Natural gums and resins: Potential dryland non timber forest products of Ethiopia

EIAR
Wubalem Tadesse
wubalemtw@yahoo.com
Ethiopian Institute of Agricultural Research
Contents of the presentation

- Introduction about Ethiopia
- Natural Gum and resin resources
- Socio-Economic roles of gums and gum resins resources in Ethiopia
- Major application of gum resin products
- Constraints in production and commercialization of natural gums in Ethiopia
- Conclusions and recommendations
ETHIOPIA

Size

Ethiopia has a total area of 1,104,300 km². The size of France, Spain and Portugal is the approximate size of Ethiopia.

- The 4th largest in Africa
- 21st largest of the world, by area.
Population

The population of Ethiopia has reached **74 million**. After **Egypt** and **Nigeria**, the **3rd** most populous in Africa.

Religion

Orthodox (Christian)  43.5 %
Muslim/Islam 33.9 %
Protestant  18.6 %
Traditional  2.6 %
Geography

The great Rift Valley dissected in two completely different zones

Altitude vary, from 120 mbsl (the Denakile Depression) to 4,620 masl (Mant Rash Dashen-4th highest in Africa)

Large part of the country's land mass is b/n 1,800 to 3,000 masl
The weather is also a reflection of the country's geographical contrast:
The hottest (Denakil Depression)
The lowest place to a cold weather (On Semen and Bale Mountains).

Semen mountain
4,620 masl

Denakil Depression
The hottest place in the world
- 120 mbsl
Biodiversity

• Flora: The flora of Ethiopia is very diverse. It is estimated that between 6,500 and 7,000 species of higher plant occur, of which about 15% are endemic.

• Fauna: The faunistic diversity of Ethiopia is also high. This is mainly due to the variations in climate, topography and vegetation.
Economy

- One of the poorest country in the world.
- The Ethiopian economy is dominated by peasant agriculture.
- The agricultural sector contributes about 50% to the total GDP, accounting for 85% of export and total employment.
The forest over vast areas have slowly degenerated under the joint impact of
- agricultural expansion,
- over grazing,
- over utilization for fuel and construction wood,
- urbanization,
- forest fire, etc.
Natural forest = 2.3 million has
Woodland/Bush land = 25 million ha
Plantation forest = 0.5 million has
Ethiopia is home to a wide range of NTFPs available in the vast arid and semiarid lowlands and highlands of the country, known to yield economically valuable products.

The most important NTFPs in the country include:

- natural gums (gum arabic, frankincense, myrrh, etc.),
- wild coffee,
- spices and condiments,
- wild honey and bees wax,
- bamboo,
- essential oils from aromatic plants etc.
Natural Gum and resin resources
Ethiopia is well recognized with respect to the production and supply of natural gum from biblical time.

The country is well endowed with over 60 gum and resin bearing species from *Acacia*, *Boswellia* and *Commiphora* species.

Available estimates prompt that the total area of oleo-gum resin bearing woodlands cover about 2.9 million ha of land in the country, with over 300,000 metric tons of natural gum production potential (Girmay, 2000).

Frankincense/olibanum constitutes 80 % of total output of resins of this type, gum Arabic 14 % and myrrh 6 % (Getachew and Wubalem 2004).
## List of the major gum-resin bearing species of Ethiopia by genus

