



# **Opportunities and challenges for sustainable production and marketing of gums and resins in Ethiopia**

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# Abbreviations

ADA	Austrian Development Agency
ASAL	Arid and semi-arid land
masl	Metres above sea level
BP	British Pharmacopoeia
CBC	Convention on Biodiversity Conservation
CCD	Convention to Combat Desertification
CIFOR	Center for International Forestry Research
CRV	Central Rift Valley of Ethiopia
DBH	Diameter at breast height
EC	Ethiopian calendar
EFAP	Ethiopian Forestry Action Program
EFY	Ethiopian fiscal year (from 7 July to 6 July)
EIAR	Ethiopian Institute of Agricultural Research
FAO	Food and Agricultural Organization of the United Nations
FRC	Forest Research Centre
IP	International Pharmacopoeia
IPCC	Intergovernmental Panel for Climate Change
JECFA	Joint Expert Committee for Food Additives
MOARD	Ministry of Agriculture and Rural Development
NCSS	National Conservation Strategy Secretariat
NGARA	Network for Natural Gums and Resins in Africa
NGO	Nongovernmental organisation
NGPME	Natural Gum Processing and Marketing Enterprise
NTFP	Non-timber forest product
P	Precipitation
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
PET	Potential evapotranspiration
TLU	Tropical livestock units
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
USP	United States Pharmacopoeia
WHO	World Health Organization



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# Foreword

Ethiopia has widely differing agro-ecological zones, commonly classified into highlands – areas above 1500 metres above sea level – and lowlands, those below. Arid and semi-arid lands (ASALs), a class of drylands, are important in both the highlands and the lowlands of Ethiopia. These areas are poverty-stricken and largely food insecure, despite being endowed with resources that could provide alternative and sustainable livelihoods if they were properly exploited and developed. Vegetation in Ethiopia's ASALs includes diverse plant species that produce commercially important oleo-gum resins such as gum arabic, frankincense, myrrh and opoponax. These products have been traded both locally and internationally for centuries and make a significant contribution to the national and local economies. They also have a range of industrial applications.

The production of gums and resins can be successfully integrated with livestock husbandry, apiculture and ecotourism, thus helping to diversify and sustain dryland livelihood options and increase household income. The important role of dry forests in soil and water conservation, biodiversity management and the fight against desertification is well known. Nonetheless, management of dry forests in order to enhance the economic and ecological benefits of gum- and resin-producing tree species is limited. One of the major constraints on promoting sustainable management of dry forests and their valuable tree species is the lack of awareness of their importance combined with inadequate knowledge about sustainable production and marketing of their products. Building understanding of the constraints and opportunities is an important step in closing this knowledge gap.

Our partners in Ethiopia and in the region requested the collection and compilation of available information on the production and marketing of gums and resins. The result is this publication, which sets out the need for vegetation-based land management as a sustainable option for the country's drylands, and highlights the potential and constraints related to the production and marketing of gums and resins in Ethiopia. We hope the information in this publication proves relevant for policymakers, researchers, teachers, development practitioners, investors and the public at large.

# Chapter 1

## Challenges and forest-based opportunities in the drylands of Ethiopia

Mulugeta Lemenih<sup>1</sup> and Habtemariam Kassa<sup>2</sup>

### 1.1 Drylands of Ethiopia

Drylands comprise the greater part of Ethiopia's landmass. Drylands are variously defined as areas characterised by a seasonal climate with several months of drought (Murphy and Lugo 1986), areas having a growing period of  $\leq 180$  days or areas with an aridity index of  $\leq 0.5$  (UNESCO 1979). UNESCO's aridity index refers to the ratio of potential evapotranspiration (PET) to precipitation (P); thus, all lands for which  $PET/P \leq 0.5$  are classified as drylands. This definition encompasses areas traditionally described as arid, semi-arid and dry subhumid, as well as the driest hyper-arid areas. Arid and semi-arid lands (ASALs) are estimated to cover 560 000–615 000 km<sup>2</sup> (50–55%) of the total landmass of Ethiopia. When dry subhumid areas are included in the definition, the total extent of the country's drylands may be 860 000–915 000 km<sup>2</sup> (76–81%) (Table 1.1). Drylands thus predominate across the lowlands and highlands in the country's north, east, west, central, south, southeast and northwest regions.

**Table 1.1** Estimated extent of drylands in Ethiopia

Bioclimatic zone	Area ('000 km <sup>2</sup> )	
	Lowest estimate	Highest estimate
Hyper-arid	53	55
Arid	300	310
Semi-arid	207	250
Dry subhumid	300	300
Total	860	915

Source: Lemenih and Teketay (2004)

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The drylands of Ethiopia support a significant proportion of the country's human and livestock populations, although the population is heavily concentrated in the dry subhumid region. ASALs, which are the focus of this publication, are relatively sparsely populated, home to only 12–15% of Ethiopia's 80 million people. Most of the people in ASALs are pastoralists and agro-pastoralists. They have long recognised the critical importance of sound management of the natural resource base in providing them with the diverse products and services that are important for their livelihoods. Thus, they have adopted pastoralism, which is a flexible, opportunistic and compatible production system, in the risk-prone ASAL environments. They also have selected highly adaptive and productive livestock species and breeds. Mobility is the norm of the production system to better exploit the various resources available during different seasons and in different locations.

Pastoralists place greater value on perennial vegetation than on annual crops because it has multiple functions, such as providing browse, particularly during the dry season, wood for carving, hut construction and energy, and a source of income from the sale of timber and non-timber products (Lemenih *et al.* 2003, Lemenih and Teketay 2004). The income from non-timber products such as gums and resins is crucial for food security in ASALs. Many of the gum and resin products obtained are traded internationally, generating considerable foreign currency earnings and supporting the national economy of Ethiopia and many other Sudano-Sahelian countries.

Demographic, environmental, socio-economic and political changes are putting pressure on the use and management of drylands.<sup>3</sup> Today, many dryland communities are experiencing increasing hardships, frequent droughts and food insecurity, as well as a declining quality of life. Areas in Ethiopia's drylands are probably amongst those with the country's highest incidence of poverty and poor access to basic social services such as infrastructure, education and health services. Due to the general misconception that drylands are resource-poor areas, they have not attracted much investment or any significant development initiatives from either the private or the public sector. These problems are further compounded by stresses related to global climate change.

## 1.2 Challenges facing the drylands of Ethiopia

The drylands of Ethiopia are facing multiple natural and anthropogenic challenges. The low and erratic rainfall is probably the most important natural problem, limiting the possibility of sustainable livelihoods from crop and animal production. In about 22% of drylands, cultivation is not possible even with

<sup>3</sup> Hereafter, unless otherwise indicated, the term 'drylands' is used to refer to ASALs.

early-maturing crops (NCSS 1993, Hawando 1997). In the remaining areas, the unpredictable timing and low amounts of rainfall have always been a severe constraint on agricultural production. Agriculture in ASALs often requires additional investment, especially in irrigation facilities and other infrastructure (Steen 1994, Lemenih *et al.* 2003). Consequently, livestock production in the form of nomadic pastoralism has been the dominant land use system. However, in recent years, the upsurge in human and livestock population, recurrent droughts, severe land degradation and the consequent shortage of fodder and water have added further constraints on the sustainability of the pastoral land use system. Food insecurity is widespread in Ethiopia's ASALs, and food aid has become common.

Ethiopia's drylands are experiencing rapid changes in both the human and livestock populations. Several factors are behind the population growth, one of the most important being government-initiated resettlement programmes. Successive governments have used resettlement to the lowland dry forests as a strategy for reducing the food insecurity of vulnerable households in the degraded highland areas (Kebede 2006). In addition to the official resettlement programme, deteriorating livelihood conditions in the highlands due to land degradation have triggered large informal migration to the lowlands. These formal and informal resettlements are causing rapid demographic and land use changes in the drylands of Ethiopia.

Over most of the country's ASALs, nomadic pastoralism is gradually shifting to agro-pastoralism, and agro-pastoralists are being encouraged to become sedentary farmers. This changing mode of life coupled with the population increase has encouraged rapid villagisation and the emergence of urban centres. This in turn has increased the demand for timber products for construction and energy, triggering further deforestation over large areas of the drylands. Poor farming practices, population pressure, overgrazing, soil erosion, deforestation and the use of livestock manure and crop residue as fuel, combined with erratic rainfall, are leading to recurrent crop failures. Consequently, people often turn to harvesting and overharvesting of forest products, notably timber, to augment their household income, thus further driving land degradation and desertification. Desertification is a widely encroaching challenge across Ethiopia's drylands (Hawando 1997).

Global climate change is adding further stress to dryland areas. Ethiopia and similar African countries are likely to suffer most from the effects of climate change, even though their contribution to its causes is negligible on a global scale. The African continent as a whole is likely to be highly vulnerable to the effects of climate change not only because of increasing aridity and other climatic

anomalies, but also because of the widespread poverty that limits the population's capacity to adapt to climate change. According to the Intergovernmental Panel on Climate Change (IPCC 2001), temperatures in land areas across the Sahara and semi-arid parts of Africa may increase by as much as 1.6 °C by 2050. Equatorial Africa might be about 1.4 °C warmer. Mean annual precipitation has gradually declined during the past couple of decades, and the frequency of irregularities has increased. Projected rainfall changes indicate a decline by about 10% by 2050 over the Horn of Africa, and potential evapotranspiration is projected to increase by 5–10% (IPCC 2001). This will lead to increased moisture stress in the drylands, and hence further decline in crop and fodder production.

To summarise, with the growing human and livestock population, increased deforestation and land degradation, shrinking farm size, advancing desertification and poor infrastructure, in addition to gloomy scenarios in connection with global climatic changes, the prognosis for the drylands of Ethiopia looks grim. It is thus essential to enhance people's adaptive capacity and promote land use systems that contribute to increased environmental resilience and better livelihoods. The question, then, is what types of curative opportunity exist for these stressed and marginal lands?

### 1.3 Opportunities for forest-based enterprises

Despite the general perception that drylands are resource-poor areas, several studies indicate that the forests and woodlands in Ethiopia's drylands offer good opportunities for improving rural livelihoods and reducing poverty. Dry forests, which cover about 55–60% of the country's drylands (WBISPP 2004), are important in terms of their contributions to human welfare and environmental health. Everywhere, dry forests provide diverse goods and services such as fodder, fuel, cash income, building materials and herbal medicines, and they help to protect the soil from erosion and to restore soil fertility. Most importantly, several species of the genera *Acacia*, *Commiphora*, *Boswellia* and *Sterculia* yield commercial plant gums and resins that have been traded since antiquity (EFAP 1994, Lemenih *et al.* 2003). The best known of these products are gum arabic, frankincense/gum olibanum, myrrh, opoponax and gum karaya. Ethiopia has one of the largest resource bases for commercial plant gum and resin production (Kuchar 1995, Tadesse *et al.* 2002). Studies have shown that the country's natural gums subsector offers viable investment options for invigorating economic development in the drylands (Lemenih 2005, Roukens *et al.* 2005). Moreover, global demand for these products is growing. Improving access to this global market could create economic incentives for farmers to sustainably manage the dry forests. Higher prices also encourage efforts to improve the quality of gums and resins. This in turn contributes to local and national economic growth.

The collection, use and trade of gums and resins are age-old activities in Ethiopia. The subsector's contribution both to the national economy and to local communities cannot be overlooked. It offers one of the few opportunities available for dryland communities to supplement their cash incomes, particularly during dry seasons, and thus its role in food security is tremendous (Lemenih *et al.* 2003). The great potential for gum and resin production and marketing implies that the implementation of appropriate policy and resource management measures could enhance the socio-economic and ecological gains from the subsector (Tadesse *et al.* 2002, Lemenih *et al.* 2003, Eshete *et al.* 2005). Another advantage of the gum and resin resource base is that production can be integrated with other forms of production, particularly with livestock production, apiculture, sericulture and civiculture, to optimise returns per unit area.

Tree-based management of drylands has a number of advantages. It helps fight desertification, promotes conservation of biodiversity and assists farmers to better adapt to climate change (Lemenih and Teketay 2004). By so doing, it helps maintain healthy social and ecological systems. The production of gums and resins, when properly practised, is non-destructive to either trees or the ecosystem. The trees remain standing to continue providing ecosystem services. Thus, this development option enables the successful marriage of sustainable livelihood provision and ecosystem conservation. Gum- and resin-producing species are adapted to extreme aridity, which makes them appropriate options for dryland conservation and combating desertification.

Ethiopia is a party to and has ratified several international conventions of direct relevance to dryland environments, such as the UN Convention to Combat Desertification (CCD), Convention on Biodiversity Conservation (CBC) and Framework Convention on Climate Change (UNFCCC). Promoting tree-based land use systems in the drylands significantly assists the country to meet its requirements under these conventions. The following points summarise how gums and resins can contribute to the development of dryland areas in Ethiopia.

- Gum and resin products and their vegetation resources provide substantial economic incentives at local and national levels, and thus contribute to food security and improved livelihoods.
- The vegetation resources can offer alternative development opportunities through integration with other economic sectors such as livestock husbandry and apiculture to diversify income sources and optimise return per unit area. In particular, livestock husbandry, which is the dominant land use and principal capital asset of the pastoral families inhabiting ASALs, heavily depends on the same vegetation as a source of fodder.
- Local people can use some of the gums and resins from these plants as emergency food during famine periods, making them a safety net.

- The plant can help in combating desertification and assisting dryland communities to adapt to climatic changes (Teketay and Lemenih 2004).

Despite this potential, exploitation of these resources has not yet generated useful gains. People in the drylands of Ethiopia continue to experience severe poverty and critical food insecurity. Factors contributing to the neglect of these resources include (1) lack of awareness of the potential of the resources, particularly non-timber forest products (NTFPs); (2) lack of clearly defined policy on the development of drylands; and (3) ill-informed agricultural development strategies that solely focus on agricultural expansion. Nevertheless, the national and local contributions from these dryland vegetation resources are increasing.

## 1.4 Dryland vegetation resources of Ethiopia

Dry forests comprise Ethiopia's largest vegetation resource. The structure and composition of the country's dry forests are diverse, reflecting their wide distribution across various climatic types and a broad altitudinal range spanning from the salt marshes of the Afar depression below sea level to the dry cool subafroalpine mountains. Structurally, dry forests cover the spectrum from a 'real' forest (closed canopy with tall trees) to desert scrub. Compositionally, the forests are rich in endemic plant and animal species, especially in the lowlands in the country's southeast. Perhaps one in four of Ethiopia's plant species is found in this part of the country, which is characterised by its high diversity of *Acacia* and *Commiphora* species. The latter are particularly important, as about half of the 150–200 species of the genus are endemic to the small area of southeastern Ethiopia, northeastern Kenya and Somalia.

According to the Conservation Strategy of Ethiopia (CSE 1997), 9 broad vegetation types are recognised in Ethiopia. Of these, 7 can be designated as dry forests: (1) dry evergreen afroalpine vegetation; (2) *Combretum–Terminalia* (broad-leaved) deciduous woodlands; (3) *Acacia–Commiphora* (small-leaved) deciduous woodlands; (4) lowland dry forests; (5) riparian (wetland) vegetations; (6) lowland semi-desert and desert vegetation; and (7) evergreen scrubs.

### 1.4.1 Dry afroalpine vegetation

Vegetation in the seasonally dry mountainous areas in the central, eastern and northern highlands of Ethiopia is collectively classified as dry afroalpine vegetation (Figure 1.1). Afroalpine vegetation is found in areas at 1500–3200 metres above sea level (masl). The drier eastern areas are mainly composed of *Juniperus procera* and/or *Afrocarpus falcatus* species, with *Acacia abyssinica* and *Olea europaea* commonly appearing together also. Other trees in the area include *Prunus africana*, *Apodytes dimidiata*, *Allophylus abyssinica* and *Euphorbia*



*ampliphylla*. This class of vegetation is poor with respect to commercial gum- and resin-producing species, but is rich in species with other commercial NTFPs, such as *Prunus africana*, a well-known medicinal plant.

#### 1.4.2 *Combretum–Terminalia* (broad-leaved) deciduous woodlands

Broad-leaved deciduous forests and woodlands are found in the western and northwestern lowlands of Ethiopia. Land in the moister western lower altitudes have deeper soils and support deciduous forests with considerable ground cover (Figure 1.2), which are the extension of Sudano-Sahelian vegetation formation (Ogbazghi 2001). Fires occur frequently, especially following human influxes from the surrounding highlands. Although natural fire has caused no noticeable deterioration and plants and animals are adapted to it, the frequency and high intensity of fire caused by human-related activities have harmed vegetation resources in recent years.



Figure 1.1 Examples of dry afro-montane forests in Ethiopia: (a) *Juniperus procera*-dominated dry afro-montane forest of Bale, and (b) *Afrocarpus falcatus*-dominated dry afro-montane forests of Munessa, central Ethiopia. Photos © M. Lemenih

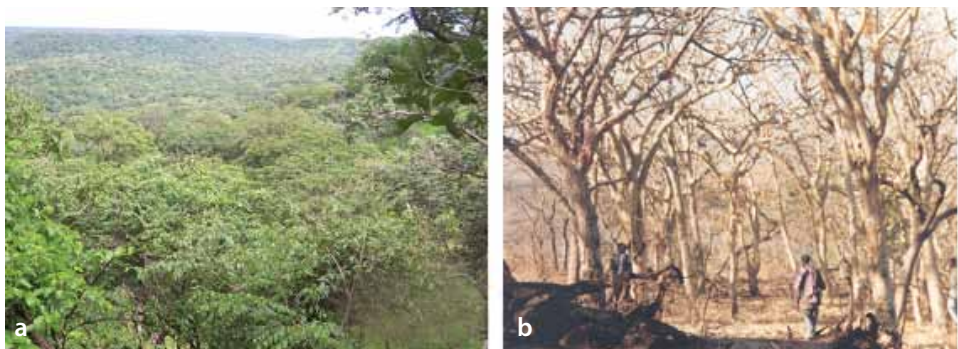


Figure 1.2 *Combretum–Terminalia* (broad-leaved deciduous) woodlands dominated by *B. papyrifera* species (a) during the rainy season and (b) during the dry season in the western lowlands of Ethiopia (Metema). Photos © M. Lemenih (a); G. Fitwi G. (b)

These woodlands represent the main *B. papyrifera*-growing regions in the Horn of Africa (Asfaw 2006).

The main tree species making up the broad-leaved deciduous woodlands of western Ethiopia other than *B. papyrifera* include *Balanites aegyptiaca*, *Combretum adenogonium*, *C. collinum*, *C. molle*, *Terminalia* spp., *Grewia* spp., *Gardenia* spp., *Flueggea virosa*, *Acacia polyacantha*, *A. senegal*, *A. seyal* and *Sterculia setigera*. Of these, *B. papyrifera*, *A. polyacantha*, *A. senegal*, *A. seyal* and *Sterculia setigera* are known to yield commercial gums and resins.

#### 1.4.3 *Acacia–Commiphora* (small-leaved) deciduous woodlands

This vegetation type is predominantly found in the southern, central (Rift Valley) and eastern lowlands of the country at altitudes below 1900 masl. Plant species characteristic of this vegetation type are drought-tolerant small-leaved trees and shrubs, such as *Acacia tortilis*, *A. seyal*, *A. senegal*, *A. etbaica*, *A. sieberiana*, *A. mellifera*, *A. drepanolobium*, *Commiphora africana*, *C. myrrha*, *C. fluviflora*, *C. habessinica*, *C. paolii*, *C. crenulata*, *C. boranensis*, *C. guidotti*, *C. erythraea*, *C. schimperii*, *C. ogadensis*, *C. rostrata*, *C. serrulata*, *C. gileadensis*, *C. hildebrandtii*, *C. erosa*, *C. cyclophylla*, *C. corrugata*, *B. microphylla*, *B. ogadensis*, *B. neglecta*, *B. rivaie*, *Balanites aegyptiaca* and *Maytenus senegalensis* (Figure 1.3). This



**Figure 1.3** *Acacia–Commiphora* (small-leaved deciduous) dryland forest dominated by *Commiphora* and *Boswellia* species in the southeastern and northeastern parts of Ethiopia. Photo © A. Worku (2006) (top); M. Lemenih (bottom)

vegetation formation is the richest in terms of commercial gum- and resin-producing species of the genera *Acacia*, *Commiphora* and *Boswellia*.

