletion of gum and resin resources, respectively.

## **Discussion**

Typical households in rural Ethiopia engage in a variety of livelihood strategies. There are several “push and pull” factors that trigger these households to attend one or the other kind of livelihood strategies, for instance, to diversify and increase income and exploit emerging opportunities to minimize risks (Babulo *et al.* 2008). According to FAO (1998), the incentives offered, for instance by off-farm activities or forest extraction, might “pull” a household to give due time and invest labor and assets to such activities rather than dwelling only on crop and livestock production. On the other hand, risks associated with climate, mainly exposure to recurrent drought and flood, and inadequate farm outputs might “push” a household to attend some other activities (Barrett *et al.* 2001). Likewise, harvesting forest products as sources of subsistence and cash income is a long-standing tradition of farming and pastoral households in Ethiopia (Babulo *et al.* 2008, Lemenih *et al.* 2003, Lemenih *et al.* 2007, Worku *et al.* 2011a). Ethiopia

is one of the few countries endowed with diverse forest resources that bear different high value commercial NTFPs. Among the most popular include forest coffee as well as gums and resins (FAO 2010, Lemenih & Kassa 2011, Woldemariam 2003). The vast low-lying agro-ecological zones of the country are home for one of the world's largest dry forests and woodlands, rich in gum- and resin-producing species (WBISPP 2004). According to Lemenih and Teketay (2004) and Worku *et al.* (2011c), these forest resources offer high-value gum and resin products with local, national, and international significances in addition to their indispensable role in maintaining a functioning environment in the fragile drylands.

Various research reports from the different parts of the world have shown the socio-economic importance of forest products. For example, NTFPs contributed about 40% of the total official forest revenues and 55% of forest-based employment in India, while in Botswana recently the government recognized that the value of NTFPs exceeds that of timber exports (Neumann & Hirsch 2000). In Guatemala, the harvest of only three NTFPs generate between four and seven million dollars in export income per year (Marshall *et al.* 2006). In Ethiopia, Lemenih *et al.* (2003) reported that gum and resin collection share up to 32% of the household's annual cash income in Somali National Regional State, next to only livestock sector. Similarly, Worku *et al.* (2011a) found gum and resin resources as a key safety-net player in time of drought among the Borana pastoral communities. The current study provided empirical evidences to strengthen the earlier findings on the socio-economic importance of gum and resin resources in Ethiopia. In spite of the observed differences in the scale of contribution among the studied localities, gums and resins are among the major livelihood occupations for vast majority of the studied households. Although most NTFPs in Ethiopia and other parts of the world have mostly subsistence roles (e.g., Shiba & Michael 2012), gum and resin resources represent a considerable amount of the annual cash income of households, the contributions ranging from about 4% in Tanqua Abergele, northern Ethiopia, to about 38% at BGNRS, northwestern Ethiopia. The relatively larger share of income from gums and resins in the households at Wenbera, BGNRS, is in agreement with the report for SNRS, southeastern Ethiopia. With their study targeting pastoral communities in southeastern Ethiopia, Lemenih *et al.* (2003) reported that gums and resins contributed to 32% of the annual income of households, only next to the livestock sector. Similarly, Worku *et al.* (2011a) identified gum and resin resources as second and third livelihood occupations in Arero and Yabelo in Borana Zone, southern Ethiopia. Our study revealed that, in the south and southeastern Ethiopia, income from gums and resins has become even more important in the face of climate change and when incomes from other livelihood activities diminish due to drought. The low contribution of gum and resin resources to the income of households at Tanqua Abergele might be due to higher dependence on

farming for income generation and income obtained from the sale of labor to the nearby commercial farms.

Stakeholder mapping identified three broader categories of actors involved in the gum and resin marketing value chain at the studied localities, namely: (i) rural farming and pastoral communities, which could be either individual or cooperative producers or sellers; (ii) cooperatives whose members are town dwellers, mainly, engaged in other businesses, including gum and resin marketing; and (iii) government and private companies. In general, the value chain of gums and resins is inefficient, demonstrated by weak horizontal and vertical linkage among the actors and poor communication and information dissemination, which, coupled with other factors, contributed to low pricing, lack of or extended waiting for buyers in some of the localities, etc. Looking at the value chain starting from local collectors up to export market, the profit to local, national, and international traders are about 22, 33, and 45%, respectively. In the northern part of the country, quite a number of companies are competing for limited resources and type of products. However, in southern and southeastern Ethiopia, where there are ample resources and diverse product types, companies are few (Woldeamanual 2011).