<table>
<thead>
<tr>
<th>No</th>
<th>Genus <em>Boswellia</em></th>
<th>No</th>
<th>Genus <em>Commiphora</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Boswellia papyrifera</em> (Del.) Hochst</td>
<td>1</td>
<td><em>Commiphora myrrha</em> (Nees) Engl. Syn. C. molmol</td>
</tr>
<tr>
<td>3</td>
<td><em>Boswellia neglecta</em> S. Moore</td>
<td>3</td>
<td><em>Commiphora habessinica</em> (Berg) Engl.</td>
</tr>
<tr>
<td>4</td>
<td><em>Boswellia ogadensis</em> Vollesen</td>
<td>4</td>
<td><em>Commiphora truncata</em> Engl.</td>
</tr>
<tr>
<td>5</td>
<td><em>Boswellia pirrotae</em> Chiov.</td>
<td>5</td>
<td><em>Commiphora boranensis</em> Vollesen</td>
</tr>
<tr>
<td>6</td>
<td><em>Boswellia rivae</em> Engl.</td>
<td>6</td>
<td><em>Commiphora guidottii</em> Chiov.</td>
</tr>
<tr>
<td></td>
<td><strong>Genus <em>Acacia</em></strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><em>Acacia senegal</em> (L.) willd var.Senegal; &amp; var. kerensis</td>
<td>7</td>
<td><em>Commiphora schimperi</em> (Berg) Engl.</td>
</tr>
<tr>
<td>8</td>
<td><em>Acacia seyal</em> Del var. seyal &amp; var. fistula</td>
<td>8</td>
<td><em>Commiphora erythraea</em> (Ehrenb) Engl.</td>
</tr>
<tr>
<td>9</td>
<td><em>Acacia polyanthera</em> Willd. Var. <em>Camplacantha</em></td>
<td>9</td>
<td><em>Commiphora corrugata</em> Gillett &amp; Vollesen</td>
</tr>
<tr>
<td>10</td>
<td><em>Acacia sieberiana</em> DC sieberiana</td>
<td>10</td>
<td><em>Commiphora cyclophylla</em> Chiov.</td>
</tr>
<tr>
<td>11</td>
<td><em>Acacia drepanolobium</em></td>
<td>11</td>
<td><em>Commiphora hildebrandtii</em> Engl.(Engl.)</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>12</td>
<td><em>Commiphora odia</em> Sprague</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>13</td>
<td><em>Commiphora kua</em> (R. Br. Ex. Royle) Vollesen</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>14</td>
<td><em>Commiphora serrulata</em></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>15</td>
<td><em>Commiphora monoica</em> Vollesen</td>
</tr>
</tbody>
</table>
## Macro Distribution of the resource.....

<table>
<thead>
<tr>
<th>Region</th>
<th>Genus</th>
<th>Esti. area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tigray</td>
<td>Boswellia, Sterculia, &amp; Acacia</td>
<td>940,000</td>
</tr>
<tr>
<td>Amhara</td>
<td>Boswellia, Sterculia, &amp; Acacia</td>
<td>680,000</td>
</tr>
<tr>
<td>Oromya</td>
<td>Boswellia, Acacia, Commiphora &amp; Sterculia</td>
<td>430,000</td>
</tr>
<tr>
<td>Gambella</td>
<td>Commiphora, Sterculia, &amp; Acacia</td>
<td>420,000</td>
</tr>
<tr>
<td>Somali</td>
<td>Commiphora, Boswellia, Sterculia, &amp; Acacia</td>
<td>150,000</td>
</tr>
<tr>
<td>B/Gumuz</td>
<td>Boswellia, Sterculia, &amp; Acacia</td>
<td>100,000</td>
</tr>
<tr>
<td>SNNP</td>
<td>Boswellia, Commiphora, Sterculia, &amp; Acacia</td>
<td>70,000</td>
</tr>
<tr>
<td>Afar</td>
<td>Boswellia, Commiphora, &amp; Acacia</td>
<td>65,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>2,855,000</strong></td>
</tr>
</tbody>
</table>
## Types of Gums & Resins In Ethiopia

<table>
<thead>
<tr>
<th>No.</th>
<th>Gum Olibanum /Frankincense</th>
<th>Gum Commiphora</th>
<th>Gum arabic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tigray type</td>
<td>Myrrh</td>
<td>Humera type</td>
</tr>
<tr>
<td>2</td>
<td>Ogaden type</td>
<td>Oppoponax</td>
<td>Harar sidamo type</td>
</tr>
<tr>
<td>3</td>
<td>Borana type</td>
<td></td>
<td>Seyal type</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gumero type</td>
</tr>
</tbody>
</table>
### Production and export of natural gums in Ethiopia

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity (tones)</th>
<th>Value (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>3465</td>
<td>3,916,700</td>
</tr>
<tr>
<td>2004</td>
<td>4205</td>
<td>4,316,900</td>
</tr>
<tr>
<td>2005</td>
<td>4381</td>
<td>5,024,000</td>
</tr>
<tr>
<td>2006</td>
<td>4323</td>
<td>4,812,200</td>
</tr>
</tbody>
</table>
Genus *Boswellia* (Frankincense/gum olibanum)
Boswellia is composed of about 20 species in the dry regions of tropical Africa.

*B. papyrifera* is an indigenous and chief gum resin producing tree species in Ethiopia.

In Ethiopia it is found in dry *Acacia-Commiphora* woodland and wooded grasslands with 950-1800 masl. altitudinal range and temperature of 20-25°C, and rainfall less than 900 mm per year (Vollensen, 1989, Azene *et al.*, 1993).

The Tigray type olibanum is the most widely traded frankincense in Ethiopia compared to the other two categories, and is the gum-resin obtained from *B. papyrifera* (Girmay, 2000).
Boswellia papyrifera (Del.) Hochst.
Comparative study of traditional and new tapping methods on frankincense yield of *Boswellia papyrifera*

Teshome Eshete
Wubalem Tadesse (Ph.D)
Sisay Feleke (Ph.D)
New tapping method...