#### 1.4.4 Lowland dry forests

In Ethiopia, lowland dry forests are found only in the Baro lowlands of Gambela Regional State. Apart from common trees, this lowland forest is characterised by the presence of species that are widely distributed across tropical Africa and West Africa up to Ghana (Friis 1992). The forest does not contain any of the common gum- and resin-producing tree and shrub species identified in other dryland vegetations in Ethiopia.

#### 1.4.5 Riparian (wetland) vegetation

In the plains of the Rift Valley, water gathers from the surrounding undulating terrains, creating swamps and wetlands. Such wetlands are abundant in the lake regions of the Ethiopian Rift Valley and along the plains of Awash and other major rivers. Although human activity has greatly damaged the wetland and riparian forests of these areas, significant patches remain in localised areas such as around Lake Langano and between the Abaya and Chamo Lakes in Arbaminch. Major species in such vegetation types are *Celtis africana*, *Ficus sycamorus*, *Mimusops kummel*, *Maytenus senegalensis*, *Acacia* spp., *Syzygium guineense* and *Afrocarpus falcatus*.

#### 1.4.6 Lowland semi-desert and desert vegetation

Desert and semi-desert areas are found along the borders of eastern and southern Ethiopia at altitudes below 900 masl. Rainfall in these areas is low and very erratic. Vegetation consists of deciduous shrubs, mostly *Acacia* species, together with sparse evergreen shrubs and succulents (Figure 1.4). *Commiphora* and *Boswellia* species also exist here and, wherever available, they, along with *Acacia* species, provide the highest-quality gum and resin in this vegetation type (Lemenih *et al.* 2003).

#### 1.4.7 Evergreen scrub

Evergreen scrub occupies the undulating and steep slopes of the highland plateaus. It covers vast areas, particularly in the north, west and east in Wello, Tigray, Shewa, Wollega and Hararghe, and is even expanding by overtaking areas where forests have deteriorated. The woody vegetation mainly consists of plants with small, tough, leathery leaves such as *Euclea schimperi*, *Dodonaea angustifolia*, *Carissa edulis*, *Scolopia theifolia*, *Rhamnus staddo*, *Myrsine africana*, *Calpurnia aurea* and *Jasminum abyssinicum*.



**Figure 1.4** Semi-desert vegetation with scattered *Commiphora* and other species in northeastern Ethiopia (Afar). Photo © Lemenih M.

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## Chapter 2

# Resource base of gums and resins and challenges of productivity

Mulugeta Lemenih<sup>1</sup>

### 2.1 Introduction

Several indigenous tree species that grow in Ethiopia's drylands produce diverse and significant quantities of commercial gums and resins. Ethiopia is one of the world's leading producers of incense, notably frankincense (product of *Boswellia* spp.) and myrrh and myrrh-like resins (products of *Commiphora* spp.) (Lemenih and Teketay 2003a, b, 2004). Ethiopia also has a large resource base for the production of gum arabic (product of *Acacia senegal* or *A. seyal*), although current production levels fall far short of the potential. The production and trade volumes of gums and resins in Ethiopia have been increasing since the 1990s. Between 1998 and 2007, Ethiopia exported about 25 192 tonnes – an average of approximately 2519 tonnes per year – of natural gums and resins with a value of 307 248 000 Eth. Birr (34 138 670 USD) (Lemenih and Kassa 2008). The export volume increased on average by 12% each year from 1998 to 2007. Recognition of the contribution that gums and resins make to local livelihoods and the national economy is growing. For instance, PASDEP's (2005) strong recognition of the subsector's economic role led to plans to double production for the period 2005–2010. Nevertheless, little documentation on the resource base is available in Ethiopia. This chapter summarises the information available on the resource base and identifies factors that threaten its sustainability.

### 2.2 Gum- and resin-producing species and their spatial coverage

#### 2.2.1 Gum- and resin-producing species

Ethiopia's diversity of plants that yield commercial gums and resins is one of the highest in the world. About 13 species of *Acacia*, 16 species of *Commiphora* and 6 species of *Boswellia* are known as potential yielders of commercial gums

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and resins in Ethiopia (Table 2.1). Among these, gums from 2 species of *Acacia* and gum resins from 3–4 species of *Commiphora* and 5 species of *Boswellia* are currently produced commercially (Table 2.2). Some of the gum- and incense-producing species are pictured in Figure 2.1. Furthermore, *Sterculia setigera* (Figure 2.1i), which produces a gum called karaya, is also abundant throughout the country, although gum karaya is not yet under commercial production in Ethiopia.

## 2.2.2 Regional distribution and spatial coverage

Gum- and resin-producing species cover substantial areas of Ethiopia. The country also has vast areas that can be considered potentially suitable for cultivating these tree crops – all the country’s arid and semi-arid lands (ASALs),

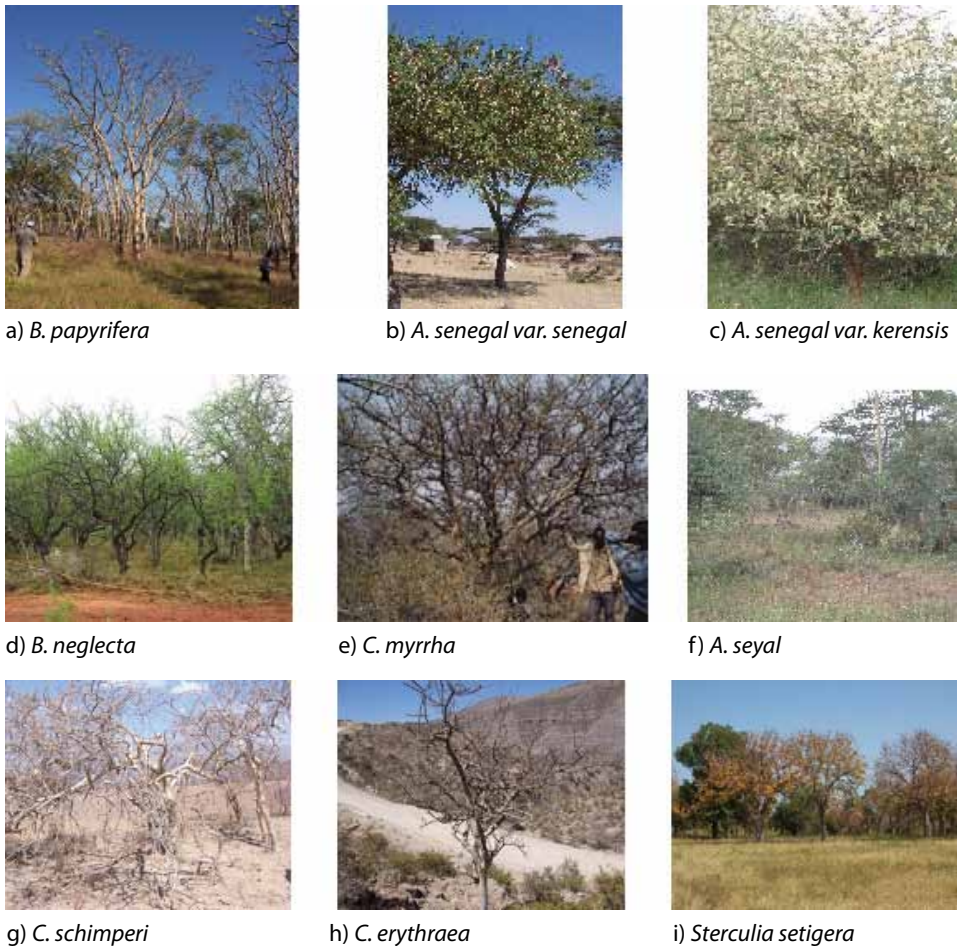
**Table 2.1 Common and potential gums and resins producing *Acacia*, *Commiphora* and *Boswellia* species found in the drylands of Ethiopia**

<i>Acacia</i>	<i>Commiphora</i>	<i>Boswellia</i>
<i>A. etbaica</i> Schweinf.	<i>C. africana</i> (A.Rich.) Engl.	<i>B. microphylla</i> Chiov.
<i>A. drepanolobium</i> Harms ex Sjöstedt	<i>C. boranensis</i> Vollesen	<i>B. ogadensis</i> Vollesen
<i>A. horrida</i> (L.) Willd.	<i>C. corrugata</i> Gillett and Vollesen	<i>B. neglecta</i> S. Moore
<i>A. mellifera</i> (Vahl.) Benth.	<i>C. cyclophylla</i> Chiov	<i>B. rivaie</i> Engl.
<i>A. oerfota</i> (Forssk.) Schweinf.	<i>C. gileadensis</i> (L.) C. Chr.	<i>B. papyrifera</i> (Del) Hochst.
<i>A. polyacantha</i> Willd.	<i>C. guidotti</i> Chiov.	<i>B. pirrotae</i> Chiov.
<i>A. senegal</i> var. <i>senegal</i> Chivo.	<i>C. habessinica</i> (Berg) Engl.	<i>B. sacra</i> Fluckiger <sup>a</sup>
<i>A. senegal</i> var. <i>kerensis</i> Schweinf		
<i>A. senegal</i> var. <i>leiorhachis</i> Brenan	<i>C. kua</i> (R. Br. Ex Royle) Vollesen	
<i>A. seyal</i> var. <i>fistula</i> Schweinf	<i>C. erythraea</i> (Ehrenb.) Engl.	
<i>A. seyal</i> var. <i>seyal</i> Hochst. Ex A. Rich	<i>C. myrrha</i> (Nees) Engl.	
<i>A. sieberiana</i> DC.	<i>C. ogadensis</i> Chiov.	
<i>A. stuhlmannii</i> Taub.	<i>C. rostrata</i> Engl.	
	<i>C. schimperi</i> (Berg.) Engl.	
	<i>C. serrulata</i> Engl.	
	<i>C. truncata</i> Engl.	

Source: Lemenih (2005)

<sup>a</sup> This species is reported to exist in Somalia and may exist in the Ogaden area of Ethiopia, although this is yet to be confirmed.





**Figure 2.1** Some of the gum- and incense-producing species in the woodlands of Ethiopia. Photo © M. Lemenih

which cover an area of 560 000–615 000 km<sup>2</sup>. Although estimates differ, because of the lack of a national-scale forest inventory, naturally growing *Acacia*, *Boswellia* and *Commiphora* species are believed to predominate across an area of 28 550–43 350 km<sup>2</sup> (Table 2.2). Natural gum-producing species occur virtually all over the low-lying zones in the country's west, south, north, east, central (Rift Valley) areas and in the major river gorges such as the Blue Nile, Tekeze, Genale and Wabi Shebelle Rivers. In terms of regional distribution, gum- and resin-producing species are found in the Afar, Amhara, Benishangul-Gumuz, Gambela, Oromia, Somali, Southern Nations and Nationalities and Tigray Regional States.

### 2.2.3 Types of gum and resin products in Ethiopia

Ethiopia produces a variety of natural gums and resins, which can be classified as either aromatic or non-aromatic (Table 2.3). The former category comprises

odoriferous gums and resins such as frankincense (gum olibanum), myrrh and opoponax, and the latter consists of gum arabic and other odourless gums and resins.

**Table 2.2 Estimated extent of area containing vegetation with gum- and resin-producing species in Ethiopia by regional state**

Regional state	Genus	Estimated area (ha)
Afar	<i>Commiphora, Acacia</i>	65 000
Amhara	<i>Boswellia, Commiphora, Acacia, Sterculia</i>	680 000
Benishangul	<i>Boswellia, Acacia, Sterculia</i>	100 000
Gambela	<i>Commiphora, Acacia, Sterculia</i>	420 000
Oromia	<i>Boswellia, Commiphora, Acacia, Sterculia</i>	430 000
SNNP	<i>Boswellia, Sterculia, Acacia</i>	70 000
Somali	<i>Boswellia, Sterculia, Commiphora, Acacia</i>	150 000–1 500 000
Tigray	<i>Boswellia, Sterculia, Commiphora, Acacia</i>	940 000
<b>Total</b>		<b>2 855 000–4 355 000</b>

Source: Fitwi (2000), Lemenih *et al.* (2003)

**Table 2.3 Commercial gums and resins with botanical sources and local designations**

Category	Common name	Botanical source	Local designation
Aromatic gums/resins		<i>B. papyrifera</i>	Tigray type
	Frankincense / Gum olibanum	<i>B. neglecta</i>	Borana type <sup>ab</sup>
		<i>B. rivae</i>	
		<i>B. microphylla</i> <i>B. ogadensis</i> <sup>a</sup>	Ogaden type <sup>b</sup>
	True myrrh	<i>C. myrrha</i>	Myrrh
	Opoponax	<i>C. guidotti</i>	Opoponax
	Hagar	<i>C. erythraea</i> / <i>C. africana/others</i>	Hagar
Non-aromatic gums/resins (gum arabic)	True Arabic gum	<i>A. senegal</i>	
	Gum talha	<i>A. seyal</i>	

a Although this species' existence is cited in some references, it remains in doubt (Girmay Fitwi, personal communication).

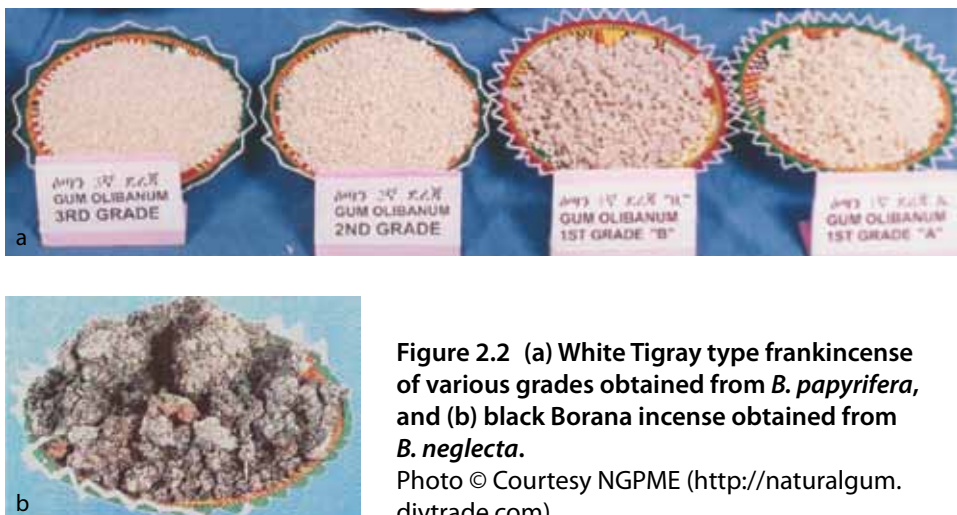
b The precise source species for these 2 olibanum classes are not well known. However, gum resin from *Boswellia*, true myrrh, opoponax and hagar are collectively referred to as gum myrrh, whereas products from *B. neglecta*, *B. rivae*, *B. microphylla* and *B. ogadensis* are often collected and traded mixed.

### 2.2.3.1 Aromatic gums and resins

Aromatic gums and resins are hardened, resinous, exudates obtained from trees of certain *Boswellia* and *Commiphora* species. Gum olibanum (frankincense), myrrh and opoponax belong to this group.

i) **Frankincense.** In the literature, the terms frankincense, incense, gum olibanum, olibanum, resin and aromatic products are all used to refer to the products of *Boswellia* trees. Frankincense refers to the dried, gummy exudates obtained from various species of the family Burseraceae and the genus *Boswellia*.

Three types of frankincense are distinguished in Ethiopia according to their origin: Tigray type, Ogaden type and Borana type (Table 2.2). Tigray type olibanum is the most widely traded on both domestic and international markets (Figure 2.2a). This is the gum resin obtained from the species *Boswellia papyrifera* (Del.) Hochst, which occurs in the northern, northwestern and northeastern lowlands of Ethiopia as well as in the river gorges of Abay and Tekeze. Ogaden and Borana types are gum resins produced from *Boswellia* species found in the dry forests of the eastern and southeastern lowlands. The specific source species for these latter types of frankincense are not clear. However, gum resins from *B. rivae* (Engl.), *B. ogadensis* (Vollesen), *B. neglecta* (S. Moore) and *B. microphylla* (Chior.) are collected from these areas and traded as frankincense (Fitwi 2000, Lemenih *et al.* 2003). Other species that yield resinous products designated as frankincense may also exist in these parts of Ethiopia, and may even include species known from Somalia, such as *B. sacra* (Vollesen 1989). The southeastern *Acacia-Commiphora* woodlands are the country's richest in terms of diversity of *Boswellia* species.

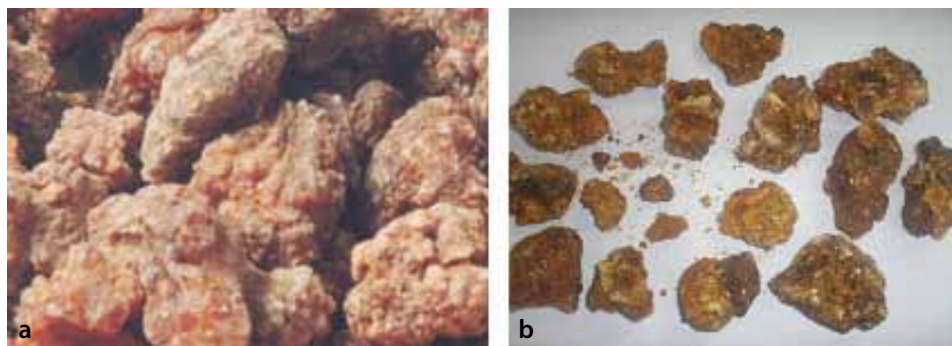


**Figure 2.2 (a) White Tigray type frankincense of various grades obtained from *B. papyrifera*, and (b) black Borana incense obtained from *B. neglecta*.**

Photo © Courtesy NGPME (<http://naturalgum.diytrade.com>)

ii. *Commiphora* gum resins. The diversity of *Commiphora* species in Ethiopia is one of the highest in the world. Fifty-two species of *Commiphora* are known to exist in the country, 14 of which are endemic (Vollesen 1989). The southeastern *Acacia-Commiphora* woodlands have the richest diversity of *Commiphora* species, with 35 (67%) of the *Commiphora* species found in the country recorded there, including 9 (64%) endemic species (Vollesen 1989, Kuchar 1995).

The major *Commiphora* gums of economic importance in Ethiopia are myrrh, opoponax and hagar. The names myrrh, bdellium or opoponax are often used interchangeably to refer to the various resinous products obtained from *Commiphora* species. However, in some literature, the products are distinguished based on botanical source. For instance, Thulin and Claeson (1991) classify *Commiphora* gum resins into scented/perfumery myrrh called ‘bissabol’ or opoponax and medicinal myrrh called ‘heerabol’. Gum myrrh (heerabol) is a typical name for the gum obtained from *C. myrrha* (Nees) Engl., which is called true myrrh (FAO 1995; Figure 2.3a). This myrrh is used mainly for medicinal purposes (Lemenih and Teketay 2003b). Opoponax or scented myrrh (Figure 2.3b) is the name given to the myrrh obtained from *C. guidotti* Chior (Thulin and Claeson 1991, Farah 1994) and from *C. kataf* (FAO 1995).



**Figure 2.3** (a) True myrrh from *C. myrrha* and (b) opoponax from *C. guidotti* species. Photo © G. Fitwi G

The resin from *C. africana* (A. Rich.) and *C. erythraea* (Ehrenb.) Engl., locally called ‘hagar’, is traded widely across borders in the south and southeastern parts of Ethiopia (Lemenih *et al.* 2003). Hagar has chiefly medicinal applications, serving as a laxative, and performs insecticidal and anti-parasitic (anti-tick) functions in traditional livestock husbandry. Many other *Commiphora* species in Ethiopia produce gums also collected and sold under the name myrrh or opoponax; these include *C. boranensis* Vollesen, Engl., *C. habessinica* (Berg.) Engl. and *C. corrugata* Gillett and Vollesen (Tucker 1986, Lemenih *et al.* 2003).