In addition to their contribution to the local communities and private sector, the gum and resin resources have considerable importance to the national economy and sustainable development of Ethiopia. Based on the data obtained from the National Revenue and Customs Authority, gums and resins are among the very few forest-based commercial articles exported to foreign markets from Ethiopia. During 2001 to 2010, the country earned more than USD 5 million annually (ERCA 2010). Business involving gum and resin resources offered thousands of jobs almost throughout the year since, even when their collection is seasonal, processing and grading activities might remain for longer periods, at least at the main processing stations. Also, respondents mentioned that collection and marketing of gums and resins are environmental friendly and, hence, enable them to combine landscape protection, mainly, in the fragile drylands. Such perceptions of respondents are in agreement with the FAO's rationale of maintaining dry forests on the landscape (FAO 2010).

Despite their significant local- and national-level socio-economic and ecological contribution, several problems undermine the optimal utilization of gum and resin resources in Ethiopia. Although national-level professional discussions have long suggested the need for specific policy that could guide development of efficient value chain and sustainable management of the gum and resin resources, the suggestion did not gain the appropriate attention of policy makers. Even if the price of gums and resins showed increasing trend, e.g., from USD 1,467 tonne<sup>-1</sup> in 1997 to USD 3,565 tonne<sup>-1</sup> in 2010, and the quantity of export increased from 2,136 to 3,518 tonnes in the same years (ERCA 2010), the market chain remain underdevel-

oped. There was no value addition, except some sort of traditional grading.

Ecological assessment reports (Eshete *et al.* 2011, Lemenih *et al.* 2007) showed that the valuable resource bases have been degrading alarmingly over the years. These gaps could be solved through mainstreaming the versatile dry forest resources and their products into the main development agenda, including enacting specific policies and putting in place appropriate institutional arrangements as needed.

### Recommendations

The following are key policy and development interventions that, if considered and addressed, could enhance the socio-economic importance of the gum and resin value chain at the local and national levels in Ethiopia, while also increasing responsibility and commitment towards long-term management of the resource bases.

- Launching integrated awareness creation programs that will promote the overall socio-economic and ecological importance of the gum- and resin-bearing dry forests and the need to urgently minimize their severe deforestation across the whole range of the country.
- Setting a comprehensive policy and regulations at national and regional levels that will guide the intended sustainable use of dry forest resources and products. This could be addressed via introduction of appropriate land-use planning, resource ownership, and management strategies within the frame of the current government-led watershed development approach.
- Setting specific market regulation policy that will govern access to resources, markets, technologies, and finance and, thereby, promote not only sustainable development of dry forests but pro-poor producer value chain of gum and resin resources in the country.
- Despite the repeated discussion made on different forums about promotion of an internationally agreed upon certification program for various products in Ethiopia, (e.g., organic certification for major gums and resins) one has not been implemented. Working in this direction will be a key step forward to optimize revenues via improving price and rational distribution of profit margins, and thereby local and national accountability for sustainable management of the dry forest and woodland resources base.
- There is a need to reconcile the observed pro-company policy issues that hinder participation of and fair benefit sharing by local communities. For instance, the "one cooperative per district" policy in the ANRS has been mentioned to pose problems for local communities since one cooperative allows a limited number of memberships.
- Tapping the scattered gum and resin markets is not an easy matter (Lemenih & Teketay 2004). Local commu-

nities should be organized into functioning, but also proactive, cooperatives or unions and other means of social organizations. This is necessary since external traders are always after profit maximization with little investment for long-term maintenance of the resource base and fair share of benefits.