In term of tapping time

- The new tapping method was effective in regard to tapping time for individual trees.
- Consequently, the introduction of the new tapping method in our *Boswellia* forests will improve frankincense production by speeding up the tapping time per day.

Ethiopian traditional tapping method

New tapping method adapted from Indian
The Ogaden and Borena types are gum-resins produced in the east and south-eastern parts of the country.

*B. rivae, B. ogadensis, B. neglecta* and *B. microphylla* are source of frankincense in these areas (Girmay, 2000; Mulugeta et al., 2003).

Other species that yield resinous products designated as frankincense may also exist in these parts of Ethiopia, and may even include those species known from Somalia, for instance, *B. sacra* (Vollesen, 1989).
Boswellia neglecta forest and Borena type incense oozed naturally.
Genus *Commiphora* (Myrrh)
Fifty-two species of *Commiphora* are known to exist in Ethiopia, and 14 (25%) of the species are endemic (Vollesen, 1989).

*Commiphora myrrha* (Nees) Engl is an indigenous tree or shrub to 4 m. The resin of this species is the raw material of the renowned myrrh.

Myrrh is also collected from other species of *Commiphora* such as *C. africana*, *C. erythraea*, *C. gileadensis*, etc. but the best quality is from *C. myrrha* (Azene et al., 1993).

Gum production is carried out by collecting exudates from trees in natural stands by random picking from naturally and/or accidentally exuding trees by peasants and pastoralists. Gum collection is considered secondary as it is carried out while executing other activities perceived to be more important namely firewood collection and livestock (Wubalem et al., 2007).
Genus *Acacia* (Gum arabic)

* A. senegal
* A. seyal
Gum arabic is the oldest and best known of all natural gums. A total of 17 Acacia species were identified as producing gum in Africa (Chikamai, 1996).

Gum arabic of commerce is produced from A. senegal, A. seyal and A. polyacantha (Chikamai, 1996).

A. senegal comprises about 70 % and A. seyal about 15–25 %. The remaining 5 % is contributed mainly by A. Polyacantha and A. drepanolobium.
Gum arabic samples collected from Ethiopia (Metema), showed a nearly identical chemical properties with a gum sample of the same species obtained from Sudan (Ermias, 2003).

Due to the increased demand of Gum arabic in international market and the socioeconomic importance of *A. senegal* in the country reforestation of the species is being carried out since the last few years in different regions.

Nevertheless, the existing gum production in the country is carried out in natural forests (Wubalem *et al.*, 2007).
Gum Sterculia (karaya gum)
The genus *Sterculia* comprises about 300 species of which approximately 25 species are said to occur in South Africa’s tropical forests (Vollsen, 1995; USAID, 2005).

Gum karaya sometimes known as gum Sterculia is the trade name for all the gum produced from *Sterculia* species (Coppen, 1995).

India is traditionally the biggest producer and exporter of gum Karaya from *S. urens*, but increasing amounts of gum enter international trade from Africa.
• Senegal produces gum from *S. setigera* and exporting around 1000 MT per year.

• Ethiopia has potential for commercializing the gum karaya product that attracts local and foreign investors, and hence contributing to the national economy.

• Therefore, gum karaya production should be started in the country’s *Sterculia* forests by introducing appropriate regeneration and tapping techniques.

• EIAR-FRC is conducting research on tapping and population status of *S. setigera*. 
Socio-Economic roles of gums and gum resins resources in Ethiopia
Gum resin sector in Ethiopia is playing significant economic role both at local and national level. Collection and processing of natural gums is labour-intensive activity that involves a huge labour resource, and hence offers off-farm employment opportunity for thousands of local people.
Trade volume and the value generated from export were steadily increasing from time to time, implying the improvement of Ethiopia’s share in the world markets (Mulugeta and Demel, 2004).

For instance, it is increased in value by 14% and 24% for the periods 2001-2003 and 2004-2005 respectively.

Such increment was probably due to the dramatic increase of the involvement of the private sector and the existing fair market for the products.
Further, the recurrent drought and its consequent impact has steadily shifted the livelihood the pastoral communities **from livestock** to other means such as **gum-resin** in an effort to diversify their income.

**Nonetheless**, at world scale Ethiopia’s gum/incense export share is still negligible (1%) and 28% of the total Africa’s export (Mulugeta, 2008).