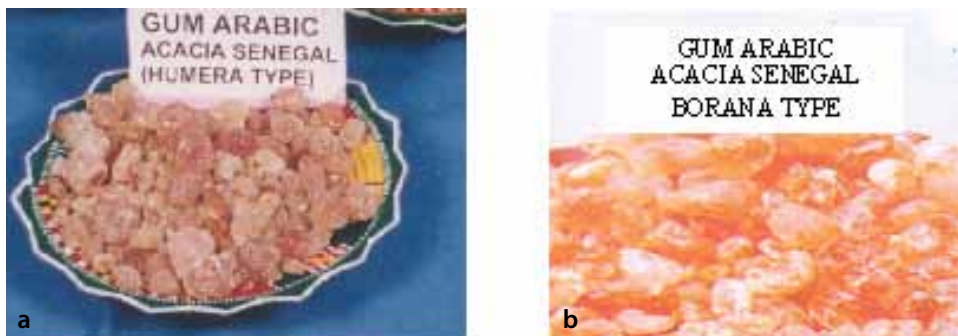


Gum resins from these species are generally sold mixed with resins of commercially known species.

### 2.2.3.2 Non-aromatic gums

The mainly odourless and/or tasteless products in this category include gum arabic and gums such as gum karaya from *Sterculia setigera*.

i. **Gum arabic.** Broadly defined, gum arabic is a dried exudate collected from several *Acacia* species, and hence is sometimes referred to as ‘gum *Acacia*’. However, international commercial specifications identify gum arabic as a dried exudate obtained from the stems and branches of *A. senegal* (L) Willdenow or *A. seyal* (Fam. Leguminosae) (FAO 1998). In Ethiopia, gum arabic in most reports refers to the gum collected from *A. senegal* or *A. seyal* (although the 2 types are clearly collected and delivered separately), with some literature referring to them as gum arabic and gum talha, respectively. True gum arabic is collected from 2 varieties of *A. senegal* in Ethiopia: *A. senegal* var. *kerensis* and *A. senegal* var. *senegal* (Figure 2.4). Good stocks of *A. senegal* and *A. seyal* are found in the western, central (Rift Valley), southern and southeastern lowlands of Ethiopia.



**Figure 2.4.** (a) Gum arabic from *A. senegal* var. *senegal* and (b) var. *kerensis*. Photo © Courtesy of NGPME (<http://naturalgum.diytrade.com>) and M. Lemenih

ii. **Gum karaya.** Gum karaya is obtained from *Sterculia* species (Fitwi 2000), several of which grow in northern and northwestern Ethiopia, although it is widely represented by *S. setigera*. Despite its potential, no actual production or marketing of this product has been reported.

### 2.2.4 Density and regeneration status

Regeneration is a central component of tropical dry forest ecosystem dynamics and restoration. Sustainable forest use is only possible if adequate regeneration occurs. Most of the species in the dry forests of Ethiopia regenerate via one or more means such as seeds, whether from seed rain (recently dispersed seeds)

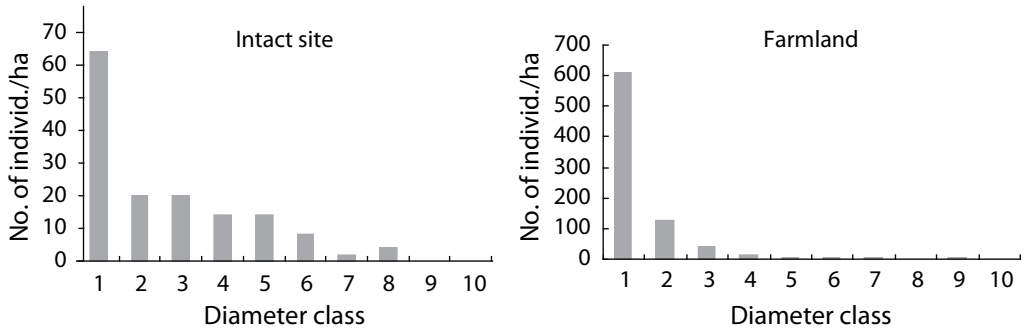
or soil seed banks (dormant seeds in the soil), seedling banks (established, suppressed seedlings in the understorey) and/or vegetative means (coppice and/or root sprouts) (Teketay 1997, Tesfaye *et al.* 2002, Tesfaye 2008). However, the regeneration profiles of most species in the dry forests of Ethiopia are generally poor because of the open access nature of the forests, despite variations according to geographical location, vegetation formation, species type and the degree of disturbance. Human-related disturbances, such as forest grazing, forest fire and intensive removal of trees for timber, construction and fuel, have a significant negative impact on regeneration of the species. The regeneration profiles of most species also vary in response to environmental variables, such as altitude, slope and edaphic conditions. Within the same plant community, some species may show a healthy regeneration and population structure, whereas others exhibit critical natural regeneration problems. *Boswellia papyrifera* in the *Combretum–Terminalia* deciduous woodlands is an example of a poorly regenerating species (Eshete *et al.* 2005, Ogbazghi *et al.* 2006, Rijkers *et al.* 2006, Lemenih *et al.* 2007). The major population obstacle for this species is not seedling emergence but the high mortality of seedlings (Negussie *et al.* 2008). Even when protected against grazing and fire, the seedlings fail to exhibit good survival (Asfaw 2006, Negussie *et al.* 2008). Following are syntheses of available information for some major gum-producing species and regions.

#### 2.2.4.1 The case of the Central Rift Valley

Ethiopia's Central Rift Valley holds great potential for gum arabic production from *A. senegal* and *A. seyal* species, which occur in the area in association with a few other species, primarily *Balanites aegyptiaca*, *A. tortilis*, *A. etbaica*, *M. senegalensis*, *Ziziphus mucronata* and *Dichrostachys cinerea*. The total woody plant density across various land use/land cover systems in the area ranges between 268 and 1584 stems/ha. The density of the gum-producing species *A. senegal* and *A. seyal* is within the range of 31–947 stems/ha. *Acacia senegal* depicts normal population structures in the Central Rift Valley, showing good regeneration and stable population (Figure 2.5). Furthermore, human-related disturbance, when modest, is found to encourage regeneration of both species (Figure 2.5b), which is a typical feature of some dryland woody species (Yebeyen 2006).

#### 2.2.4.2 The case of Metema (northwestern lowlands)

In the western, northern and northwestern lowlands of Ethiopia, the principal gum- and resin-producing species is *B. papyrifera*. For example, in Metema district, *B. papyrifera* on average accounts for 51% of the woody plant density (Eshete 2002), although variations occur from site to site as a function of local edaphic, climatic and anthropogenic factors. A similar population structure for *B. papyrifera* has been reported in Eritrea (Ogbazghi 2001, Ogbazghi *et al.* 2006, Rijkers *et al.* 2006) and Tigray, Ethiopia (Gebrehiwot 2003, Gebrehiwot

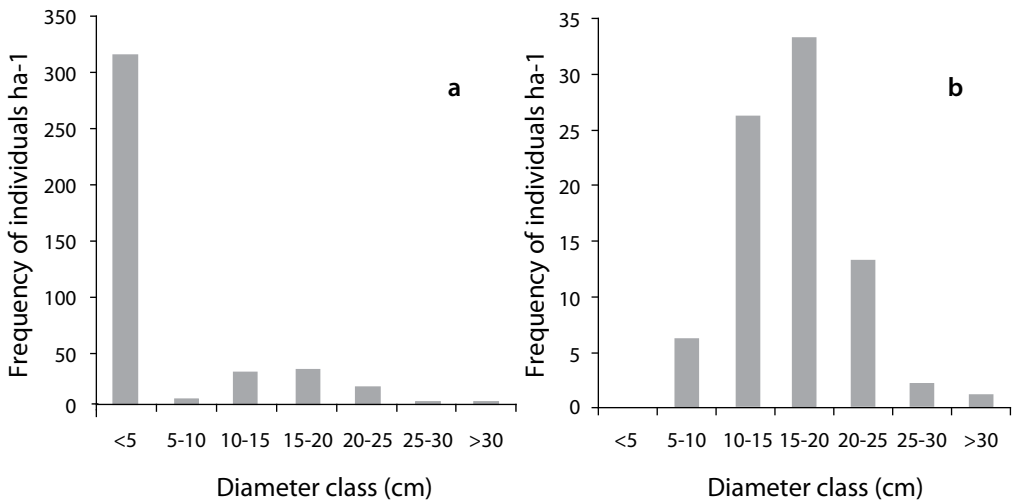


**Figure 2.5. Population structure of *A. senegal* at 2 contrasting sites in Central Rift Valley of Ethiopia: (a) protected and (b) farmland**

Source: Yebeyen (2006)

*et al.* 2002). The density of *B. papyrifera* in the Metema area ranges from 64 to 225 stems/ha, similar to reports from Tigray (Gebrehiwot 2003) and Eritrea (Ogbazghi 2001).

The population structure of *B. papyrifera* shows the presence of a large proportion of individuals in the medium diameter classes, and few individuals in the smaller (seedling and sapling) diameter classes. Great contrasts are evident in the population structure of the species in different seasons (rainy season vs dry season) (Figure 2.6). These contrasting structures demonstrate that although a



**Figure 2.6 Population structure of *B. papyrifera* species in Metema, Ethiopia: (a) during the rainy season and (b) during the dry season**

large number of seedlings emerge during summer, almost none survive the dry season to grow to sapling and adult individuals. This high seedling mortality is a major obstacle for this species and is currently threatening the population. Different studies have revealed that even when protected against grazing and fire, the seedlings fail to exhibit good survival (Asfaw 2006, Negussie *et al.* 2008).

#### 2.2.4.3 The case of Borana (southern lowlands)

Ethiopia's southern lowland woodlands are characterised by a higher diversity of gum- and resin-producing species than other woodland areas in the country. For instance, in Liban district, 8 species in the genera *Acacia*, *Boswellia* and *Commiphora* that provide currently traded gums and resins have been identified (Lemenih *et al.* 2003). Similarly, in Borana district, 15 woody species have been recorded: 9 from the genus *Commiphora*, 3 from the genus *Boswellia* and 3 from *Acacia* (Table 2.4).

The density of gum- and resin-producing species in the southern lowlands ranges between 562 and 1742 stems/ha. These species account for 43–83% of

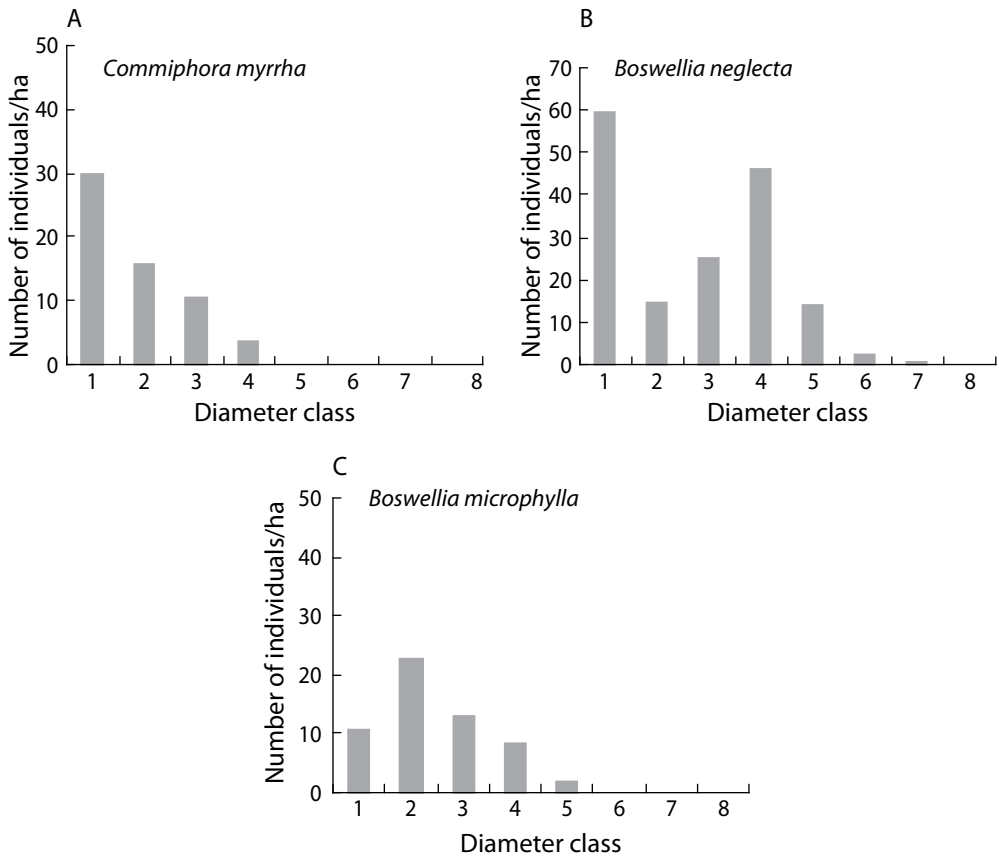
**Table 2.4 Gum- and incense-producing tree species found in the Borana area**

Scientific name	Family	Product
<i>Acacia seyal</i>	Fabaceae	Gum arabic
<i>Acacia senegal</i>	Fabaceae	Gum arabic
<i>Acacia mellifera</i>	Fabaceae	Gum arabic <sup>a</sup>
<i>Boswellia neglecta</i>	Burseraceae	Incense
<i>Boswellia microphylla</i>	Burseraceae	Incense
<i>Boswellia rivae</i>	Burseraceae	Incense
<i>Commiphora africana</i>	Burseraceae	Hagar
<i>Commiphora baluensis</i>	Burseraceae	Myrrh
<i>Commiphora confuse</i>	Burseraceae	Myrrh
<i>Commiphora myrrha</i>	Burseraceae	Myrrh
<i>Commiphora habessinica</i>	Burseraceae	Myrrh
<i>Commiphora kua</i>	Burseraceae	Myrrh
<i>Commiphora terebinthina</i>	Burseraceae	Myrrh
<i>Commiphora boranensis</i>	Burseraceae	Myrrh
<i>Commiphora schimperi</i>	Burseraceae	Myrrh

Source: Worku (2006)

<sup>a</sup> Gum from *A. mellifera* is not recognised as gum arabic according to international designations. Products collected from this species are commonly sold mixed with true gum arabic of *A. senegal* and *A. seyal* origins.





**Figure 2.7** Diameter class distribution of 3 gum- and resin-producing species in Borana showing impacts of human disturbances on population structure (diameter classes in cm: 1 =  $\leq 4$  cm; 2 = 4–8; 3 = 8–12; 4 = 12–16; 5 = 16–20; 6 = 20–24; 6 = 24–28; 7 = 28–32; 8 = 32–34; 9 = 34–38)

Source: Worku (2006)

the total stem density in the woodlands (Lemenih *et al.* 2003, Worku 2006). The population structure for gum- and resin-yielding species varies (Figure 2.7). Some species show an inverted ‘J’ shape distribution, e.g. *C. myrrha* (Figure 2.7a), which indicates a normal and stable population. However, for most of the species, including *C. kua*, *B. neglecta*, *B. microphylla*, *C. habessinica*, *C. boranensis*, *C. terebinthina*, *C. baluensis*, *C. confusa* and *B. rivae* (e.g. Figure 2.7b and c), the population structure deviates from this inverted J-shaped pattern, possibly indicating the effects of human-induced disturbances on the species’ regeneration ecology (Worku 2006).

## 2.3 Yield and productivity

### 2.3.1 Yield at tree level

Reliable and rigorous data on annual yields of gums and resins per tree and/or area in Ethiopia are scarce. Few scientific studies have been conducted on these aspects, and thus it is near impossible to provide reliable information. Most yield statistics for different products from different geographical regions are expert guesses, and should be treated with due caution. Yield variations are expected between species, varieties, size and age classes and across different geographical regions. Similarly, climatic conditions, edaphic characteristics and genetic differences are all expected to cause variations in yield between the same species located in different geographical regions. For *B. papyrifera* in the Metema district, Tadesse *et al.* (2004) reported an annual yield of 6.7–451.4 g per tree, and Eshete and Asmamaw (unpubl.) reported an annual yield of 207–352 g per tree in the Metema district. These variations in incense yield are attributed to tree size and tapping intensity. Generally, trees with a bigger diameter at breast height (DBH) yield more incense than trees with a smaller DBH. Similarly, increased tapping intensity increases incense yield per tree, although this has also been shown to affect tree vitality and reproductive biology. Incense yield can be doubled or even tripled by increasing the number of tapping spots per tree from 4 to 12. However, it is recommended that smaller trees be wounded in only a few spots, with the number of wounds increasing as the tree grows in diameter/size. Trees in more arid environments also yield more incense than trees in wetter environments. Other estimates for olibanum and myrrh show yields in the range of 0.07–1.0 kg per tree per year, with the average being 0.50 kg (Fitwi 2000), whereas another report provides an estimate as high as 3.0 kg per tree per year (Gebremedhin 1997). Yield of arabic gum is estimated to be 0.25 kg per tree each season, which is often considered to be the average yield (Coppen 1995).

### 2.3.2 Potential and actual annual production levels at national scale

Reliable information is lacking on the potential and actual production levels of gums and resins at the national scale in Ethiopia. Reasons for the lack of information are: (1) poor documentation by purchasing firms and producers; (2) lack of proper forest management and accountable forest product control offices that are responsible for quantifying and/or controlling the production processes; (3) open access harvest and uncontrolled trade of forest products, particularly gums and resins in different parts of the country; and (4) uncontrolled trade across borders with neighbouring countries as well as between enterprises in the country. Reasonable estimates for potential production of the various gum and resin products based on stand density and spatial coverage are given in Table 2.5. With regard to actual production, fairly

**Table 2.5 Estimated potential and annual production of gum and incense in Ethiopia**

Type of product	Estimated area (ha) <sup>a</sup>	Estimated annual production (tonnes) <sup>b</sup>
Gum olibanum	2 284 000	57 100
Gum arabic	399 700	4 996 ( <i>A. senegal</i> 52%, <i>A. seyal</i> 48%)
Gum <i>Commiphora</i>	171 300	8 565 (myrrh 88%, opoponax 12%)
Total	2 855 000	70 661

Source: a Fitwi 2000; b Calculated based on 50 trees per ha and yields of 0.5, 0.25 and 1 kg per trees for gum olibanum, gum arabic and gum *Commiphora*, respectively, as well as the share calculated from 10-year production data for each type

**Table 2.6 Natural gums (gum olibanum, gum arabic, myrrh/opoponax) exported from Ethiopia by various enterprises, 1995–2010**

Year	Total production (tonnes)	Export quantity (tonnes)	Value of export sale (USD)
1992/1993	2 671	354	3 138 000
1993/1994	3 421	755	7 418 000
1994/1995	5 303	987	7 672 000
1995/1996	4 557	389	3 738 000
1996/1997	2 522	710	5 660 000
1997/1998	3 606	1 925	2 411 263
1998/1999	4 934	1 663	1 990 947
1999/2000	4 608	1 648	2 264 737
2000/2001	4 532	2 183	2 764 737
2001/2002	4 427	2 138	2 712 526
2002/2003	4 778	1 544	2 014 737
2003/2004	7 479	3 109	4 001 053
2004/2005	4 906	3 791	4 529 474
2005/2006	2 894	3 529	4 911 368
2006/2007	1 474	3 976	5 293 158
2007/2008	1 544	3 834	5 201 368
Average	3 979	2 033	4 107 586

Source: Compiled from data collected from companies, the Ethiopian export promotion agency and the Ethiopian customs authority

good estimates can be obtained by gathering scattered statistics from various sources. Proper records exist for trade, specifically export trade, which may thus provide reasonably reliable statistics.

Estimates for actual production and export volumes for the past decade, as obtained from various sources, are presented in Table 2.6. The data show that Ethiopia has exported on average 2033 tonnes of gums and resins to the world market each year during the past 15 years. However, the problem with export statistics is the aggregation of all products (frankincense, myrrh, opopanax, balsam, etc.) into a single commodity. This makes it difficult to provide separate statistics for individual gum and resin products.

Supplies to domestic markets are hard to quantify. Domestic consumption is mainly for household uses such as fumigation during coffee ceremonies, chat chewing, dispelling of bad smells and use in religious rituals; hence, rough estimates can be provided based on findings from surveys of households and religious institutions. Lower grades (Grades 4 and 5) of Tigray type olibanum and myrrh, and all Borana and Ogaden type olibanum, almost always end up in the domestic market. A household consumes about 5–10 g of incense per day, mainly during the coffee ceremony. The average annual consumption for this purpose is thus estimated at 4500 tonnes. Similarly, about 6000 tonnes of incense is consumed annually in connection with religious ceremonies, putting the average annual domestic consumption at 10 500 tonnes. The domestic market consumes almost all of Grades 4 and above of the Tigray type olibanum and nearly all of the Borana and Ogaden type incenses.