- Studies suggest existing tapping techniques are either inefficient (e.g., damage the tree) or inappropriate for the various gum- and resin-bearing species. Until recently, there is no suitable tapping technique to tap gum- and resin-bearing species except *B. papyrifera*. Hence, searching for best techniques to optimize harvesting of quality product from different species, product processing, and value addition to the final product (e.g., grading based on chemical composition and oil extraction) are critical (Asefa 2011).
- Substantiated via key informant discussions in the present study, case studies from different localities showed that various gum- and resin-bearing species, including the key *B. papyrifera*, exhibited hampered natural regeneration (Eshete *et al.* 2005, Eshete *et al.* 2011). Enhancing landscape-level rehabilitation of the already degrading dry forests in general and selected high value gum- and resin-bearing species in particular is, hence, a key concern to conform the long-term benefits of local communities and the country. Such appeals could be achieved through area enclosures (Aerts *et al.* 2009) and other means of integrated resources management such as watershed approach (Birhane *et al.* 2006, Mengistu *et al.* 2005a, 2005b).
- Afforestation and reforestation programs in Ethiopia have focused on highland woody species so far, and little is known about how to propagate the various lowland woody species. Hence, due attention should be given to research aimed at developing protocols for the efficient propagation and field establishment of gum- and resin-bearing species.
- Research has to also address consumer characteristics as well as environmental and social issues that affect the marketing chain of gums and resins in the country.
- Cooperatives and investors engaged in marketing of gums and resins should also be responsibly involved in the sustainable resource management of gum and resin resources.

### Acknowledgments

The logistic provision from Forestry Research Center of the Ethiopian Institute of Agricultural Research is highly appreciated. We thank all the stakeholders at all levels of the value chain of gum- and resin-bearing resources including farmers, pastoralists, agro-pastoralists, office managers and experts, and firm and enterprise owners for their unreserved cooperation during the survey period and for their provision of secondary data. We also extend our thanks to Kassahun Mammo, Kifle Asfaw, Omarsherif Mohammed, Zebene Taddese, Tatek Dejene, Asmamaw

Alemu, Alemayehu Negasa, and Worku Zewdie for their indispensable contribution at various levels of the study.

### Literature Cited

- Aerts, R., J. Nyssen & M. Haile. 2009. On the difference between “exclosures” and “enclosures” in ecology and the environment. *Journal of Arid Environments* 73:762–763.
- AFC (Agriculture and Food Council of Alberta). 2004. *Value Chain Guidebook: A process for value chain development (2<sup>nd</sup> edition)*, Alberta, Canada.
- Ambrose-Oji, B. 2003. The contribution of NTFPs to the livelihoods of the ‘forest poor’: Evidence from the tropical forest zone of south-west Cameroon. *International Forestry Review* 5:106–117.
- Asefa, M. 2011. A preliminary physicochemical study on the meaningfulness of grading in *Boswellia papyrifera* (Del.) Hochst (frankincense) trade. Pp. 87–100 in *Proceedings of the National Workshop on Research and Development in Dryland Forests of Ethiopia*. Edited by A. Worku, G. Animut, H. Kassa, S. Sintayehu, W. Tadesse & Y. Gebru. Forum for Environment, Addis Ababa, Ethiopia.