For instance, the **proportion between the resource base and what we are sharing from global market** is not parallel and need serious attention and work out.
Major application of gum resin products
Major application of gum resin products

Frankincense and myrrh

- **Food and beverages:**
  beverages, candies, chewing gums, confectioneries, gelatins, nut products.
  Typical applications include: adhesive thickeners, thickeners, stabilizers, flavouring, fixatives and emulsifying agents in food products, clarification in beverages, and release agents for rubber products (FAO, 1995).

- **Pharmacological uses:**
  The applications of fragrant oleo-gum resins known as frankincense and myrrh for medicinal values are among man’s oldest therapies (Michie and Cooper, 1991). They are still widely used therapeutically in regions ranging from North Africa to China (Krieglstein et al., 2001).
Major application of gum resin products

- **Gum Arabic**

- **Food and beverages:**
  Used as thickening, stabilizing, emulsifying and suspending agent in food and drink industries; as tablet-binding agent and cream- and lotions.

- **Pharmacological uses:**
  It is still used as a suspending agent, emulsifier, adhesive, and binder in tablet and in demulcent syrups.

- **Other applications:**
  In cosmetics, gum arabic functions as a stabilizer in lotions and protective creams, where it increases viscosity, imparts spreading properties, and provides a protective coating and a smooth feel (Whistler, 1993).
Major application of gum resin products

Gum karaya

- **In food industry:**
  Of all the gum karaya produced only 5% (Coppen, 1995) is used as a food additive; the remainder 95% goes into pharmaceutical products (Anderson, 1993).

- **Pharmaceutical industry:**
  Colostomy bag fixings are the most common use of gum karaya. Its use in dental fixatives started declining when research showed that habitual use of acidic gum karaya had an adverse effect upon any remaining natural teeth.

- **Traditional medicine:**
  Various parts and products of *S. setigera* trees are used as a traditional medicine to cure different diseases in Africa (Igoli et al., 2005; Ogbagzhi, 2006). Bark and leaves are used as a traditional medicine in Eritrea (Bein et al., 1996). Gum karaya is traded at the local market mainly for medicinal purposes in Eritrea (e.g. Barentu and Keren) (Ogbagzhi, 2006).
Constraints in production and commercialization of natural gums in Ethiopia
Despite the great actual and potential socio-economic and ecological benefits that could be derived from dryland forest resources in Ethiopia, they had been under tremendous pressure from unsustainable utilization, which has resulted in their rapid dwindling or complete disappearance in some areas.

Their development, conservation and sustainable utilization have been constrained by quite a number of complex factors. Hence numerous research results revealed that several gum resin bearing species are endangered (Kindeya, 2003; Abeje et al., 2005; Vivero et al., 2005; Adefires, 2006; Dagnew, 2006).
One of the major problems associated with *B. papyrifera* is hampered natural regeneration (Oqbazghi, 2001, Abeje, 2002), which could be attributed to several factors.

At present frankincense production, and even the existence of the species in the country is seriously threatened by accelerated deforestation rate mainly through land clearing for more agricultural land, frequent wildfires and overgrazing.
Factors affecting the resource base:

Improper tapping.

- Gum and resin products in Ethiopia are collected from natural ooze except the case of frankincense from *B. papyrifera*.
- Even tapping of frankincense is not properly developed and still creating damage to the trees.
- The methods of post harvest handling/cleaning and storage are also not well developed.
Factors affecting the resource base…

Deforestation and agricultural expansion, resettlement and other land use change impacts; over grazing, Human-induced fire;

absence of strategies and continuous action plans for the development, sustainable utilization and conservation of the respective resource bases.
Factors affecting the commercialization of the resources:

Inadequate information on the resource base and market access:

Information on the amount, type and extent of gum and resin resources at national level is lacking which is the major problem in determining the actual production potential and planning for efficient production. Only preliminary estimations are available (e.g. Girmay, 2000).
Absence of policy guidelines favorable to the gum and resin sector:

The one year leasing of *Boswellia* stands to gum and resin producing enterprises and lack of supervision of the leased areas is causing damage to the resource (Wubalem *et al.*, 2002).

The short time lease system has limited the enterprises to invest on the resource for enhanced and sustainable production.
• Inaccessibility/location of the resource in remote areas:

from their very nature gum and resin bearing tree species are distributed in remote areas characterized by ragged terrain, lack of access roads and infrastructure facilities.

This contributed much to the low volume and quality produced (Girmay, 2000; Wubalem et al., 2002; Adefires, 2006).