**Table 2.7 Comparison of actual and potential gum and resin production in Ethiopia, based on figures for 2003/04**

Regional state	Estimated actual production (in tonnes) <sup>a</sup>	Share of total annual production (%)	Estimated potential production (in tonnes) <sup>b</sup>	Share of actual production of estimated potential (%)
Tigray	4993	62	30 433	16
Amhara	2396	30	16 545	14
Benishangul	316	4	2500	13
Oromia	130	2	4031	3
Somalia	185	2	4106	5
Others	–	–	13 042	–
<b>Total</b>	<b>8020</b>	<b>100</b>	<b>70 661</b>	<b>14</b>

Source: a MOARD for 2003/04; b see Table 2.6.

Comparison of actual and potential production levels in the various regions shows that the present supply falls far short of the potential (Table 2.7). For instance, Tigray Regional State, which is the largest producer of gum resin in the country, produces less than a quarter of its potential. As shown in Table 2.7, gum olibanum from *B. papyrifera* in Tigray Regional State contributes almost two-thirds (62%) of the total annual production. It also provides the bulk of exports (Lemenih 2005).

## 2.4 Economic and ecological significance

### 2.4.1 Economic significance

#### 2.4.1.1 Contribution to the national economy

An important benefit of gums and resins is that they generate foreign currency earnings gained through exports. Ethiopia, as a developing country, has few items to export, and gums and gum resins are among the few products from the country's forestry sector with export value. As shown in Table 2.6, Ethiopia exported 29 340 tonnes of natural gums and resins during the 10 years from 1997/98 to 2007/08, generating about 38 million USD worth in foreign currency. This is equivalent to average annual earnings of about 3.5 million USD (32.8 million Eth Birr). This value does not include the large but unregistered parallel trade across borders with neighbouring countries. Despite declining trends in production volumes, the export quantity and the value of foreign currency that the country is earning from the gums and resins subsector have been increasing in the past decade. This is probably due to the increasing participation of private enterprises in the production, processing and exporting of natural gums as they take advantage of the Ethiopian government's recent policy reforms and export promotion support.

The subsector also makes a relatively high economic contribution through domestic markets. Based on current prices of an average of 10 Birr per kg, the domestic market's annual turnover is estimated at 100.5 million Eth Birr (11.7 million USD). Combined with export earnings, therefore, the total annual turnover from the subsector is equivalent to about 133 million Eth Birr (15.5 million USD). However, gums and resins could contribute more to the national economy if the full potential of the subsector were exploited. Based on

current prices, the potential yield equivalent of 70 660 tonnes/year could generate annual revenues of about 757 million Eth Birr (88 million USD).

#### 2.4.1.2 Contribution to the local economy



**Figure 2.8 Women sorting and grading gums and resins**  
Photo © Courtesy of NGPME (<http://naturalgum.diytrade.com>)

The gums and resins subsector also contributes to the local economy and to rural livelihoods. Women in particular benefit from the processing and retailing of gums and resins. The subsector contributes to the local economy in terms of employment, income diversification, emergency food supply and direct support of other economic sectors, principally livestock production.

**i. Employment.** The lack of modern production and processing technology means that gums and resins are collected, cleaned, sorted and graded using traditional, labour-intensive processes (Figure 2.8).

Along the production and marketing chains, the gums and resins business is estimated to employ about 25 000–35 000 people annually at the national level. Money earned by tappers and collectors varies from year to year and place to place, but tends to be within the ranges of 165–300 Birr for Tigray type, 150–285 for Borana type, 500–600 for Ogaden type, 225–800 for gum arabic, 1300–1800 for myrrh and 600–700 for opoponax. Graders earn about 7 Birr per kg, with payment based on the grades.

**ii. Income diversification.** Gum and resin products are an important source of income for households in producing areas. In some cases, gums and resins are the only source of household income, whereas in others they function as a safety net (Lemenih *et al.* 2003, Worku 2006). For instance, a study in the southeastern lowlands of Liban showed that income from the collection and sale of oleo-gum resin is the second most important means of household livelihoods (Lemenih *et al.* 2003). The economic incentives provided by gums and resins have wider implications in the overall socio-economic conditions of households living in arid and semi-arid lowlands. Diversification of economic activities could potentially minimise the risks associated with the frequent crop and fodder failures that result from the recurring droughts. In particular, in the dryland areas where the economic activities of pastoralists and agro-pastoralists cannot produce sufficient food for families' basic subsistence, collection of gums and resins may be important for supplementing household income and livelihoods. Forest income tends to be important more for its timing than its magnitude. One advantage associated with gum and resin collection in this regard is their availability during the dry season when forage and grains are scarce (Lemenih *et al.* 2003); thus they provide an alternative source of income during the dry season.

**iii. Contribution to livestock production.** Gum- and resin-producing trees also contribute to household food security by supporting other economic sectors, principally livestock production. Livestock production, which is the mainstay of the agro-pastoral and pastoral economy, is heavily dependent on fodder supplied from the woody plant biomass (Kuchar 1995). Particularly in the dry season and during droughts, trees and shrubs comprise the only source of fodder for livestock. The Burseraceae and Mimosaceae families in particular provide nutritious fodder, and virtually all plants in the 2 families are palatable to livestock (Kuchar 1988, Farah 1994). During prolonged drought periods, perennial woody vegetation supplies more fodder than annual grasses, which makes it more useful in dryland regions. The pastoral and agropastoral communities' priority is to use the vegetation resources for grazing (Lemenih *et al.* 2003).

**iv. Other local uses of economic importance.** Gums and resins also have significant socio-economic and cultural values (Table 2.8). Some gums and resins are used as emergency food during periods of famine. Others are smoked in houses and during cultural and divine worship to stimulate deep spiritual meditation. Several gum resins, including frankincense and myrrh, are widely used as herbal medicines, insecticides and hygienic and sanitation detergents.

**Table 2.8. Local uses of gums and resins and their source species in lowland areas of Ethiopia ('-' denotes not applicable; '+' denotes applicable)**

Species	Use			
	Famine food/ chewing	Fodder	Sanitation/ medicinal	Fumigation
<i>Acacia senegal</i>	+/-	+	-	-
<i>Acacia seyal</i>	-/-	+	-	-
<i>Acacia mellifera</i>	-/+	+	-	-
<i>Boswellia papyrifera</i>	-	+	+	+
<i>Boswellia neglecta</i>	-/+	+	-	+
<i>Boswellia microphylla</i>	-/+	+	-	+
<i>Boswellia rivae</i>	-/+	+	-	+
<i>Commiphora baluensis</i>	-/+	+	-	+
<i>Commiphora kua</i>	+/+	+	+	+
<i>Commiphora habessinica</i>	-/+	+	+	+
<i>Commiphora africana</i>	-/-	+	+	-
<i>Commiphora myrrha</i>	-/-	+	+	+
<i>Commiphora terebinthina</i>	-/-	+	-	+
<i>Commiphora confusa</i>	-/+	+	-	+
<i>Commiphora boranensis</i>	-/+	+	-	+

Source: Lemenih *et al.* (2003), Worku (2006)

Timber from stands is used for fuel, construction and household utensils, which are either used in the household or sold for additional income.

### 2.4.2 Ecological significance

Gum- and resin-producing trees are characteristic plants of the drier low-lying ASALs. These trees are distributed across an altitudinal range of 200–2000 masl. The hot and dry regions in which these trees naturally occur are vulnerable to the effects of desertification and threats from global climate change. In this situation, the existence of vegetation, especially vegetation with economic importance, is of great significance. Such vegetation offers better options for adaptation to and mitigation of climate change. The vegetation resources could: (1) help to fight against desertification and soil erosion by water and wind; (2) contribute to the conservation and enhancement of biodiversity; (3) improve soil fertility; and (4) provide opportunities for C-sequestration. Indeed, *Acacia*, *Boswellia* and *Commiphora* species could be managed to provide multiple services, both economic and ecological. Such services would also enable Ethiopia to successfully comply with the various international conventions it has ratified,



such as the CBC, CCD and FCCC. The following paragraphs look at the roles of this vegetation type in addressing issues related to these conventions.

#### **2.4.2.1 Potential for combating desertification**

Many techniques for desertification control involve improving degraded areas using vegetation and preventing/controlling soil erosion by wind. As desertification is driven by factors related to the rural economy, an eco-economic model for developing the rural economy must be formed and applied to control desertification (Shengyue and Lihua 2001). *Acacia*, *Boswellia* and *Commiphora* species, which are naturally adapted to and thrive in desertification-prone ASALs, offer a suitable means to integrate economics with desertification control (Lemenih and Teketay 2003a). These plants have proven useful as windbreaks and shelterbelts against desert encroachment. Their canopies intercept raindrops and their root systems are effective in reducing soil erosion, thereby stabilising soils (Jaiyeoba 1996). The fact that gum and resin collection is non-destructive means the vegetation can provide constant ground cover, thus preventing or reducing soil erosion and controlling desertification. Therefore, by managing dryland vegetation resources for sustainable economic benefits, their ecological services in desertification control can also be realised (Lemenih and Teketay 2004).

#### **2.4.2.2 Potential for biodiversity conservation**

*Acacia*, *Boswellia* and *Commiphora* species can be managed to contribute to biodiversity in 2 main ways. The first way is through gum and incense extraction. Extraction of gum and incense, when properly conducted, is non-destructive, and thus causes no damage to biodiversity; hence, the economic benefit and biodiversity value intersect.

The second way is by integrating the species with other economic sectors. *Acacia*, *Commiphora* and *Boswellia* species can be integrated with dryland farming systems in different forms of agroforestry, which is receiving considerable attention as an integrated approach to biodiversity conservation. In fact, Ethiopian farmers have long since developed various traditional agroforestry systems as coping mechanisms in the face of dwindling forest resources and products. Traditional agroforestry practices such as parkland, homestead and farm boundary tree management have been developed and practised for centuries. These practices have obviously created refuge for several indigenous tree species, many of which are endangered in natural stands. The agroforestry approach has also been acknowledged as an important strategy for controlling desertification and conserving biodiversity, particularly in dryland regions. This form of land use can allow biodiversity conservation in dryland zones even with a high rural population density (Le Houerou 1996).

Many *Acacia*, *Boswellia* and *Commiphora* species possess the necessary qualities to be integrated in agroforestry systems. *Acacia* trees improve soil fertility through N-fixation, provide shade for crops and workers and supply fuelwood and fodder. Several studies have demonstrated the potential of these parkland trees for enhancing crop production and soil fertility (Poschen 1986, Chadhokar 1989, Jiru 1989).

#### 2.4.2.3 Potential for carbon sequestration and climate change response

Ethiopia's current level of greenhouse gas emissions is negligible compared with those of developed countries. In Ethiopia, land use change, through deforestation and the conversion of forests into farmlands, is the principal source of CO<sub>2</sub> emissions, accounting for nearly 81% of the 16 297 Gg annual emissions of CO<sub>2</sub> in Ethiopia (Woldegiorgis 1995).

As a signatory to the FCCC, Ethiopia is obliged to join ongoing efforts for C-sequestration by making use of various sink potentials. Drylands are probably the most difficult environments in which to achieve large amounts of C-sequestration, especially in the form of organic carbon. Inadequate rainfall limits the production and storage of high biomass (primary productivity), thereby resulting in the sparse distribution and low stature of the vegetation. In addition, poorly developed shallow soils, with low organic matter content, are common in dryland regions, and the high temperatures prevalent in the dryland environment imply that the turnover of C is rapid, meaning its significant storage in the soil will be difficult. These facts indicate that C-sequestration attempts may not be easy or convenient in drylands.

The most viable approach to achieve significant C-sequestration in drylands is by means of productive vegetation management practices. Reducing dryland degradation and increasing biomass through improved management can offer large opportunities for C-sequestration in both the soil and biome, and the reduction of other factors, such as dust and aerosols, can have a direct effect upon climate change. Such activities can also qualify for emerging carbon finance initiatives such as REDD (reducing emissions from deforestation and degradation). If successful, REDD could provide considerable financial incentives to fight poverty in dryland areas that will help strengthen their adaptation capacity. The fact that *Acacia*, *Boswellia* and *Commiphora* species can grow in harsh environments means there is potential to sequester carbon even in such extreme environments. The plants can also act as windbreaks and, thus, reduce loss of soil C by wind; furthermore, by intercepting raindrops in wide-spreading canopies, they can reduce the speed of surface run-off and thus reduce soil erosion, thereby effectively stabilising soils and protecting soil carbon. The predominance of N-fixing *Acacia* species in the dryland vegetation would mean higher soil fertility and higher potential, at least in the context of drylands, for

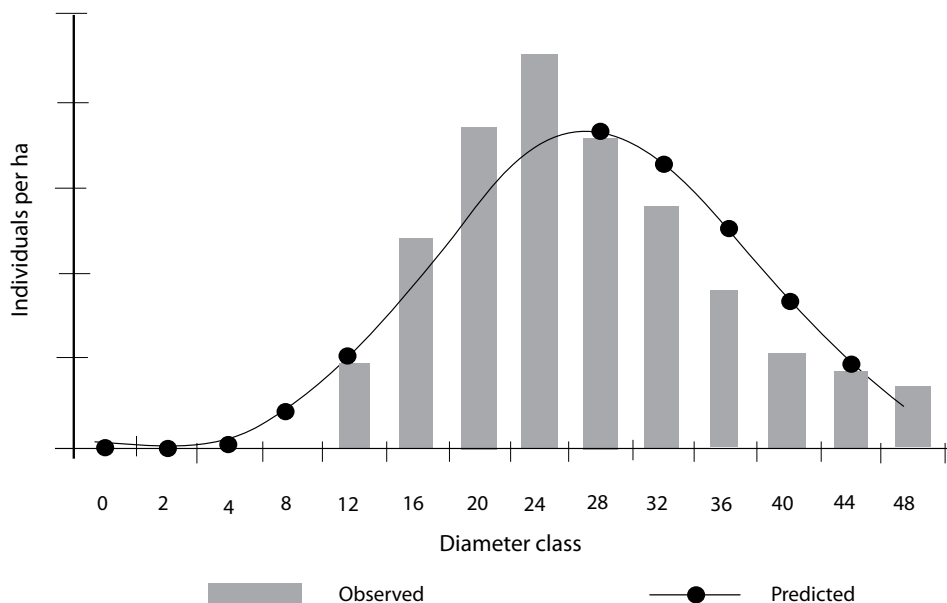
higher soil C sequestration. N-fixing-vegetation has been shown to provide greater potential for soil C-sequestration than non-N-fixing vegetation (Lemenih and Itana 2004).

## 2.5 Degradation of gum and resin resources and major causes

Ethiopia's dryland vegetation resources are facing a severe threat of degradation from several forces – mainly human-induced. Drivers of dryland degradation include population growth and farmland expansion, lack of regeneration, human-induced fires, improper use of woodlands, improper tapping, overgrazing and bush encroachment (Ogbaghzi 2001, Eshete *et al.* 2005, Worku 2006).

### 2.5.1 Lack of adequate regeneration

Several studies have observed that young trees (seedlings and saplings) for most of the gum- and resin-producing species are consistently absent from their natural environments (Eshete 2002, Worku 2006, Lemenih *et al.* 2007, Dejene 2008). For instance, for *B. papyrifera*, some studies report that 65% of the total population falls into the diameter categories of 13–15 cm and 16–24 cm. Under normal regeneration conditions, the population structure should show an inverted-J shape, with a higher density of lower diameter classes than of higher diameter classes. However, the low density of individuals in the lower



**Figure 2.9** Population structure of *B. papyrifera* in Metema district, northwestern Ethiopia.

Source: Dejene (2008) The predicted curve was derived using the Weibull distribution function.

diameter classes (Figure 2.9) suggests that regeneration and new recruitment are not occurring and that the population is unstable or threatened by unsustainable conditions.

Several factors are possible causes of the inadequate regeneration, as detailed below.

1. **Reduced quality and quantity of seeds.** Studies reveal that *Boswellia* trees produce fewer and lower-quality seeds when intensively tapped (Ogbazghi 2001, Eshete *et al.* unpubl.). This leads to low germination and regeneration rates. For instance, Ogbazghi (2001) shows that germination rates for seeds from intensively tapped trees were 14% compared with rates of more than 80% for seeds from untapped stands. Similarly, Eshete *et al.* (unpubl.) show that untapped trees yield significantly higher numbers of viable (germinable) seeds than continuously tapped trees. The same study shows that the effect of tapping is more pronounced in older trees than in younger ones. Tapped stands also produce seeds with a higher incidence of insect attack and a higher proportion of unfilled seeds than untapped stands. Therefore, tapping, by interfering with tree physiology, results in the production of a high proportion of unfilled seeds and seeds that are vulnerable to opportunistic predators. These seeds fail to produce seedlings, leading to insufficient natural regeneration.
2. **Seedling damage due to overgrazing.** Overgrazing is another cause of low regeneration. Seedling establishment has been found to be better in enclosed or fenced experimental plots than in openly grazed sites (Ogbazghi 2001), although new unpublished studies by Eshete (personal communication) do not support this conclusion. Rather, Eshete's research indicates that seedling mortality for *B. papyrifera* remains high in both enclosed and openly grazed sites. The seeds and seedlings of most gum and resin trees are vulnerable to grazing because (a) their seeds have epigeal growth; (b) the seedlings are succulent and palatable and are therefore preferred by livestock and wildlife for browse; and (c) the seedlings grow too slowly to escape grazers. In Eritrea, for instance, after 3 years, seedlings attained a maximum height of only 15 cm and a basal diameter of 1.5 cm (Ogbazghi 2001). This extended juvenile period increases the seedlings' risk of being eaten, trampled or damaged.
3. **Damage by fire.** Another factor in this respect is fire, which can kill most seedlings. Fire intensity and frequency have increased in most dryland areas because of population growth, which means fires wreak more damage than under natural occasions. The increased fire intensity is damaging the young seedlings, leading to their poor survival.

### 2.5.2 Population pressure

Population growth is a major driver of woodland degradation in Ethiopia. Population growth in woodland areas has been spurred government-sponsored resettlement programmes and self-initiated migration in search of croplands.

As a strategy to enhance food security, successive governments during the past 30 to 40 years have implemented resettlement programmes for vulnerable people, moving them from degraded highlands to dry forest areas. For example, in 2002–2005, about 340 000 households were officially resettled from 3 regional states (Tigray, Amhara and Oromia). Resettlement is an ongoing programme, with 161 108 households targeted for resettlement in 2005–2010 (PASDEP 2005). Most of the resettlements are taking place in lowland dry forests. For instance, in Tigray the major resettlement is in Humera, and in Amhara Regional State, Metema and Quara are major recipients of resettlers. In Metema district, the native Gumuz community makes up only 2% of the total population of 78 741, meaning 77 141 individuals are migrants of one form or another. Furthermore, during 1995–1998 EC,<sup>2</sup> about 18 586 household heads were officially resettled in Metema through the Amhara Regional State resettlement programme.

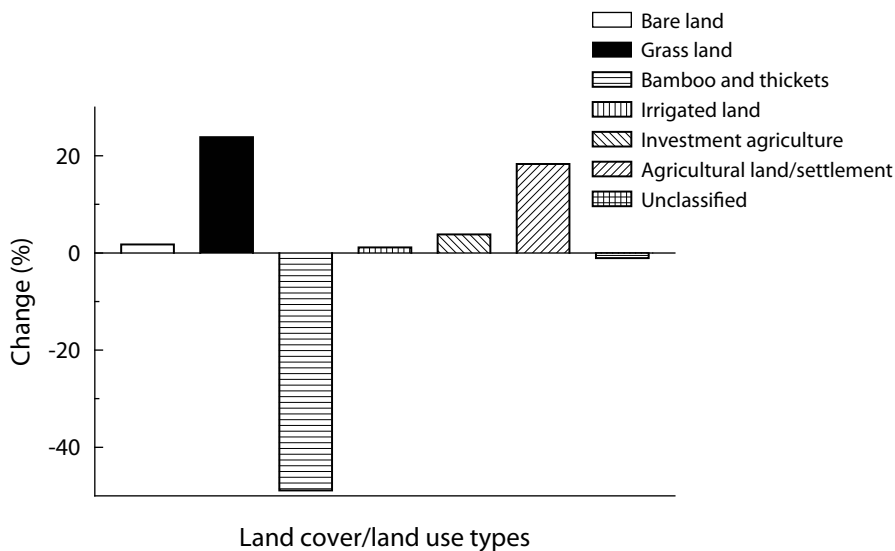


**Figure 2.10 Settlement parcels and agricultural fields in the midst of *Boswellia* forest in Metema district. Photo © M. Lemenih**

<sup>2</sup> EC stands for Ethiopian Calendar. Ethiopian dates are 7 and 8 years behind European dates for the months from September to December and January to August, respectively.