- Babulo, B., M. Bart, N. Fredu, T. Eric, N. Jan, D. Jozef & M. Erik. 2008. Household livelihood strategies and forest dependence in the highlands of Tigray, Northern Ethiopia. *Agricultural Systems* 98:147–155.
- Barrett, C., T. Reardon & P. Webb. 2001. Non-farm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food Policy* 26:315–331.
- Birhane, E., D. Teketay & P. Barklund. 2006. Actual and potential contribution of exclosures to enhance biodiversity of woody species in the drylands of Eastern Tigray. *Journal of Drylands* 1:134–147.
- Campbell, B.M., S. Jeffrey, W. Kozanayi, M. Luckert, M. Mutamba & C. Zindi. 2002. *Household livelihoods in semi-arid regions: options and constraints*. CIFOR, Bogor, Indonesia.
- CIFOR (Center for International Forestry Research). 2005. *Forest products, livelihood and conservation, case study of NTFPs system. Volume 2 – Africa*. CIFOR, Bogor, Indonesia.
- Creswell, W. 2009. *Research design. qualitative, quantitative and mixed methods approach*. SAGE Publications, New Delhi, India.
- Dalle, G., M. Brigittie & I. Johannes. 2005. Plant biodiversity and ethnobotany of Borana pastoralists in southern Oromia, Ethiopia. *Economic Botany* 59:43–65.
- ECA (Economic Commission for Africa). 2007. *Africa Review Report on Drought and Desertification: Fifth meeting of the Africa Committee on Sustainable Development (ACSD-5 Regional Implementation Meeting (RIM) for CSD-16)*. ECA, Addis Ababa, Ethiopia.
- ERCA (Ethiopian Revenues and Customs Authority). 2010. *Ethiopian Revenue and Custom 2010*. ERCA, Addis Ababa, Ethiopia.
- Eshete, A., D. Teketay & H. Hulten. 2005. The socio-economic importance and status of populations of *Boswellia papyrifera* (Del.) Hochst. in northern Ethiopia: The case of North Gondar Zone. *Forests Trees and Livelihoods* 15:55–74.
- Eshete, A., S. Frank & B. Frans. 2011. Diversity and production of Ethiopian dry woodlands explained by climate- and soil-stress gradients. *Forest Ecology and Management* 261:1499–1509.
- Ethiopian NAPA (National Adaptation Programme of Action). 2007. *Climate Change National Adaptation Programme of Action*. Ethiopian NAPA, Addis Ababa ([www.preventionweb.net/files/8522\\_eth01.pdf](http://www.preventionweb.net/files/8522_eth01.pdf), accessed on 22 August 2011).
- FAO. 1998. *Rural Non-farm Income in Developing Countries*. Economic and Social Development Department. FAO Rome, Italy ([www.fao.org/docrep/w9500e/w9500e12.htm](http://www.fao.org/docrep/w9500e/w9500e12.htm), accessed on 28 July 2012).
- FAO. 2010. *Guideline on Sustainable Forest Management in Drylands of Sub-Saharan Africa. Arid Zone Forest and Forestry Working Paper No. 1*. FAO, Rome, Italy.
- ICRAF. 2009. *Making Sub-Saharan Africa Forest Work for People and Nature: Policy approaches in a changing global environment*. ICRAF, Nairobi, Kenya.
- IPCC. 2007. *Africa: Climate Change, Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC on Climate Change*. IPCC, Cambridge University Press, U.K.
- Gemtessa, K. 2001. *Study to Initiate Sustainable Micro-finance Service in the Somali National Regional State: Report submitted to the regional affairs sub-sector of the Prime Minister’s Office and the Somali Regional Government*. Addis Ababa, Ethiopia.
- Georgis, G., A. Dejene & M. Malo. 2010. *Agricultural Based Livelihood Systems in Drylands in the Context of*