Due to the associated hardship (harsh temperature, thirsty and disease) and difficulties to mobilize labour force, equipments and supplies as well as collection and transportation of the products.
• Lack of quality control and illegal boarder trades:

Although there is no quantitative information on the exact amount of gum-resin, registered enterprises are complaining that lack of control on both domestic and illegal trade of gum resin products in Ethiopia is affecting the expansion of official commercialization of the product (Mulugeta, 2005).
**IUCN Red list** gum resin bearing species in Ethiopia

*B. ogadensis* and *B. pirrotae* are listed in the IUCN Red List of Threatened Species in Ethiopia (Vivero *et al*., 2005). *B. ogadensis* is located only from one river location, while *B. pirrotae* is only from three river locations, implying how sensitive these species if care not taken.

*Commiphora monoica* Vollesen, is a tree known only from five collections around the Sof Omar caves. It grows in dense *Commiphora* bushland on rocky limestone slopes at altitudes of 1250-1400 m. It is also listed in IUCN threatened species list (Vivero *et al*., 2005).
Research status on gum resin bearing species and their products
**Summary of past and present research endeavors on different issues of gum and resin sector in Ethiopia (Adefirs et al., in press)**

<table>
<thead>
<tr>
<th>Main issues addressed</th>
<th>Author</th>
<th>Study species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxonomic account of the species</td>
<td>Vollesen, 1989; Gemedo et al., 2005; Adefires, 2006</td>
<td>B. papyrifera, Commiphora and others in Borana area</td>
</tr>
<tr>
<td>Seed germination</td>
<td>Tilahun, 1996; Tilahun and Negash, 1999</td>
<td>B. papyrifera</td>
</tr>
<tr>
<td>Opportunities and constraints</td>
<td>Tilahun, 1996; Abeje 2002; Mulugeta et al., 2007</td>
<td>B. papyrifera</td>
</tr>
<tr>
<td>Resource status/ ecology</td>
<td>Fetwi, 2000; Gindaba et al., 2007; Adefris 2006; Adefris et al. 2007; Adefires and Dagnew, 2008; Abeje 2002; Kendeya, 2003;</td>
<td>All gum and resin trees B. papyrifera, A. senegal</td>
</tr>
<tr>
<td>Socioeconomic contribution</td>
<td>Mulugeta et al., 2003; Adefires, 2006; Adefires et al., 2007; Abeje et al. 2005</td>
<td>All gum resin trees B. papyrifera</td>
</tr>
<tr>
<td>Characterization/ Chemistry</td>
<td>Ermias et al.; 2003, Aman et al., 1999</td>
<td>B papyrifera frankincense, Commiphras</td>
</tr>
<tr>
<td></td>
<td>Dagnew et al., 2009</td>
<td>A. senegal/gum arabic</td>
</tr>
<tr>
<td>Tapping techniques</td>
<td>Wubalem et al, 2004</td>
<td>B. papyrifera</td>
</tr>
<tr>
<td>General issues</td>
<td>Fitwi, 2000; Wubalem et al. 2002; Mulugeta and Demel; 2003 a and b; Muleugate, 2005</td>
<td>All gum and resin bearing tree species</td>
</tr>
</tbody>
</table>
FRAME is a joint research project between different parties from Ethiopian side and the Wageningen University, The Netherlands. The following are list of the research titles of the project:

- **PhD project 1, Ecophysiology:** Criteria for sustainable harvesting of gum/resin resources using the frankincense tree *B.papyrifera* as a model
- **PhD project 2, Ecology:** Population dynamics of resin trees in dry woodlands in Ethiopia: the impact of environmental versus human induced factors
- **PhD project 3, Socioeconomics:** Local perspectives on use and management of gum and resin producing trees in Ethiopia
- **PhD project 4, Geography-GIS:** Environmental profile and sustainability of gum and resin producing trees in Ethiopia
- **Post-doctoral research 1:** Resource use scenario analysis (project management), Scenarios for sustainable resin production and conservation of dry woodlands in Ethiopia.
Conclusions & recommendations
Given the significant socio-economic, cultural and ecological importance of natural gum bearing species in Ethiopia, viable strategies and realistic action plans for research, development, sustainable utilization and conservation of the species and their habitats have to be developed and implemented in the country before it is too late.
Therefore, research & development efforts and international collaborations could have strong potentials to the conservation, production and commercialization of these vast and untapped renewable natural resources for the benefits of the local, national as well as the international communities.

The country is collecting and exporting only the crude gum resin resources and again imports with foreign currencies their various final products from developed countries.

Therefore, devising mechanisms to promote the countries' potential for value addition and industrialization of gum resin products should be one of the priority collaboration line in the near future.
Thank you