The population increase affects the dry forests in several ways. Clearance of woodlands for cropland expansion is probably the major effect. For instance, in addition to the officially allocated 2 ha of land for each household resettled, recent research shows that land holdings per household in Metema district exceed 7 ha (Lemenih *et al.* 2007, Dejene 2008), indicating the large impact of the population influx. If considering only the official land allocation of 2 ha per household, at least 37 172 ha of woodland in the district was converted to agricultural land in a period of just 4 years. In general, estimates show that nearly 303 180 ha of woodland in Metema district was converted into arable land and settlements in a period of 30–35 years (Figure 2.10). Similarly, in Tigray Regional State, more than 177 000 ha of *Boswellia* forest has reportedly been destroyed in the past 20 years (Gebrehiwot 2003). Multi-temporal satellite image analyses in Pawe, a district that has received large numbers of resettlers, show that bare areas and grasslands increased by 659.6 ha (1.78%) and 8956.3 ha (23.8%) respectively, in just 15 years, and that 18365.8 ha of bamboo forests and woodland thicket was lost following resettlement during the same period. Agricultural land/settlements increased by 6876.5 ha (18.3%) during the same period (Figure 2.11).

Population growth, particularly through resettlement, also affects woodlands through wood harvest for such purposes as house construction, fencing, firewood and charcoal for domestic use and sale. For instance, according to information from Metema district, hut construction consumes on average 150 logs plus 180 bamboo stems.



**Figure 2.11** Change in land cover and land use over a 15-year period

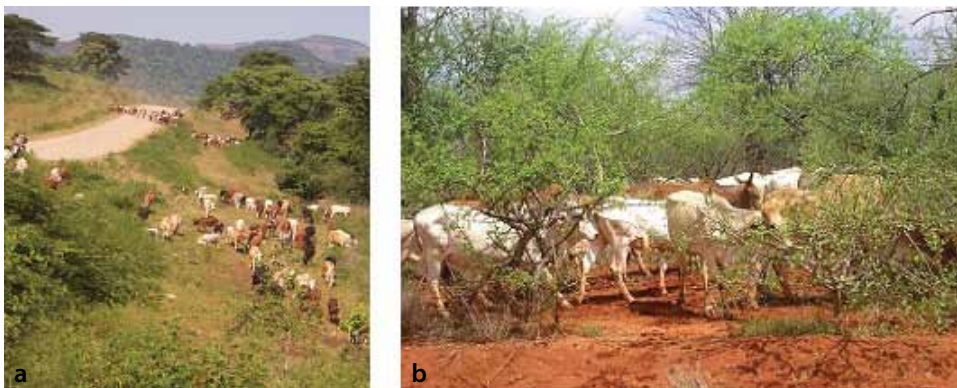
Source: Kebede (2006)

### 2.5.3 Overgrazing

Ethiopia's livestock population is the largest in sub-Saharan Africa. Livestock rearing is an integral component of Ethiopian farming culture, in both highlands and lowlands, and has major economic and social functions in the rural sector. Ethiopia is home to about 35 million tropical livestock units (TLU), equivalent to 70–80 million heads. The country has 30 million head of cattle, more than 42 million head of sheep and goats and 7 million equines (FAO 2004). Nearly 30% of the livestock population is concentrated in ASALs. Moreover, highlanders migrate with their cattle to lowlands during the rainy season, a period when the highlands are fully under crop cultivation. Excluding this seasonal migration, the density of livestock is 160 TLU per square kilometre in Ethiopia, which is significantly higher than the recommended TLU level for both humid and semi-arid areas, resulting in widespread overgrazing and land degradation (FAO/World Bank 1996).

The Ethiopian livestock sector degrades forest because, under its open pasture production system, animals graze and browse freely (Figure 2.12). Farmlands, natural woodlands, forestlands and grasslands all serve as open pasture. Studies indicate that forests and woodlands provide 15% and 60% of feed for livestock during rainy season and dry seasons, respectively.

The free grazing system implies that animals can browse on seedlings and samplings, as well as debarking mature trees. Consequently, the ecological disturbance and damage caused by overgrazing, particularly the negative impacts on natural regeneration of woody species – including resin-producing plants – is immense (Eshete 2002). Changing life styles, from nomadism to semi-



**Figure 2.12** High livestock populations in the dryland forests of (a) Metema and (b) Borana lowlands, resulting in overgrazing. Photo © M. Lemenih (a) and A. Worku A (b).



permanent or permanent settlements, as encouraged by population pressures, is also breaking down the traditional and relatively sustainable system of woodland management in several dryland areas such as Borana (Dalle 2004). Consequently, large livestock populations are confined to small areas, leading to severe vegetation and other ecological damage.

#### 2.5.4 Fire

Fire is a component of traditional savannah and woodland vegetation management, particularly by cattle herders and pastoralists (Figure 2.13). Although the vegetation in dryland areas evolved under cyclic fire, species such as *B. papyrifera* need some fire-free years to allow enough regeneration and the development of seedlings into saplings and poles to maintain the populations (Menaut *et al.* 1995). However, in most cases, woodland vegetation is exposed to annual burning, which severely affects not only delicate seedlings but also mature trees (Eshete 2002). Furthermore, tapped trees (e.g. *B. papyrifera*) are more susceptible to fire damage than untapped trees, because the resin they exude is highly inflammable, intensifying the fire and causing tree death.

#### 2.5.5 Improper tapping practices and inadequate resting periods

*Boswellia* trees, specifically *B. papyrifera*, are tapped to produce frankincense. Tapping involves making incisions in (wounding) the tree body. Incisions are made by shaving off the bark of the trees using sharp instruments. The depth, intensity and frequency of the incisions vary according to the tapper, as no



Figure 2.13 Dry forests of Metema district damaged by fire. Photo © Lemenih M.



standards, training or monitoring apply to the practice. Careless tapping and repeated intense wounding in an attempt to increase yield are harmful to the trees. Furthermore, deep incisions that affect the inner bole (the sapwood) of the trees can cause the trees to dry up and die (Tadesse *et al.* 2002). Deeper incisions lead to prolonged healing periods; this is exacerbated because wounding is done during the dry season when poor growth conditions inhibit quick healing. There are also indications that incisions predispose trees to insect and pathogenic infections (Farah 1994, Gebremedhin 1997). Incisions create a route by which woodborers and other parasites can access and infect the trees. Such infections coupled with the trees' weakened resistance due to intense wounding in dry seasons frequently cause the trees to die (Farah 1994, Gebremedhin 1997).



**Figure 2.14** Signs of damage from improper tapping

Under best practice, a tree is tapped for no more than 3 consecutive years, and should be rested so it can recover and regain vigour. However, in most cases, *Boswellia* trees are repeatedly tapped at intervals of 15 days throughout the dry season for up to 7 or more years. This causes premature death and production of poor-quality seeds that are unable to regenerate (Figure 2.14).

### 2.5.6 Bush encroachments

Several native and alien species such as *A. drepanolobium*, *A. mellifera*, and *Prosopis juliflora* are emerging as threats to native plant species biodiversity in Ethiopia. This is particularly affecting gum- and resin-producing species in the country's southern, central and eastern lowlands.

### 2.5.7 Institutional factors

Weak governance and regulatory frameworks in terms of policy, legislation and institutional arrangements are adding to the rapid degradation of dry forest species in Ethiopia. There are four main issues.

**Short-term land leasing for production.** This is blamed for overextraction and thus damage to the stands.

**Weak controls on production processes and intensity.** The absence of institutions responsible for following up on production processes means trees are vulnerable to improper tapping practices such as the use of unskilled labour or inappropriate tapping intensity for tree size. In the absence of a monitoring body, concessionaires and even farmers are striving to maximise production for short-term benefit.

**Lack of community participation in production and forest management.** In most production areas, local communities have no incentive to share either the management responsibility or the benefits accruing from the forest resources in their vicinity. Rather, people from outside areas often engage in production, which strips locals of any sense of ownership and thus responsibility for forest stewardship. Instead, farmers often compete to convert land into farmlands, as this creates greater entitlement and ownership.

**Lack of management plans and supervision of forest use.** Ethiopian forests, including dry forests, are legally state property. The low capacity of government institutions means proper forest management does not take place in reality. Consequently, forests are mined rather than managed, which accelerates their already rapid degradation.

## 2.6 Options for restoration

Insufficient regeneration of *Boswellia* forests and the decline of natural stands of dryland forests are evident. No plantations of any gum- and resin-producing species have been established in Ethiopia, with the exception of small plantation trial stands of *A. senegal*. Furthermore, there are few instances of cutting trails being established, as in the Blue Nile gorge for *B. papyrifera*. Most gum- and resin-producing species can be propagated via many means such as from natural seed germination (wildings), nursery seedling production and transplantation, rooted cuttings and root sprouting/suckers (Figure 2.15).



**Figure 2.15** Vegetative propagation of *B. papyrifera* (top) and planted stand of *A. senegal* (bottom)

Following are some possibilities for conserving and improving the dryland woodlands.

- Plantation establishment and woodland management. Both the government and the private sector should be involved in this. Management involves enrichment plantings, protection, improved production systems, etc.
- Rational planning in settlement programmes; training and retraining of settlers to responsibly use and live with the resources.
- Leasing, policy support and incentive provision to encourage private sector involvement in planting and managing the resources on a long-term basis.
- Effective coordination and integration of all efforts to ensure sustainability.

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# Chapter 3

## **Production, handling and quality control**

Girmay Fitwi<sup>1</sup> and Mulugeta Lemenih<sup>2</sup>

### **3.1 Introduction**

This chapter presents information on the production processes, harvesting and handling, quality control and associated constraints in Ethiopia. It also proposes measures to improve product quality and to enhance gains from the subsector at both local and national levels.

### **3.2 History of gum and resin production in Ethiopia**

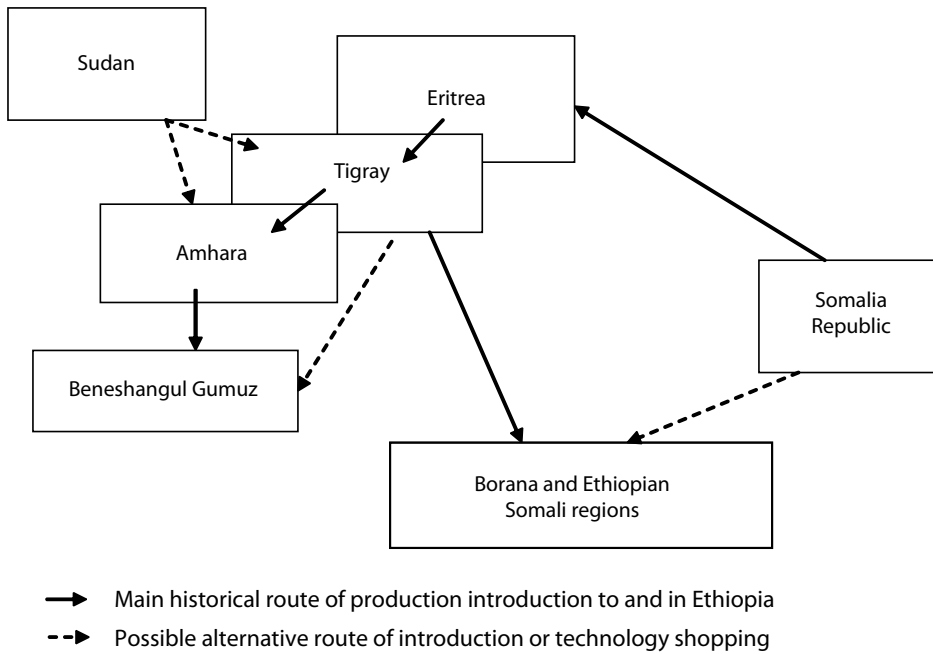
According to oral legend, myrrh and incense production and trade in Ethiopia date back to the Aksumite Empire, which flourished around 500 BC (Gebremedhin 1998). The introduction of Christianity into the country around the 3<sup>rd</sup> century AD is believed to have increased production and trade. Despite this, hardly any historical documentation or other solid evidence exists to unequivocally support claims of the ancient commercial production of myrrh and incense in Ethiopia. Available records for commercial production only date back to the 1940s (Taib 1982), when Italians introduced incense production into Ethiopia via Eritrea. Somalia also introduced production into Eritrea. Over time, commercial production extended further southwards through Ethiopia to other parts of the country, including Tigray, Metema (Amhara), Benishangul-Gumuz and Borana (Oromia) (Figure 3.1).

The organised production and trade of gums and resins by local companies began in the 1960s following the founding of a private company called Tigray Agricultural and Industrial Development Share Company (TAIDL), which was co-owned by the then government of Ethiopia and some private individuals. The company operated until 1974 when it was nationalised by the socialist

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1 Natural Gum Production and Marketing Enterprise, Addis Ababa, Ethiopia

2 Hawassa University, Wondo Genet College of Forestry and Natural Resources, Ethiopia



**Figure 3.1 Historical development of commercial gum and resin production in Ethiopia**

government, which soon established a state-based company called Natural Gum Processing and Marketing Enterprise (NGPME).

NGPME further expanded gum and resin production throughout the rest of the country. NGPME was also active in technology shopping, such as seeking tapping equipment for improved exploitation, from neighbouring countries, principally Sudan and Somalia (Figure 3.1). For 17 years (1974–1991), NGPME operated alone as the country’s sole enterprise responsible for the production and marketing of gums and resins. Since 1991, following the fall of the socialist regime and the beginning of a free market economic policy, several private entrepreneurs have renewed their interest in gum and resin production and marketing. Today, 34 private companies are engaged in the production and/or trade of gums and incenses in various sites throughout the country.

### 3.3 Production processes and gum handling

The production of various gums and resins varies according to the type and place of production. Common to all, however, is the fact that production and harvesting are seasonal and performed solely during dry seasons. Production during rainy seasons is not recommended because of the rapid deterioration in

quality in connection to the high moisture content. Ethiopia's current gum and resin production system can broadly be subdivided into 2 activities: production by tapping and collection of naturally oozing gums and resins.

### 3.3.1 Tapping

Tapping is the artificial wounding of the stems and branches of trees for the production of gums and resins. It involves shallow blazing (wounding) of the stems and branches by shaving off the bark using a sharp instrument, locally known as a *mingaf* or *sonke* (Figure 3.2).

When the stems and branches are blazed, incense begins to ooze through the openings created by the wounds. These incense tears start to solidify and granulate upon exposure to wind and sun radiation (Figure 3.3). Leaving



Figure 3.2 (a) Two of the most commonly used tapping tools (*mingaf* and *sonke*) and (b) tapping an incense tree



Figure 3.3 Solidifying tear of frankincense after artificial wounding of *B. papyrifera*

the tears on the trees for a sufficient length of time is important to allow the tears to mature and to avoid them clumping into ungranulated masses. In Ethiopia, tapping is commonly practised for Tigray type incense production from *B. papyrifera*.

The tapping and collection of gum olibanum from *B. papyrifera* are carried out according to a specific pattern starting from mid-October until the onset of the rainy season, usually early June. Due to the mono-modal rainfall pattern in the north, production and collection take place for an extended 8–9 months each



Figure 3.4 Tapping of *B. papyrifera* after 1 year (left), 2 years (centre) and more than 2 years (right). Photo © Mulugeta L.



Figure 3.5 Picking of incense tears from stems after maturity and collection vessels used in the north

year. The first cycle of conventional tapping of *B. papyrifera* trees begins with wounding the tree stems at 3 spots, at approximately 25–50 cm apart (Figure 3.4).

Wounds are often made on the eastern and western sides of the tree to allow sufficient exposure to sunlight for quicker drying of gums. However, on big trees, there could be 4 or more tapping spots. Successive tapping cycles involve refreshment of older wounds by removing the bark from the upper edges of the former blaze (wound) and by carving down by 2 cm of the lower edge, until the whole wound size reaches a width of 10 cm at the end of the year. Wounding and refreshments continue at intervals of 2–3 weeks until the onset of the rainy season. Usually, a tree is tapped and refreshed 8–12 times during each production season.

Incense tears are manually picked from the stems before refreshment and put into collection vessels made of local materials (Figure 3.5). It is crucial that wounds be refreshed at the right time. If not, old wounds may heal and plants may take longer to reinitiate production of adequate and superior quality resins during the delay. This will also reduce annual yields. It is also important to limit



**Figure 3.6** (a) Naturally oozing gum of *A. senegal* and (b) incense from *B. neglecta*  
Photo © Worku (2006).

the number of wounds per tree, as a tree with too many wounds will produce smaller or dusty tears, which are generally regarded as of inferior quality.

### 3.3.2 Collection of natural exudates

Most gums and resins, particularly those produced in the country's south and southeast, are produced from natural exudates (Figure 3.6). Various reasons for the absence of tapping have been suggested. Some studies suggest that as there

is more than enough supply for the current market demand, there is no need to invest the effort (Lemenih *et al.* 2003, Worku 2006). Others suggest that farmers are unaware of how to use tapping to produce high-quality gums and resins in good quantities (Fitwi 2000).

In the south of Ethiopia, there are 2 harvest seasons because of the bimodal nature of the rainfall. The production seasons are December–February (following the main rain in October–December) and June–September (following the short rain in March–June). Collectors, who are mostly cattle herders, handpick gums from tree trunks and branches. They include in their collection both tears on the tree and pieces that fall to the ground during picking.

### 3.3.3 Organisation of the production system

*Boswellia papyrifera* gum production has recognised production systems, with 3 systems commonly observed. In the first system, producing enterprises (private or state) employ and organise the production themselves. Companies hire experienced staff as coordinators and tappers, or they contract coordinators who then employ tappers. Companies provide the workers with all their basic needs such as cooking utensils, clothes, medicines, food, petty cash and tools. The cost of these items is then deducted from workers' wages, with the exception of medicine, which is provided free. The tappers are then organised into a work team commonly known as a *squadra*, with several *squadra* organised under a coordinator. Each *squadra* delivers the olibanum collected to the coordinator, who then delivers it to the company. Final payment, which is based on a rate per piece, is made upon delivery of the olibanum.

The second system is a concession system, in which licensed gum/incense-producing companies select and contract with individuals who have knowledge and experience in production, as well as the financial means to cover the food and transportation costs of tappers. Depending on the size of the concession site, the concessionaires employ tappers and provide their basic needs. Concessionaires cover all expenses and pay tappers according to a contracted seasonal wage. Concessionaires do not provide tappers with medicine or clothes. The concessionaires ultimately deliver the produce to the companies.

In the third system, farmers or local residents are organised as producer cooperatives and produce gums and resins, which they formally sell to wholesalers and gum exporters. This system, although less common, is growing in importance. With the increasing recognition that locals should have the right to benefit from their nearby resources, there is a growing trend of locals in many producing areas, including Metema, Borana and Tigray, forming local cooperatives for the production and sale of gums and resins. This approach can encourage local people to enhance production of the goods while conserving the resources (Worku 2006, Lemenih *et al.* 2007).