- Climate Change: Inventory of adaptation practices and technologies of Ethiopia*. FAO, Rome, Italy.
- Kassa, H., T. Berihun & F. Girmay. 2011. *Preliminary Value Chain Analysis of Gum and Resin Marketing in Ethiopia: Issues for policy and research*. CIFOR Brief No. 4, Bogor, Indonesia.
- Lemenih, M. 2005. Production and marketing of gums and gum-resins in Ethiopia. Pp. 55–70 in *Production and Marketing of Gum and Resin: Frankincense, myrrh, and opopanax*. Edited by B. Chikamai & E. Casadei. Network for Natural Gum and Resin in Africa (NAGARA), Nairobi, Kenya.
- Lemenih, M. & D. Teketay. 2003. Frankincense and myrrh resources of Ethiopia: II. Medicinal and industrial uses. *SI-NET, Ethiopian Journal of Science* 26:161–172.
- Lemenih, M. & D. Teketay. 2004. Natural gum and resin resources: Opportunity to integrate production with conservation of biodiversity, control of desertification and adapt to climate change in the drylands of Ethiopia. *Paper Presented to the First National Workshop on Conservation of Genetic Resources of Non Timber Forest Products (NTFPs) in Ethiopia*. Addis Ababa, Ethiopia.
- Lemenih, M. & H. Kassa, eds. 2011. *Opportunities and Challenges for Sustainable Production and Marketing of Gums and Resins in Ethiopia*. CIFOR, Bogor, Indonesia.
- Lemenih, M., S. Feleke & W. Tadesse. 2007. Constraints to smallholder's production of frankincense in Metema District, north-western Ethiopia. *Journal of Arid Environments* 71:393–403.
- Lemenih, M., T. Abebe & O. Mats. 2003. Gum and resin resources from some *Acacia*, *Boswellia*, and *Commiphora* species and their economic contributions in Liban, south-east Ethiopia. *Journal of Arid Environments* 55:465–482.
- Marshall E., K. Schreckenber & A.C. Newton, eds. 2006. *Commercialization of Non-timber Forest Products: Factors Influencing Success. Lessons learned from Mexico and Bolivia and policy implications for decision-makers*. UNEP and World Conservation Monitoring Centre, Cambridge, U.K.
- Mengistu, T., D. Teketay, H. Hulten & Y. Yemishaw. 2005a. The role of enclosures in the recovery of woody vegetations in the hillside of central and northern Ethiopia. *Journal of Arid Environment* 60:259–281.
- Mengistu, T., D. Teketay, H. Hulten & Y. Yemishaw. 2005b. The role of communities in closed area management in Ethiopia. *Mountain Research and Development* 25:44–50.
- MoFED (Ministry of Finance and Economic Development). 2010. *Ethiopia: Millennium Development Goal Report*. MoFED, Addis Ababa, Ethiopia.
- Neumann, R.P. & E. Hirsch. 2000. *Commercialization of Non-Timber Forest Products: Review and analysis of research*. Center for International Forestry Research Bogor, Indonesia, and Food and Agriculture Organization of the United Nations, Rome, Italy.
- Shiba, P.K. & G.J. Michael. 2011. NTFP income contribution to household economy and related socio-economic factors: Lessons from Bangladesh. *Forest Policy and Economics* 14:136–142.
- Teketay, D. 2004–5. Causes and consequences of dryland forest degradation in Sub-Saharan Africa. *Walia* 24:3–20.
- Tesfaye, Y., R. Anders, M.C. Bruce & B. Folke. 2011. Livelihood strategies and the role of forest income in participatory-managed forests of Dodola area in the Bale highlands, southern Ethiopia. *Forest Policy and Economics* 13:258–265.
- Toure, S. 2009. Gum arabic and gum resins. *International Trade Centre's (ITC) Market News Service, Issue 2*. Geneva, Switzerland.
- WBISPP (Woody Biomass Inventory and Strategic Planning Project). 2004. *Forest Resources of Ethiopia*. Ministry of Agriculture and Rural Development, Addis Ababa, Ethiopia.
- Woldeamanuel, T. 2011. *Dryland Resources, Livelihoods and Institutions: Diversity and dynamics in use and management of gum and resin trees in Ethiopia*. PhD Dissertation, Wageningen University, Wageningen, Netherlands.
- Woldemariam, T. 2003. Vegetation of the Yayu forest SW Ethiopia: Impacts of human use and implication for *in situ* conservation of wild *Coffea arabica* L. populations. *Ecology and Development Series No. 10*, University of Bonn, Germany.
- Worku, A., D. Teketay, M. Lemenih & M. Fetene. 2011a. Socio-economic importance of gum and resin resources in the dry woodlands of Borana, southern Ethiopia. *Forests, Trees and Livelihoods* 20:137–156.
- Worku, A., D. Teketay, M. Lemenih & M. Fetene. 2012. Diversity and population structure of gum and resin producing woody species in Borana, southern Ethiopia. *Journal of Forest, Trees and Livelihood* iFirst article, 2012:1–12.
- Worku, A., A. Alemu & W. Tadesse. 2011b. Overview of research achievements and gaps on dryland forests of Ethiopia: The case of gum-resins bearing resources. Pp. 1–24 in *Proceedings of the National Workshop on Research*

*and Development in Dryland Forests of Ethiopia*. Edited by A. Worku, G. Anmut, H. Kassa, S. Sintayehu, W. Tadesse & Y. Gebru. Forum for Environment, Addis Ababa, Ethiopia.

Worku, A., J. Pretusch, H. Kassa & U Uibrig. 2011c. When there is not enough milk and meat! Would improved management of dryforests and products marketing contribute to the adaptive capacity of pastoral and agro-pastoral communities and to environmental resilience in Ethiopia?

Pp. 201–212 in *Proceedings of the 2<sup>nd</sup> International DAAD Workshop on Forest in Climate Change Research and Policy: The role of forest management and conservation in complex international settings*. Edited by F. Lutz & K. Christophe. Cuvillier Verlag, Göttingen, Germany.

Yin, R. 2009. *Case Study Research: Design and methods, Volume 5*. International Professional Publisher, Sage Publishing, New Delhi, India.