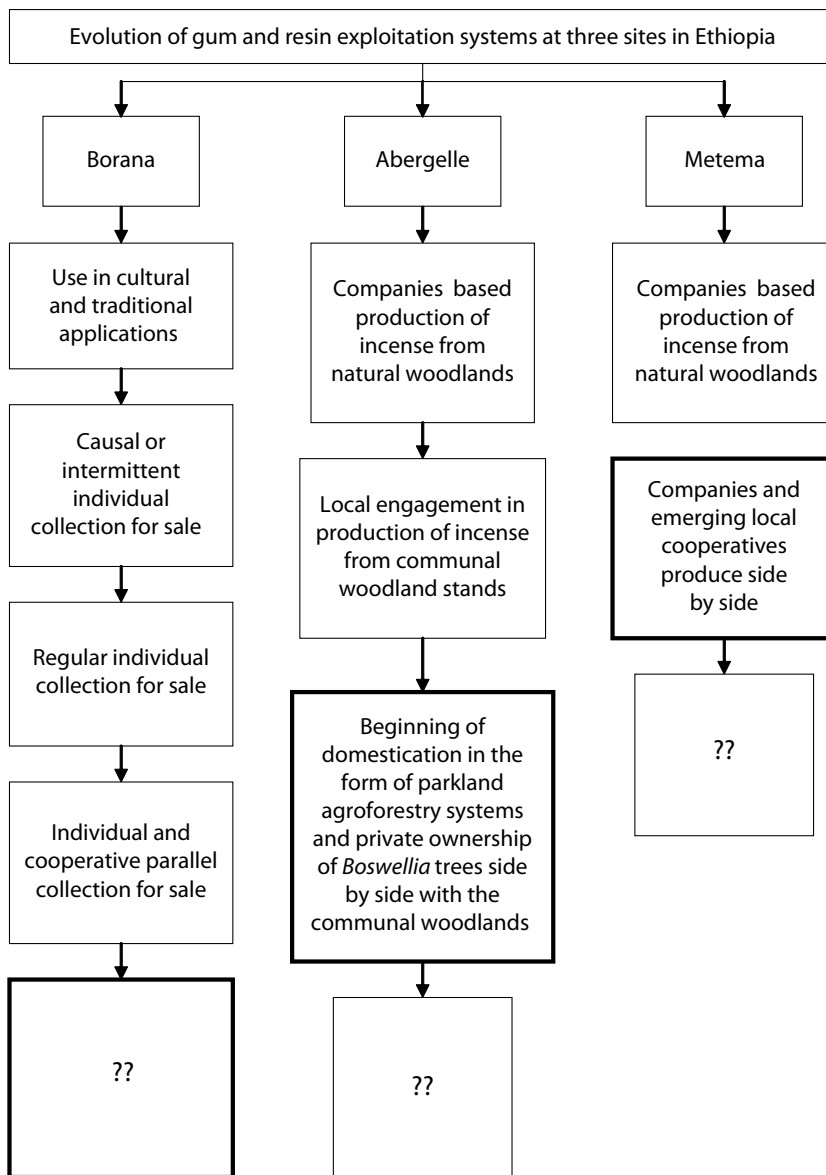


**Figure 3.7 (a) Children collecting gum and incense and (b) collection vessel**  
Photo © Worku (2006)

In the south of the country, there has been no systematic production organisation as such, with the exception of the recently emerging cooperative-based collection system. Farmers, often women and children (Figure 3.7), collect gums and resins that they come across while herding cattle; collection is thus a subsidiary activity. However, when a household's situation is particularly dire, or when market demand is high, men will also get involved in collection and poor households might engage the entire family (Worku 2006). Amounts collected daily or weekly are amassed, or occasionally delivered to local markets and sold to local retailers. Collectors use local items such as old milk containers or sacks for field collection and handling.

Given the erratic climate in the drylands of Ethiopia, the federal and regional governments and other development actors, mainly NGOs, are beginning to explore ways to improve woodland management and to integrate gum and resin production into wider livelihood strategies. Consequently, not only state institutions but also several NGOs are currently engaged in activities related to improving management and exploitation of woodland resources. NGOs are engaged in training, organising and facilitating woodland management and gum and resin production.

There is also growing national interest in intensifying the production of gums and resins (PASDEP 2005), mainly because of their growing contribution to national foreign currency earnings, but also because of rising global demand. For instance, the government strategy for 2005–2010 projected a doubling of gum and resin production and export (PASDEP 2005).



**Figure 3.8 Evolution of gum and resin exploitation systems in 3 sites in Ethiopia** (boxes with bold borders represent the current system; question marks indicate the future situation)

Alongside these initiatives, new production systems are evolving (Figure 3.8). A rapidly emerging production model in gum and resin exploitation is the cooperative model. This model may come to dominate the country’s production system because it may remove obstacles related to: (1) policy of public ownership of land and resources (woodlands or forest), and (2) the arduous and labour-intensive nature of gum and resin production.





**Figure 3.9** Shades constructed for incense seasoning at or near production sites

Photo © G. Fitwi

**Table 3.1** Grades of gum olibanum (Tigray type)

Grade	Grade name	Description	Ratio (%)
1st	1 A	Size: $\geq 6$ mm; white	22
2nd	1 B	Size: $\geq 6$ mm; creamy white	9
3rd	2	Size: 4–6 mm	11
4th	3	Size: 2–4 mm	8
5th	4 A	Any size; brown ('special')	19
6th	4 B	Any size; black ('normal')	17
7th	5	No size limit; powder and bark	14

### 3.4 Post-harvest handling

Post-harvest handling of gums and resins varies according to the type of gum. In the case of Tigray type gum olibanum, the gums collected from the trees are seasoned in the field by spreading on beds made of local materials under temporary shades (Figure 3.9). Seasoning is essential to avoid clumping of the tears.

#### 3.4.1 Processing and grading of Tigray type gum olibanum

After seasoning in the field under shade, the incense is transported to permanent warehouses for further processing. Processing of Tigray type olibanum involves cleaning, sorting and grading of the gums. The entire operation is manual and is usually done by women (see Figure 2.8 in Chapter 2). Grading of olibanum involves sorting the pieces into 7 different grades according size and colour criteria (Table 3.1).

### 3.4.2 Grading myrrh and gum arabic

Grades for myrrh are the same as those for Tigray type olibanum, except that Grade 1A gums are bright red in colour and Grade 1B gums are brown. No grading system for gum arabic has yet been developed in Ethiopia, even though the country exports quite a substantial amount of clean gum arabic.

## 3.5 Quality of gums and resins

### 3.5.1 Chemistry of gums and resins

A key factor constraining gum and resin trading in Ethiopia is the subsector's failure to guarantee consistent quality. Importers of gums and resins prefer to receive a reliable supply of raw materials of consistent and predictable quality. One of the main practices leading to quality deterioration is adulteration, mostly because of attempts by producer farmers to boost trade volume. Farmers can get away with mixing products of different quality because traders do not have the skills or means to assess the purity of the gums and resins in a trade batch. As most of the gums look similar in terms of colour (e.g. gum arabic of *A. senegal* and gum from *A. drepanolobium* or *A. mellifera*), it is difficult to discern them by visual inspection alone. Indeed, farmers seeking to adulterate batches deliberately choose adulterants that are similar to genuine products in colour and texture.

Necessary measures to ensure gum and resin quality are chemical characterisation of each type, testing of each batch and labelling with information on locality and botanical origin. Chemical characterisation is essential because gums from different species, for instance from *A. senegal* and *A. seyal*, which are both classified as gum arabic for trading purposes, exhibit characteristics that are intrinsically different. Achieving this form of quality control requires the establishment of commercial test laboratories and industry standards. Farmers and retailers can then be trained not to mix types, but to collect and trade gums and resins from different botanical sources separately. Recognising the differences in gum quality and their end uses (applications) from different species or even varieties is an important part of producing gums and resins that guarantee customer (importers) satisfaction and reassure users regarding safety.

In terms of applications, stringent regulations exist for almost all gums, especially those used as food additives, such as gum arabic (*A. senegal* origin). Most of these gums are not only tested for chemical composition but also subject to extensive toxicological control by importing countries, organisations and end users. This process demands quality assurance that exceeds simply labelling products with the botanical source and locality. Proper handling of the produce from collection to shipment is crucial to avoid toxicological contaminations.

To meet these consumer requirements and stimulate strong market demand for gums and resins, supply must comply with set chemical specifications (Seif el Din and Zarroug 1996). Users also want to be able to trace products to their source localities, and to receive guarantees that products are free from any risk.

Some research on chemical characterisation of gums and resins in Ethiopia has been carried out recently, although much remains to be done. Available information on the chemistry of some of the gums and resins from Ethiopia is presented in the following sections.

### 3.5.2 Gum arabic

Gum arabic is a complex arabinogalactan-type polysaccharide exudates of *Acacia* trees (Sanchez *et al.* 2002). The exact chemical and molecular structure differs according to the botanical origin of the gum, and these differences are reflected in the analytical properties, functional properties and uses of gum arabic. Gum arabic is essentially a technical product that is often blended with other gums or materials to produce precise ingredients for food and pharmaceutical applications (Holmes 1997). Vast sums of money go into developing new product lines, thus demanding that ingredients be relatively consistent.

Increasing international pressure for tighter trade specifications, labelling regulations, identity and purity has led to the Revised Specifications (FAO/WHO–JECFA), which define gum arabic as gum originating from *A. senegal* or a closely related species, with a specific optical rotation range of  $-26^{\circ}$  to  $-34^{\circ}$  and a Kjeldahl nitrogen content of 0.27–0.39% (FAO 1995).

Gum arabic contains neutral sugars (L-rhamnose, L-arabinose and D-galactose) and acids (D-glucuronic acid and 4-methoxyglucuronic acid). It also contains some cations such as calcium, magnesium, potassium and sodium, as well as heavy metals such as lead, copper, cadmium and zinc. Protein is also one of its constituents. However, the exact values and relative proportions of the analytical parameters of gum arabic vary depending on botanical origin and geographical location. Laboratory analysis data for the physico-chemical characteristics of the gum arabic samples from *A. senegal* are presented in Table 3.2.

Physically, the gum ranges from pale-white to orange-brown in colour, is solid and breaks with a glassy fracture, just like the high-quality gum arabic described in the literature (FAO 1999). The gum is tasteless and odourless. It is readily soluble in water and insoluble in ethanol. The gum's lead content is too low to be detected through laboratory investigation by atomic absorption spectrometer (Table 3.3). As gum arabic is used as a food additive, it must have minimal amounts of heavy metals such as lead, and standards limit the content to less than 2.0 ppm (FAO 1999); gum arabic from *A. senegal* in Ethiopia's Central Rift

**Table 3.2 Data on the physical and chemical properties of gum arabic from *A. senegal* in the Central Rift Valley, Ethiopia**

Characteristic	Value
Moisture content (%)	15
Ash content (%)	3.56
Viscosity (centipoise) at 10 (gl-1)	0.9954
at 7.5 (gl-1)	0.9552
pH (25% sol.)	4.04
Nitrogen content (% w/w)	0.35
Protein (%; N x 6.6) <sup>a</sup>	2.31
Specific rotation (degree) <sup>a</sup>	-32.5
Tannin content (% w/w)	0
Gel (25% sol.) <sup>b</sup>	Moderate
Ca (g/100 g)	0.7
Mg (g/100 g)	0.201
K (g/100 g)	0.95
Na (g/100 g)	0.014
Fe (g/100 g)	0.001
P (g/100 g)	0.6
Pb (g/100 g)	ND
Mn (g/100 g)	ND
Co (g/100 g)	ND
Cu (g/100 g)	ND
Zn (g/100 g)	ND
Ni (g/100 g)	ND
Cd (g/100 g)	ND
Cr (g/100 g)	ND

Source: Yebeyen *et al.* (2009)

ND = not detected; a = at 25 °C; b = based on classifications of no gel, light gel, moderate gel and heavy gel after Chikamai and Banks (1993).

Valley complies with this requirement. The characteristics of gum arabic from the Central Rift Valley were evaluated against several international specifications and compared with gum arabic from well-known sources such as Sudan, Uganda and Kenya. As the assessment presented in Table 3.3 shows, the gum satisfies specifications, and has characteristics similar or superior to gums from Sudan, Kenya and Uganda.

Table 3.3 Assessment of gum arabic from the Central Rift Valley of Ethiopia against international specifications and gums from other sources

Quality parameter	International specifications by organisations				Values for gum arabic from 4 countries <sup>a</sup>		Values reported by studies from different areas				Evaluation of gum arabic from CRV <sup>b</sup> of Ethiopia
	JECFA	USP	BP	IP	Mrosso (1997)	Mhinzi and Karamalla <i>et al.</i> (1998)	Idris <i>et al.</i> (1998)	Al-Assaf <i>et al.</i> (2005)			
Moisture content (%)	< 15	< 15	< 15	< 15	13–15	14.1–15	8.1–14.05	12.5–16			Good
Ash content (%)	< 4	< 4	< 4	< 4	3.0–3.9	3.8–4.5	2.75–5.25				Very good
Intrinsic viscosity (ml/g)					15–22		1–73			9.7–26.5	–
pH (25% sol.)					4.3–4.4		4.3–5.1				Fair
Nitrogen content (% w/w)					0.27–0.44	0.28–0.33	0.23–0.43	0.22–0.39			Very good
Protein %					1.8–3.0	1.75–2.06		1.5–2.6			Very good
Specific rotation (degrees)	NS	NS	NS	NS	-30–34	-25–26	-23–29	-27–36	1.8–2.1	-29–33	Very good
Tannin content (% w/w)	0	0	0	0	0	0.28–0.52					Very good
Gel (25% sol.)					Not determined						–
Ca (g/100 g)						0.43–0.72					Very good

Quality parameter	International specifications by organisations			Values for gum arabic from 4 countries <sup>a</sup>	Values reported by studies from different areas			Evaluation of gum arabic from CRV <sup>b</sup> of Ethiopia	
	JECFA	USP	BP		IP	Mhinzi and Mrosso (1997)	Karamalla et al. (1998)		Idris et al. (1998)
Mg (g/100 g)									Very good
K (g/100 g)									Very good
Na (g/100 g)									Very good
Fe (g/100 g)									-
P (g/100 g)									-
Pb (g/100 g)									Very good
Mn (g/100 g)									Very good
Co (g/100 g)									Very good
Cu (g/100 g)									Very good
Zn (g/100 g)									Very good
Ni (g/100 g)									Very good
Cd (g/100 g)									Very good
Cr (g/100 g)									Very good

For values of chemical parameters for Ethiopian gum, see Table 3.2.

Source: Yebeben et al. 2009. NS—Not specified; a = Ranges of values for *A. senegal* var. *senegal* from Sudan, Nigeria, Kenya and Uganda (Source: Chikamai 1997); JECFA = Joint Expert Committee for Food Additives; IP = International Pharmacopoeia; BP= British Pharmacopoeia; USP = United States Pharmacopoeia). b = CRV: Central Rift Valley of Ethiopia.

### 3.5.3 Aromatic gum resins

The gum resins (olibanum, myrrh and opoponax) from different species differ in quality because of their chemical composition. The chemical composition of a gum's volatile oil content accounts for its sensory characteristics and determine its fragrance and flavour applications. In other words, most applications of aromatic gum resins depend on their volatile oil content. Nevertheless, non-volatile constituents are also essential as these account for some biological properties of the products and have several applications such as in medicine (Coppen 2005).

Myrrh contains 57–61% water-soluble gums, 7–17% volatile oils, 25–40% alcohol-soluble resins and 3–4% impurities. Olibanum is composed of about 5–9% essential oil and 65–85% alcohol-soluble resins; the remainder is water-soluble gum or 8–9% essential oil, 45–50% resin, 30–40% gum and 4–5% impurities. The volatile oils consist of mixtures of mono-, sesqui- and diterpenoids, with the precise composition varying from resin to resin depending on tree species and source locality. The non-volatile components include numerous triterpenoids of the lupan, oleanolic and ursolic acid types. *Boswellia* resins contain components such as  $\alpha$ - and  $\beta$ -boswellic acids, which are the main active constituents for their medicinal applications.

#### 3.5.3.1 Essential oil composition of olibanum

Olibanum's most important ingredients are its essential oils (volatile oil). The constituents of these volatile compounds in terms of composition and amounts vary between and within species depending on such factors as geographical location, collection time and product handling. Research on the characterisation of essential oils of several *Boswellia* species has been conducted, but *B. papyrifera* has received the most attention. Major components in the essential oils of *B. papyrifera* of Ethiopian origin are octyl acetate (50–90%),  $\alpha$ -pinene (6.1%), camphene (0.6%),  $\beta$ -pinene (2.0%), myrcene (1.7%), limonene (4.8%), 1-octanol (5.9%), linalool (3.6%), octyl acetate (46.8%) and geraniol (1.1%) (Dagne *et al.* 1997, Dekebo *et al.* 2002). The essential oils of *B. neglecta* gums are mainly composed of hydrocarbon monoterpenes of  $\alpha$ -thujene (26%),  $\alpha$ -pinene (20%), 4-terpineol (15.7%), p-cymene (4.5%), camphor (2.8%) and  $\beta$ -pinene (1.9%) (Dagne *et al.* 1997).

Information from a recent report on the yield and chemical constituents of different grades of *B. papyrifera* gum resins is presented in Table 3.4. In all grades, the major component is n-octyl acetate, which accounts for more than 65%, except in Grade 5, which contains around 60%. The essential oil from the Grade 1 sample is rich with an n-octyl acetate content of 65.25% followed by an n-octanol content of 4.5%. The table comparing chemical composition indicates that

**Table 3.4 Composition (%) of the essential oils of different grades of frankincense from *B. papyrifera* ('G' = grade)**

SN	Compound	G-1A	G-2	G-3	G-4N	G-5
1	$\alpha$ -Thujene	0.29	ND	ND	ND	ND
2	$\alpha$ -Pinene	2.51	1.95	0.45	2.36	1.14
3	Camphene	0.69	0.50	ND	0.58	0.38
4	Sabinene	1.23	1.06	0.26	1.90	0.79
5	$\alpha$ -Pinene	0.52	0.43	ND	0.45	0.32
6	Myrcene	0.57	0.41	ND	0.40	0.26
7	n-Hexyl acetate	0.81	0.78	0.46	0.96	0.55
8	p-Cymene	0.31	ND	ND	0.33	0.28
9	Limonene	1.74	1.37	0.56	1.62	1.50
10	1,8-Cineole	1.69	1.67	0.73	1.60	1.28
11	Trans-ocimene	1.13	1.83	ND	ND	ND
12	n-Octanol	4.51	3.63	4.55	7.46	7.75
13	Linalool	2.00	1.89	1.81	ND	1.89
14	Endo-borneol	1.31	1.06	0.96	1.96	1.00
15	4-Terpineol	0.22	ND	0.32	ND	ND
16	$\alpha$ -Terpineol	0.47	0.44	0.46	0.51	0.42
17	n-Octyl acetate	65.25	68.76	69.08	67.87	60.89
18	Bornyl acetate	2.50	2.43	2.97	2.24	2.07
19	Carvacrol	0.96	ND	0.25	ND	ND
20	Unidentified	0.22	ND	0.26	0.30	0.28
21	Neryl acetate	0.38	0.40	0.25	ND	0.27
22	Geranyl acetate	0.43	0.42	0.50	0.49	0.50
23	n-Hexyl hexanoate	ND	ND	ND	0.23	ND
24	n-Decyl acetate	0.50	0.42	0.57	0.50	0.53
25	Hexyl caprylate	0.21	ND	0.39	0.24	0.26
29	Incensole	0.59	0.58	1.25	0.28	1.40
30	Incensole acetate	2.51	3.12	5.37	1.51	5.80
<b>Total</b>		<b>99.03</b>	<b>95.57</b>	<b>97.94</b>	<b>95.59</b>	<b>97.63</b>

Retention indices were obtained relative to alkane mixture of C8–C30 and C32, product of Sigma-Aldrich. ND = not detected. G-4N refers to the category Grade 4 Normal.

current practices of grading and sorting of frankincense have no value in terms of essential oil production. The amount of n-octanol found in Grades 4 and 5 is 1.7–2.0 times higher than that found in Grades 1A, 2 and 3. However, variation in the chemical composition of volatile oils may arise due to tapping season (incision time), tapping cycle and geographical location (Fengel 1984).



### 3.5.3.2 Essential oils of myrrh and opoponax

The volatile oil of myrrh contains terpenes, sesquiterpenes, esters, aldehydes and alcohols. Seven sesquiterpene hydrocarbons, a furanosesquiterpenoid oil and furanoidiene have been detected in the volatile oil of *C. guidotti* or opoponax.

## 3.6 Quality control

Factors that affect the quality of gums and resins in Ethiopia include botanical origin, adulteration, collection and handling of the products.

### 3.6.1 Gum arabic

In Ethiopia, gum arabic is produced from *A. senegal* and *A. seyal* species. In most cases, the gums of these 2 species are collected, handled, transported and traded separately. However, gums from different varieties are not separated, but are all traded as gum arabic. Adulteration is a major problem affecting the gum arabic trade. Often gums from different species such as *A. mellifera* and *A. drepanolobium* are deliberately used as adulterants in gum arabic to boost the trade volume. A relatively rapid means to implement quality control of gum arabic would be to train collectors to avoid adulteration, and to train traders and suppliers to label their gum products with information on variety and locality.

### 3.6.2 Gum olibanum and myrrh

With respect to quality control, frankincense products in Ethiopia are classified as either Tigray type olibanum or other. Tigray type olibanum is produced from *B. papyrifera*, which is the only *Boswellia* species growing in the forests of the northern and northwestern lowlands, and hence adulteration with gums and resins from other similar species does not occur. Hence, Tigray type frankincense is the purest in terms of botanical origin. Furthermore, sorting and grading



Figure 3.10 (a) Commonly used collection vessels and (b) transportation sacks

of this frankincense are advanced because of the long history of processing. The granules are sorted, graded and shipped properly, leading to purity of quality grades.

By contrast, Borana and Ogaden type frankincense produced in the south, southeastern and eastern lowlands are characterised by poor quality because of the mixing of gums and resins from different botanical origins. It is not even possible to determine whether these olibanums are different or the exact species of their origin. This is because gums and resins from *B. neglecta*, *B. rivae*, *B. ogadensis* and *B. microphylla* are mixed, either intentionally or unintentionally. Some batches from these regions even contain gums and resins from some *Commiphora* species because of their similar colour and scent.

Handling and production systems for Borana and Ogaden type olibanums are much less developed than those for Tigray type. Grading is less common and collection is restricted to natural exudates. Quality of natural exudates is compromised by such factors as overexposure to radiation, which bakes the resins and discolours them, and premature collection, which means the gum has a high moisture content, making it clumpy and with loose granulation. Sometimes, fallen granules are collected from the ground, and these tend to be contaminated with soil and other foreign materials. Careless storage and use of inappropriate containers are other common quality-degrading factors affecting all sorts of olibanum products in Ethiopia. Storage and transportation with substances such as petroleum and flammable items are also common. To maintain quality, clean and airtight containers should be used for transport and storage (Figure 3.10), and collected olibanum should not be held in the field under high-temperature conditions. Prolonged storage at high temperatures and in perforated containers can cause the loss of a significant proportion of essential oils, reducing the quality.

### 3.7 Challenges related to production and supply

Numerous constraints and problems, related to management, technical, policy and other interrelated factors, are affecting the production of natural gums and resins in Ethiopia. The major factors challenging gums and resins production are outlined below.

1. **Lack of access to roads.** Gum- and resin-producing trees tend to grow on rugged and undulating land in remote areas. Inaccessibility or lack of infrastructure such as roads and housing and inadequate transport to potential forest areas always make production and marketing of gums and resins very difficult. Mobilisation of labour force, equipment and other

supplies as well as collection of gums and transportation to markets are always difficult without adequate road infrastructure.

2. **Lack of health facilities.** Diseases such as malaria, relapsing fever and water-borne diseases, which frequently affect tappers, are common in the resource base areas. As these areas are remote and inaccessible, lack of access to proper medical treatment often causes tappers to stop work, thus reducing production.
3. **Lack of water.** As the resource base is in hot and dry areas, workers have high water requirements. However, these areas have a severe shortage of drinking water, and lack of water causes tappers to stop work.
4. **Poor food availability.** Catering services are extremely low or non-existent. The lack of food availability makes tappers weaker and more susceptible to disease, thus reducing their working capacity and, in turn, production levels.
5. **Shortage of labour force.** Tappers receive lower wages than for other work, thus encouraging labourers to seek alternative employment.

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## Chapter 4

# Value-added processing and marketing of gums and resins

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### 4.1 Introduction

Natural gums are important for 2 main reasons. First, they have a wide range of industrial applications, from confectionery to cosmetics to atomic reactors, and second, gum production is a farmer-based industry providing income to farmers when it is needed most. Thus, the subsector performs an important function in terms of food security and income generation for people living in production regions. Export earnings from the subsector are important for a country with limited exports. The commercial activity is creating employment opportunities and income for an estimated 25 000–35 000 Ethiopians annually. Of these, about 90% are believed to be poor, rural residents who seasonally participate in collecting, tapping, cleaning and grading activities. The average annual cash income generated per individual from tapping and collection of gums and resins is estimated to be 172 USD and that from cleaning and grading is estimated to be 165 USD. This forms 42% of annual household income.

Even though Ethiopia is one of the few countries with large frankincense and myrrh resources and is a leading exporter, the country has neither industrial uses or applications nor value-added processing for any of the gums and resins produced there. There is no doubt that introducing value-added processing of the resources, rather than merely supplying raw gum and resin materials, would produce greater benefits for exporting countries such as Ethiopia. This particularly applies given that relatively large proportions of the apparently low grades of gums and resins are left for non-industrial local uses. Introducing value-added processing would enable Ethiopia to realise the full benefits of its gum and resin resources.

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Despite the huge potential, Ethiopia is not making useful gains from the subsector. Numerous problems constrain marketing of gum and resin products, including fluctuating supply of the products in terms of both quantity and quality, lack of appropriate usage and marketing policies, inadequate infrastructure and poor market accessibility. In general, knowledge about market performance and market-development linkages in the subsector is limited.

## 4.2 Industrial application and local use of gums and resins

### 4.2.1 Gum arabic

Gum arabic is a unique, extensively used natural product with several industrial applications. It is used in pharmaceutical preparations, confectionery, sweetmeats and cosmetics, and for the production of products such as ink, paint, paper, matches, ceramics, water-colours, wax polishes, liquid gum, and to dress fabrics, giving lustre to silk and crepe, thickening colours and mordants in calico printing (FAO 1988). Gum arabic is highly valued for numerous applications because of its combination of high solubility in water and low viscosity.

Gum arabic is used in the food industry to fix flavours, to prevent the crystallisation of sugar in confectionery products, as an emulsifier and as a stabiliser in frozen dairy products; its viscosity and adhesive properties have been found to be useful in baked goods, and as a foam stabiliser and clouding agent in beer. Despite increased demand for convenient foods as part of a modern lifestyle, growing awareness of the relationship between food and health has increased demand for high-fibre, low-fat food products. These factors have resulted in considerable interest in the use of hydrocolloids including various gums, modified starches and gelatin in foods and this is expected to continue in the future (Casadei 1997).

In the pharmaceutical industry, gum arabic is used as a stabiliser for emulsions, as a binder and coating for tablets and as an ingredient in cough drops and syrups (Coppin 1995). In modern pharmacy, it is commonly employed as a demulcent in preparations designed to treat diarrhoea, dysentery, coughs, throat irritation and fevers. It serves as an emulsifying agent and gives viscosity to powdered drug materials; it is used as a binding agent in making pills and tablets, particularly cough drops and lozenges. In recent years, it has been used in a medicine to treat kidney problems.

Gum arabic is used in cosmetics as an adhesive for facial masks and powders, and to give a smooth feel to lotions. Industrially, gum arabic is applied as an adhesive, as a protective colloid and safeguarding agent for inks, sensitiser for lithographic plates, coating for special papers, sizing agent for cloth to give body to certain



fabrics and coating to prevent metal corrosion. Gum arabic is also used in the manufacture of matches and ceramics (Cossalter 1991). Powdered, reddish-brown gum exudate mixed with fat or grease is used to massage the body. Fresh gum exudate is used as a depilatory. A solution of gum, drunk on an empty stomach, is used to relieve chest pains. The eating of gum is reputed to strengthen the stomach muscles. However, excessive eating of gum can cause flatulence and some discomfort. Gum is highly nutritious, 175 g being sufficient to support an adult for 24 hours (Coppen 1995).

#### **4.2.2 Gum olibanum and myrrh**

Oleo-gum resins of olibanum, myrrh and opoponax are widely used in perfumery, food industries and pharmaceuticals. Both myrrh and frankincense are highly valued for their fragrance and are common ingredients in incense, perfumes and potpourris, soaps, detergents, creams and lotions; they are also often included in meditation blends, as they strengthens the psyche and aid in deepening the meditative state (Coppen 1995). Frankincense is a favoured ingredient for potpourris, as it is known to hold its fragrance for a very long time – some even say indefinitely (Tucker 1986). In addition to its fragrance, it is noted to have some value as a fixative in perfumes and potpourris. Perfumers use it as an absolute (by alcohol extraction), oil or resinoid (by hydrocarbon extraction) and include it in oriental bases, ambers, powder perfumes, floral perfumes, citrus colognes, spice blends, violet perfumes, male fragrances, soaps, lotions, creams and others (Leung 1980:241–242 Tucker 1986, Coppen 1995). It is also used in the formulation of many modern perfumes including Replique by Colonia, Me! by Frances Denney, Mennen Millionaire by Mennen, Nino Cerruti Pour Homme by Uniperf, Onna by Gary Farn and Sculptura by Jovan (Tucker 1986).

The odour of myrrh is described as warm-balsamic, sweet, somewhat spicy-aromatic, sharp and pungent when fresh. Hence, perfumers use myrrh as an absolute, oil or resinoid, and in oriental-spicy bases, chypres, woody bases, forest notes, pine fragrances and others (Tucker 1986). Myrrh is included in the formulation of several modern perfumes including Fidji by Guy Laroche, Onna by Gay Farn and Volcan d'Amour by Diane von Furstenburg (Fragrance Foundation 1983). The resinoids are also used in soaps and detergents; users include multinationals such as Unilever, Proctor and Gamble (Farah 1994).

Frankincense and myrrh products also have a wide range of other industrial uses, such as in beverages, candies, chewing gums, confectioneries, gelatins, nut products, puddings and canned vegetables (Coppen 1995). Typical applications include as adhesive thickeners, thickeners, stabilisers, flavour fixatives and emulsifying agents in food products, for clarification in beverages and as release agents for rubber products.

Both frankincense and myrrh have modern pharmacological applications for the treatment of diseases, mostly as diagnosed and practised in traditional therapies. In Germany, myrrh gum resin and myrrh tincture are included in the official German Pharmacopoeia (Wichtl and Bisset 1994, Braun *et al.* 1997). The tincture is used as a mono-preparation, and also as a component of various dental remedies and mouthwashes, toothpaste, ointments, paints and coated tablets, as well as in the applications of paint, gargle and/or rinse in dentistry. For example, the product Merfluan is an effervescent dentifrice salt with myrrh (Mielck 1970). In paediatric medicine, tincture of myrrh is used in Germany to treat oral candidiasis (thrush), which is common in infants (Schilcher 1997).

Myrrh is officially in the United States Pharmacopoeia (USP) and National Formulary (Leung and Foster 1996). In the United States, it is used as an aromatic astringent mouthwash. In tincture form, myrrh gargles and mouthwashes are considered useful in treating sore throats or other oral mucosal or gingival irritations (Tyler 1993). The British Herbal Pharmacopoeia and European Pharmacopoeias recognise the pharmaceutical applications of myrrh (Coppen 2005). The British Herbal Compendium indicates the use of myrrh tincture as a gargle to treat pharyngitis and tonsillitis (Bradley 1992). In France, its topical use is approved for the treatment of small wounds, for nasal congestion from common cold and for local application as an anodyne to treat infections of the buccal cavity and the oropharynx (Bradley 1992, Bruneton 1995). The Merck Index reported its therapeutic action as carminative and astringent (Budavari 1996). Myrrh has also been shown to have disinfecting, deodorising and granulation-promoting properties (Wichtl and Bisset 1994).

In Chinese medicine, myrrh from *C. myrrha* (*C. molmol*) is used as a component in many patent medicines, including bu-gu-zhi-wan (psoralea pills) and zhi-wan (haemorrhoid pills), as well as various topical plaster adhesives and lotions, including die-da-yao-jing (traumatic injury medicine essence) (Fratkin 1986:125–134, 142–148; Yen 1992). Myrrh is also used as an insecticide, especially against termites, and as a mosquito repellent when blended as incense sticks. Several recent pharmaceutical studies on the resins of many *Commiphora* and *Boswellia* species have reported their wide applications. A constituent of the resin from *C. rostrata* has repellent effects against the maize weevil, and the gum resin of *B. papyrifera* and *C. africana* affects 3 insect pests of economic importance, by leading to the morphological malformation of adults and pupae, reducing the emergence of adults and increasing insect mortality rate (Karamalla 1997). Recently, 2 compounds in myrrh, furanoeudesma-1,3-diene and curzarene, were reported to have pronounced pain-relieving (analgesic) properties, as claimed by traditional therapies (Freese, 1996). Myrrh's anti-inflammatory (Duwiejua *et al.* 1993), antipyretic and antihistaminic (Tariq

*et al.* 1985), hypolipidaemic (Malhotra *et al.* 1977, Michie and Cooper 1991), hypocholesterolaemic, anti-atherosclerotic (Lata *et al.* 1991, Michie and Cooper 1991), anti-arthritic (Duwiejua *et al.* 1993), anti-gastric ulcer and cytoprotective (Al-Harbi *et al.* 1997), anti-tumour (Qureshi *et al.* 1993, Al-Harbi *et al.* 1994), smooth muscle relaxing (Claeson *et al.* 1991), anti-schistosomiasis (Massoud *et al.* 1998) and anti-fascioliasis (Massoud *et al.* 2001) properties have been verified, as has its usefulness in paediatric and blood lipid remedies in children (Michie and Cooper 1991) and lack of toxic side effects (Rao *et al.* 2001, Massoud *et al.* 2001). Myrrh also has astringent properties and has a soothing effect on inflamed tissues in the mouth and throat. Studies have also examined the anti-cancer potential of myrrh resin (Al-Harbi *et al.* 1994, Dolara *et al.* 1996). In addition to its antiseptic and expectorant abilities, myrrh destroys putrefaction in the intestines and prevents the absorption of toxins in the blood. It also stimulates blood flow to the capillaries and promotes menstruation (Frawley and Lad 1986).

The resinous portion of myrrh carries significant anti-inflammatory, anti-rheumatic and hypocholesterolaemic/hypolipidaemic activity. It is known to contain a rich source of steroids, which may find use as an alternative raw material for the synthesis of important corticosteroid drugs such as dexamethasone and betamethasone (Bhatt *et al.* 1989). For instance, a preparation by the name 'Guglip' developed from guggal (gum resin from *C. wightii*) by the Central Drug Research Institute, Lucknow, India is reported to possess hypolipidaemic activity equivalent to that of Clofibrate (ethyl p-chlorophenoxyisobutyrate), the drug of choice at the time of the relevant study (Bhatt *et al.* 1989). It was anticipated that with the discontinuation of Clofibrate in the USA because of its toxic manifestations, there would be ample scope to introduce Guglip on a commercial scale (Bhatt *et al.* 1989).

Frankincense has also been employed for medicinal purposes since antiquity. Various civilisations (including Egyptian, Greek, Roman, Chinese, Arabic and Indian) used it as an anti-catarrhal, anti-depressant, antiseptic, anti-tumour, diuretic stimulant, emmenagogue, expectorant, immune-system stimulant and sedative, as well as for treatment of cough and asthma (Wahab *et al.* 1987). Today, it is used against asthma, ulcers, aging, allergies, snake and insect bites, bronchitis, cancer, carbuncles, catarrh, colds, coughs, diarrhoea, headaches, haemorrhage, herpes, high blood pressure, inflammation jaundice, laryngitis, meningitis, nervousness, prostate, pneumonia, scarring sciatic pain, soars, spiritual awareness, staph, strep, stress, syphilis, tuberculosis, typhoid, wounds and warts and to strengthen the immune system (Leung and Foster 1996).

Pharmacological applications have recently justified the use of frankincense for its anti-tumour and anti-carcinogenic (Huang *et al.* 2000), anti-inflammatory (Shao *et al.* 1998, Safayhi *et al.* 2000, Krieglstein *et al.* 2001), anti-proliferative (Glaser *et al.* 1999, Hoernlein *et al.* 1999), anti-chronic colitis (Gupta *et al.* 2001)

and anti-bronchial asthma (Gupta *et al.* 1998) effects, as well as for anti-human leukaemia HL-60 cells and the DNA, RNA and protein synthesis in HL-60 cells (Shao *et al.* 1998). Controlled, double-blind studies have shown that *Boswellia* extracts are very helpful for ulcerative colitis (Singh and Atal 1986). The anti-inflammatory effects of treatment with *Boswellia* extract or AKBA (acetyl-11-keto- $\beta$ -boswellic acid) in experimental ileitis in rats are comparable to those achieved by treatments with standard drugs for inflammatory bowel disease such as prednisolone and sulfasalazine (Yamada *et al.* 1993). A pilot study in human ulcerative colitis of the same procedure reported fewer side effects from the treatment with *Boswellia* extract than from steroids (Gupta *et al.* 1997). *Boswellia* extract was found to inhibit pro-inflammatory mediators in the body, such as leukotrienes (Singh and Atal 1986) and, in contrast to non-steroidal anti-inflammatory drugs, long-term use of *Boswellia* extracts does not lead to irritation or ulceration of the stomach (Gupta *et al.* 2001).

The liquid part of freshly collected *Boswellia* oil is very similar to turpentine oil obtained from *Pinus* species, and readily dissolves colophony, dammar and other resins (Murthy and Shiva 1977). The higher iodine number of the volatile oil, which consists mainly of dextropinene mixed with L-pinene of *Boswellia* gum, indicates its suitability for the paint and varnish industry, and can be a substitute for pine turpentine oil (Murthy and Shiva 1977).

### 4.3 Value-added processing and implications

Gums and gum resins have various industrial and local applications because of their chemical constituents and physical properties. At the final destination or application sites, these gums and resins are processed and reprocessed into their various constituents. This processing multiplies their value and economic returns. For instance, gum resins such as olibanum, myrrh and opoponax are processed for their essential oils, which are regarded as important industrial raw materials. By extracting the essential oils and further processing, the complex mixture of the chemical compound can be separated into its individual compounds, which are used in several applications. During this process, as necessary, a particular flavour or aroma can be amplified, eliminating unwanted fractions and concentrating on desired ones. Certain chemicals can also be separated in groups by physical or chemical methods, and thus a diversity of products can be generated from just a single raw material.

Most commonly used essential oils in several industrial applications are derived from plant materials. Oils can be extracted in several ways, including the following.

- **Expression mechanical flow.** An Indian type olibanum produces essential oils in such a way that the exudate collected from the tree in a semi-viscous state is left in the shade for the oil to flow from the resin.
- **Solvent extraction.** Low boiling organic solvents are used to extract the essential oil and other non-polar compounds or liquid gases such as CO<sub>2</sub>. This method requires further processing of essential oils and resinous products. For example, pine oils, from the foliage and resins of pine trees, are produced in this manner.
- **Vacuum distillation.** This involves isolation of the oil under vacuum pressure.
- **Stem/hydro distillation.** This method results in pure production of the essential oils, which float over the condensate.

Processing of frankincense for the production of essential oil is simple and does not require any special skills. Gum olibanum is added to a proportion of water and distilled from the apparatus at boiling point. The steam created by dissolving or vaporising the volatile oils from the frankincense is allowed to condense; the condensation is collected in a basin where the oil floats on top of the water. This technology can be adopted to the farmer level using prototype apparatuses. By doing so, more returns can be fetched.

#### 4.4 Advantages of value-added processing

There are several advantages of value-added processing, as follows.

**Optimisation of profit gains.** Essential oils have a higher market value than raw gum resins. One kilogram of frankincense collected from *B. papyrifera* costs about 2–3 USD on the international market. However, this same amount can yield the equivalent of 0.7–1% w/w essential oil (i.e. 70–100 gm/kg), which can be sold for up to 10 times as much.

**Increased tradable quantity and foreign currency earnings.** Producing essential oils does not require sorting and grading. Furthermore, as chemical evaluation of the different grades has not revealed any significant difference in terms of chemistry or yield, all grades can be used for essential oil production; thus, greater net exports can be achieved. Furthermore, by avoiding the labour-intensive grading and sorting activities, producing essential oils can reduce processing costs and increase profit margins.

**Transport-related advantages.** Essential oils are lightweight products compared with raw gums and resins. If oils are extracted at the production site, the finished product can be easily and cheaply transported. Ethiopia is a landlocked country, and ports are far from the production and processing centres. This is one cause of the subsector's high production costs and low

Table 4.1 Major world and African exporters of gum arabic in 2005

Exporters	Value ('000 USD)	Quality (tonnes)	Unit value (USD/tonne)	Annual growth in value 2001–2005 (%)	Annual growth in quantity 2001–2005 (%)	Annual growth in value 2004–2005 (%)	Share in world market (%)	Share in Africa market (%)
World	346 938	92 750	3741	34	6	72	100	
Sudan	131 179	35 218	3725	47	7	102	38	70
France	88 140	17 745	4967	23	2	48	25	
Chad	32 822	14 138	2322	28	4	122	9	18
United Kingdom	26 352	5532	4764	35	6	52	8	
Nigeria	18 165	7225	2514	53	15	99	5	10
Germany	15 408	2627	5865	29	1	0	4	
USA	12 371	2812	4399	24	10	96	4	
The rest of Africa	187 080	58 434						
Eritrea	2351	495	4749	30	-26	1052	1	1
Senegal	870	323	2693	160		203	0	0.5
Mauritania	638	145	4400	194		-59	0	0.3
Cameron	362	371	976				0	0.2
Ethiopia	171	80	2138	50		10	0	0.1
Mali	166	144	1153	7	-8	-51	0	0.1
Tanzania	127	185	686			96	0	0.1
Chile	82	16	5125				0	0
Niger	76	57	1333	22	-1	-19	0	0
South Africa	71	37	1919	31	13	492	0	0

Source: ITC [no date]

Table 4.2 Major world and African exporters of gums and resins other than gum arabic in 2005

Exporters	Value (‘000 USD)	Quality (tonnes)	Unit value (USD/tonne)	Annual growth in value 2001–2005 (%)	Annual growth quantity 2001–2005 (%)	Annual growth in value 2004–2005 (%)	Share in world market (%)	Share in Africa market (%)
World	170 892	–	–	3	-4	-6	100	
Pakistan	25 309	21 962	1152	–	–	6	15	
USA	24 872	6484	3836	2	-13	3	15	
Indonesia	18 047	27 840	648	4	-2	21	11	
India	16 624	–	–	1	–	26	10	
Africa	7833	3010	–	–	–	–	–	–
Ethiopia	2169	–	–	14	–	24	1	28
Senegal	1794	863	2079	-2	-3	-20	1	23
Kenya	1313	1176	1116	21	–	-21	1	17
South Africa	1104	135	8178	15	-28	100	1	14
Somalia	1012	591	1721	-1	-5	36	1	13
Sudan	415	245	1694	-21	-25	-57	0	5
Uganda	26	–	–	–	–	–	0	0

Source: ITC [no date]

**Table 4.3 Natural gum and resin exports from Ethiopia by destination in 2005/06 Ethiopian Fiscal Year**

Country	Weight (kg)	Value (USD)	Share (%)
United Arab Emirates	543 404	986 390	18.39
Germany	413 905	773 850	14.43
Tunisia	316 976	721 422	13.45
China	672 810	505 836	9.43
Greece	212 120	318 330	5.94
Djibouti	227 782	228 978	4.27
Guatemala	132 984	205 926	3.84
Yemen	107 278	174 161	3.25
Egypt	87 165	165 424	3.08
France	75 000	136 594	2.55
Sudan	145 400	136 500	2.55
Saudi Arabia	70 000	135 930	2.53
Turkey	60 000	132 688	2.47
Taiwan	60 000	128 324	2.39
Belgium	62 318	115 958	2.16
Dubai	49 500	98 078	1.83
India	46 000	76 650	1.43
Sierra Leone	64 000	71 200	1.33
Italy	32 300	56 964	1.06
Netherlands	46 470	56 356	1.05
Cuba	32 300	55 200	1.03
Peru	14 250	29 925	0.56
Hong Kong	30 000	20 700	0.39
United Kingdom	16 974	17 754	0.33
Israel	10 497	12 207	0.23
Tanzania	105	1350	0.03
United States of America	60	442	0.01
Canada	40	40	0.00
<b>Total</b>	<b>3 529 338</b>	<b>5 363 176</b>	<b>100.00</b>

Source: Ministry of Trade and Industry (2006)



profit margins, which can be addressed by value-added processing such as essential oil production.

**Raw materials for local market and local industries.** Processing of some of the gums and gum resins will provide opportunities for import substitution. Some products can be used in local pharmaceuticals, detergents/soaps and other industries, which currently rely for most of their raw materials on imported items.

## 4.5 Trade and marketing of gums and resins

### 4.5.1 Exports

According to recent data, both the value and the volume of gum exports from Ethiopia are increasing. Gum and resin exports contribute about 0.54–0.73% of the country's total export revenue. Of the 4 export products in this subsector – frankincense, myrrh, gum arabic and opoponax – frankincense, typically that of Tigray type frankincense accounts for 91% of the value and 93% of the quantity.

Despite the huge potential for gum arabic production in Ethiopia, exports of gum arabic remain negligible – close to 0% at world scale and only 0.1% in Africa (Table 4.1). However, the value of Ethiopian gum arabic alone in the world market grew by 50% and 10% for the periods 2001–2005 and 2004–2005, respectively. If the estimated potential of 4996 tonnes – or even half of it – were produced and exported, Ethiopia could increase its gum arabic exports to be 3–4% of the world total.

In terms of the market for gums and resins other than gum arabic, Ethiopia has 1% of the world market and 28% of Africa's export trade. Ethiopia is thus Africa's leading exporter of natural gums and resins other than gum arabic (Table 4.2). Although Ethiopia has only 1% of the global market for gums and resins except gum arabic, its share increased in value by 14% and 24% for the periods 2001–2005 and 2004–2005, respectively.

The world's leading exporter of all natural gums and resins other than gum arabic (Pakistan) supplied 21 962 tonnes in 2005 (Table 4.2). This amount is small compared with Ethiopia's estimated potential of 70 650 tonnes.

Many countries import gum resin products from Ethiopia (Table 4.3). The major destinations are the United Arab Emirates (18.39% of exports), Germany (14.43%), Tunisia (13.45%), China (9.43%) and Greece (5.94%). Together, these countries account for 61.64% of Ethiopia's total gum and resin exports (Table 4.3).

Table 4.4 Global imports of gum arabic and other gums and resins ('natural gums') in 2006

Product	World imports of products in million USD (share from DC in %)						Performance of DC <sup>a</sup>		
	2000	2001	2002	2003	2004	2004	Annual growth volume 2000–2004 (%)	Change in market share DC 2000–2004	Performance
	Annual growth value 2000–2004 (%)		Annual growth value 2000–2004 (%)		Annual growth volume 2000–2004 (%)		Performance		
Gum arabic (in %)	106 49.3%	107 49.5%	116 45.6%	133 44.7%	206 50.5%	16.8	7.7	-0.6	Under achiever
Natural gums (in %)	139 64.9%	125 62.5%	126 60.7%	136 58.7%	167 64.3%	4.7	2.3	-0.9	Declining market

Source: ITC [no date]

<sup>a</sup> DC = Developing countries.

Table 4.5 Minimum, maximum and average selling prices (Birr/quintal) of different products by main players

Product type	Collector's selling price	Retailer's selling price	Wholesaler's selling price	Exporter's selling price	Proportion of other costs (%)
Tigray incense Average	165–300 210	300–450 375	400–600 500	300–1720 777	57
Borana incense Average	150–275 205	205–295 250	285–305 280	300–400 375	28
Ogaden incense Average	500–600 550	550–750 650	650–800 725	700–900 800	22
Opononax Average	600–700 650	650–750 700	700–850 775	800–1000 900	27
Gum arabic Average	225–800 610	290–850 665	375–900 727	600–1000 868	13
Myrrh Average	1300–1800 1550	1500–2000 1750	2000–2200 2100	2500–3100 2900	29

### 4.5.2 International demand

Gums and resins are required around the world both for traditional use in churches, mosques and households and for use in industrial processes. The competitive advantage of gums and resins compared with their substitutes is that they are natural and free from chemical modifications. Nevertheless, the market fluctuates: in the period 2000–2004, the natural gums market value declined in 2000–2001 and increased in 2002–2004, although the market for gum arabic grew throughout this period. In 2000–2003, the proportion of imports from developing countries decreased for gums and resins but remained nearly the same for gum arabic; in 2004, the proportion rose for all types. Imports of gum arabic and other gums and resins on average increased by 16.8% and 4.7% in value, respectively, and 7.7% and 2.3% in volume, respectively (Table 4.4).

## 4.6 Marketing chain

The marketing chain involves the flow of gum and resin products from producers/collectors to consumers and domestic or export markets through intermediary enterprises, wholesalers and retailers. Current marketing chains for the major gum and resin products of Ethiopia can be categorised into 4 groups according to product type and players:

- exporters directly producing and selling directly to consumers (mono actor);
- cooperatives producing and selling to gum companies (exporters), which then sell to consumers;
- individual collectors submitting to cooperatives, which then sell to gum companies, and then finally to consumers; and
- farmers/pastoralists collecting selling to rural retailers, which then sell to wholesalers and onto exporters and finally to consumers.

The first three models are common to Tigray type incense, whereas the fourth and longest chain is common to southern gum and resin products. The long chain creates additional costs, which increases sale prices along the chain (Table 4.5).

As shown in Table 4.5, the average selling prices of Tigray type olibanum, Borana type olibanum, Ogaden type olibanum, opoponax, gum arabic and myrrh increased by 270%, 83%, 45%, 38%, 42% and 68%, respectively, between the collector/producers and exporters. However, the share of costs other than production increased by 35%, 13%, 14% 16%, 11% and 12%, respectively. This indicates that increases in the number of intermediaries in market chain lead to high price increments. Other reasons for the price increments are collectors' lack of access to market information and variations in product quality.

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## Chapter 5

# Challenges, opportunities and actions for sustainable gum and resin production

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### 5.1 Challenges and opportunities

Ethiopia's dry forests are notably important natural resource endowments of drylands that have long contributed to human welfare and environmental health. In addition to their direct and indirect support of the livelihoods of 15–20% of Ethiopia's population, their commercial gum and resin products make them socio-economically important resources beyond the local level. These products are generating considerable foreign currency earnings for the country, and thus government and business interest in boosting production is growing. The government has targeted dry forests in its strategy to diversify its export goods to secure foreign currency (PASDEP 2005). Such intensified interest can lead to short- or medium-term changes to existing management and production systems. Decentralised (region-based) resource governance and improved regulatory frameworks are also showing signs of creating more responsible resource-base management and production systems.

The contribution of gums and resins to local livelihoods is increasing. This is expected to stimulate improved, locally evolving resource ownership, as shown in the emerging domestication of the resources such as in Tigray. Private sector involvement in the industry is increasing, and NGOs are intensifying their efforts to improve management of the resources for sustainable livelihoods. Overall, the growing interest from all sides – government, NGOs, private entrepreneurs – is likely to increase the economic and social benefits derived from these resources and consequently their management.

Nevertheless, despite the growing local and national importance of the gums and resins subsector, several factors continue to hamper sustainable management of the resource base:

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- climate change, political agenda or national economic policies and market forces that are forcing adaptation through new livelihood activities, particularly shifts towards increased crop cultivation;
- cultural transformations occurring through the penetration of urbanization, foreign religions, formal education and increased interaction with outside communities that are collectively weakening traditional cultural systems of resource management; and
- the shift from communal ownership and management of the resources through indigenous institutions to more individualistic and private-based ownership and management.

The following sections set out a SWOT analysis of the current resource management and exploitation systems to examine the existing strengths to build upon, weaknesses to avoid, opportunities to grasp and threats to prepare for.

### **5.1.1 Strengths of the gums and resins subsector**

Following are indicators of the strengths of Ethiopia's gums and resins subsector.

- Economic incentives from the subsector are attracting increasing private investment.
- Growing recognition of the importance of the resources to rural livelihoods and environmental quality is spurring increased involvement of development partners such as NGOs in supporting local efforts and national and/or regional government initiatives for improved management and exploitation of the resources.
- The use of gum producing species for gum-resin exploitation when done properly is environmentally friendly and can allow the country to comply with the international agreements it has signed, such as the CCC, CBC and CCD.
- The resources have multiple values and functions, including providing fodder for livestock production, wood for charcoal and nectar for apiculture; this can encourage improved integrated management as a climate change adaptation mechanism, a route that several donors are interested in and seeking to pursue.
- The country has an efficient loan provision system and availability of credit for those interested in investing in the subsector.
- The subsector can attract research and development efforts at various scales.

### 5.1.2 Weaknesses of the gums and resins subsector

Despite the considerable importance of the gums and resins subsector to Ethiopia's local and national economies, the following factors constrain the proper use of resources.

- Infrastructure development and access to areas where gum- and resin-producing trees grow are poor. This leads to higher energy costs, which eats into profits and can discourage investment in the subsector.
- In their natural form, gum-producing trees are scattered across wide areas located in hot climates and mostly on rugged land. Consequently, production is arduous and labour intensive and the subsector is less competitive in attracting labour. These limitations coupled with low product prices may discourage many private companies from continuing their involvement in the subsector.
- Despite the long tradition, ambiguities in access rights and ownership lead to unsustainable and irresponsible exploitation and resource degradation.
- Poor handling and lack of quality control, especially for products from the Borana area, are obstacles to improved and sustainable marketing.
- The slow process of land leasing and lack of monitoring over production processes are allowing over-exploitation, thus damaging the natural stock.
- Lack of value-added processing that weakens income gain from the resources.
- Low community mobilisation and involvement in the management and protection of the resources.

### 5.1.3 Opportunities

The following points describe opportunities for better and sustainable development and exploitation of the gums and resins subsector.

- Improved recognition of the contribution of the resources to rural livelihoods and the national economy and their potential in sustainable land management, which has been incorporated into Ethiopia's current national strategy (PASDEP) as well as several international conventions such as desertification control.
- Increased government attention to the resources for diversification of export products and, consequently, growing encouragement and various incentives such as tax exemptions for importation of goods needed for the production and management of the resources for those investing in the development of the resources. This could encourage entrepreneurs to invest in developing the resources.
- The existence of a long tradition and rich indigenous knowledge regarding the biology and silvics of the woodlands and their species.

- Strong market demand at domestic and international levels. Growing consumer interest in organic/natural products is boosting demand for products from Ethiopia.
- Organic/natural products could attain higher prices through certification.
- Establishment of Global Mechanisms for securing funding for dryland management; several NGOs and bilateral and multilateral donors can support development initiatives related to dry forest management.
- Extraction of gums and resins is not destructive to the tree and the vegetation ecosystem can also benefit from other global opportunities such as REDD (carbon funds).
- Exemptions from import duties applied for Ethiopia in the US and EU markets.
- Developing countries, mainly Africa, have a considerable share of the gum and incense market, particularly gum arabic and frankincense.
- Value-added processing is possible and will boost returns from the subsector.
- Global demand for gums and resins is rising.
- The policy of private sector-driven development in the country and the growing involvement by private entrepreneurs in the subsector that boosted production and trade.
- Several regional and international institutions exist that can contribute towards the development of the resources, such as Global Mechanisms to facilitate and support fund-raising for national projects, Network for Natural Gums and Resins in Africa (NGARA) to support provision of market information, networking, etc.
- The country has sufficient labour to engage in the large-scale management or exploitation of resources if properly organised and mobilised.

#### 5.1.4 Threats

The following points hinder the achievement of optimal and sustainable use of gum and resin resources, thereby reducing the benefits that the subsector could generate. It is necessary to address and mitigate these threats to ensure enhanced, sustainable benefits from the subsector.

- Climate change, increasing global food and energy prices and low product prices could reduce interest in the management of gum and resin resources.
- Excessive firewood harvesting and improper tapping practices damage trees and reduce their population in the woodlands .
- The area is under intensive grazing, as most herders keep their livestock there.

- Unintentional wounding of trees by herders and improper wounding of trees by local collectors.
- High intensity of forest fires and agricultural expansion.
- Conflicting policies, programmes and strategies, particularly the impact of non-forestry policies such as resettlement, and economic and rural development policies and strategies.
- Changing role of traditional resource management institutions due to exogenous factors.
- Uncontrolled migration and poor legal and regulatory systems, leading to open access to the resource base.
- Low financial and technical capacity of most private entrepreneurs currently interested in the subsector, particularly with regard to engagement in value-added processing and large-scale development activities.
- Population growth and associated migration to the lowlands in search of livelihoods from natural resource exploitation.
- Ongoing land and environmental degradation in the highlands that necessitates large-scale resettlement programmes to the lowlands.
- Climate change, frequent drought, poor performance of the livestock sector will drive further woodland clearance.
- Increasing global prices for food and energy products could accelerate the conversion of woodlands to other forms of land use and expand the use of wood resources for energy.

## 5.2 Future actions

Ethiopia's naturally growing gum and resin resource base is abundant, and the country has a vast area suitable for developing these resources. Production of gums and resins has increased during recent decades and it is expected to intensify as national economic development initiatives increase pressure on the natural resource base for intensive exploitation. Designing and implementing sustainable production systems is necessary not only to conserve the resources but also to enhance their sustainable socio-economic and ecological significance. To achieve these dual goals, it is essential to implement concerted and integrated multidimensional management interventions. Such interventions require multi-institutional collaboration and integration of actions to optimise impacts for the sustained production and development of the resources. Activities may be shared among various institutions and stakeholders at federal, regional and local levels, including the private sector. Following are some priority activities recommended for interventions in the short and medium term.

- Conducting a national-scale resource inventory (ground and/or remote sensing based), assessing with a high level of accuracy the available resource base in order to provide the business community with reliable information on the quantity, type and quality of currently marketable gum and resin products as well as potentially suitable areas for future development.
- Training and retraining of producers and traders to increase awareness of the need for sustainable management, to build and improve the capacity and technical skills of all concerned (local and business community and development/extension agents) in terms of silvicultural management techniques and to establish systems for ongoing support in managing dryland resources.
- Training and retraining producers in quality control, handling and transport of gum and resin commodities.
- Creating sufficient incentives and promoting sustainable dryland vegetation management through improved and sustained market links, market networks and timely provision of market information.
- Facilitating and supporting the establishment of transparent and effective producers and traders associations and strengthening their function through ongoing technical support.
- Strengthening the collaboration of pertinent institutions in relation to appropriate research to advance the management, production and commercialisation of gums and related dryland products.
- Creating the required infrastructure for documentation and dissemination of information, best practices and lessons learnt from within and outside the country in areas related to gum and other dryland product management and commercialisation.
- Aggressively pursuing value-added processing at various scales to enhance economic gains from the products and create more employment opportunities, while also creating inland capacity for further finished product processing and exports.
- Working collaboratively to tap into Global Mechanisms to channel some essential funds for development in the drylands.

The following more specific and short-term recommendations are also worth outlining.

- Production processes should be closely monitored and trees should be rested for a sufficient period to allow them to recover and regenerate.
- Producers should be given long leases and should be made accountable for changing forest conditions in their respective production areas. For this, monitoring systems need to be established and enforced.

- Ways to engage local communities in the management, production and benefits of the subsector should be seriously considered. Transferring responsibility for forest governance to locals is the best way to fill the institutional vacuum that leads to proper access to resources and thus reduces unsustainable exploitation of the resources; in particular, overgrazing and clearance should be minimised.
- Resettlement should be mainstreamed with improved management and conservation of the forest ecosystem. The resettlers can be organised, trained and thus engaged in the production of gums and resins as well as in complementary activities such as animal husbandry and apiculture that are dry forest ecosystem friendly.

Training and retraining producers in best-practice handling, storage and transportation, including ways to avoid adulteration, are essential steps in building a strong reputation, gaining a sustainable market and competing with other producing countries in the global market.







This publication is intended to serve researchers and teachers as well as development practitioners. It was prepared based on requests from CIFOR's national partners in Ethiopia and the region to compile existing information and help address the lack of documents available for teaching graduate and undergraduate students about the management of forests in dryland areas in general, and the production and marketing of gums and resins in particular.

By describing the current status of the dry forest resource base and the production and marketing of gums and resins, this publication contributes toward filling the existing knowledge gap. Chapter 1 presents an overview of challenges and forest-based opportunities in the drylands of Ethiopia. Chapter 2 describes in detail the resource base of gums and resins as well as the challenges to their productivity. Chapter 3 discusses production, handling and quality control, while Chapter 4 addresses value-added processing and the marketing of gums and resins. Finally, Chapter 5 summarises challenges and opportunities as well as actions for sustainable gum and resin production.

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