



BOSWELLIA PAPYRIFERA PRE-DOMINATED WOODLANDS OF ETHIOPIA: PRESENT ROLES AND THREATS

Tatek Dejene^{1*}, Omarsherif Mohamed¹ and Haile Adamu²

¹Forestry Research Center, P.o.Box 30708 Addis Ababa, Ethiopia

²Debre Zeyete Agricultural Research Center, P.o.Box 32 Debre Zeyete, Ethiopia

*E-mail: tdejenie@yahoo.com

ABSTRACT : The *Boswellia* pre-dominated woodland, belonging to the Combretum–Terminalia deciduous woodlands of the dry forests of Ethiopia, forms the largest vegetation cover and is widespread in the northern and north-western lowland part of the country. This paper has tried to review and discuss the current contribution of the *Boswellia* dominated woodlands and its main threats which contributed for its degradation based on different empirical studies. From the review it is understood that the *Boswellia* dominated woodland represents important natural resources on which development could be based since it offer diverse products of commerce such as incense, wood and honey, and support to other economic activities such as fodder for livestock and soil conservation for crop farming. However, the annually cash income generated by households from the *Boswellia* woodland is only 1089.55 ETB, which is 18.32 fold less than that of the income from the agriculture. The low cash flow is shown to be due to policy restrictions on the engagement of the local people in producing and marketing frankincense, a principal product from the woodland. Such low cash contribution by the woodland motivated the local people to continuously clear and convert the woodland in to agricultural land. In lined with this, the structure of some of the important species in the woodland showed a hump shaped curve distribution, suggesting regeneration is severely lacking and the population is under serious threat in the long term. Therefore, the main conclusion of this study is that the *Boswellia* woodland, although worthy of sustainable management and utilization even on the basis of economic criteria, is continuing to suffer conversion to other land uses which offer benefits in the short term and in which farmers have more confidence in terms of economic benefits and ownership rights of the land. Therefore, to maximize the actual value of the *Boswellia* pre-dominated woodland, policies and institutions that govern access to and use of forest resources and their management need to be revised in such a way that the locals will have the legal right and the confidence to own or co-own the forest resources in their vicinity, and will continue to manage and utilize it.

Keywords : Drylands, *Boswellia*, woodlands, threats, current role.

Drylands are parts of the earth's surface where rainfall is very low and erratic, and rates of evaporation are high. Such lands account for 54% of the World's, and 61% of Africa's productive landmass (UNDP, 2005). Dry tropical forests, as the forests in these areas are referred to, encompass 42% of all tropical forests (Murphy and Lugo, 16) and are the largest forest type in some African countries such as Ethiopia (Tefera *et al.*, 25).

Dry tropical forests contain a wealth of unique biodiversity (Janzen, 11) and are important resource base for livelihoods and economic development (Suderland and Ndoye, 23;

Shackleton *et al.*, 24; Paumgarten and Shackleton, 21). If managed wisely, the dryland forests have the capacity to provide perpetual streams of income and subsistence products, while supporting other economic activities through ecological services and functions (Mulugeta and Demele, 17; Chikamai *et al.*, 5).

In Ethiopia, dry forest is the largest remaining forest type that currently covers 55 M ha (WBISPP, 26). These forests are rich in *Acacia*, *Boswellia* and *Commiphora species* (Abiyu *et al.*, 2; Abeje *et al.*, 1; Dejene *et al.*, 7), that provide the important export commodities such as gum arabic, frankincense and myrrh (FAO, 8; Lemenih, 14;

Lemenih and Kassa, 15; Abiyu *et al.*, 2; Abeje *et al.*, 1).

The *Boswellia* pre-dominated woodland, which belongs to the Combretum–Terminalia deciduous woodlands of the dry forests of Ethiopia (Fig 1), forms the largest vegetation cover and widespread in the northern and north-western lowland part of the country and found in five regional states, namely Benishangul-Gumuz, Gambella, Oromiya, Amhara and Tigraye regions (Girmay, 9) of the area with an altitudinal range of 600–1800 m asl, with an annual mean temperature of 20–25°C and an annual mean precipitation of less than 900 mm (Girmay, 9; Azene, *et al.* 4). The *Boswellia* pre-dominated woodland is composed of various species of *Acacia*, *Boswellia* and *Commiphora* that are known to produce commercial plant gums and resins such as gum arabic, frankincense and myrrh, respectively (Mulugeta and Demel, 17). The wood and non-wood products from these species play a significant role in the livelihood of many people in the dryland regions of Africa. The *Boswellia papyrifera* dominated woodland mainly existed in Benishangul-Gumuz, Gambella, Oromiya, Amhara and Tigray regions (Girmay, 9). Thus in this paper we tried to review and discuss some points on the current contribution of the *Boswellia* pre-dominated woodlands to rural livelihood in the country and its threats based on different empirical studies. This review focused on the empirical studies on the North West part of the country mainly in Metema woreda of the Amhara regional state.

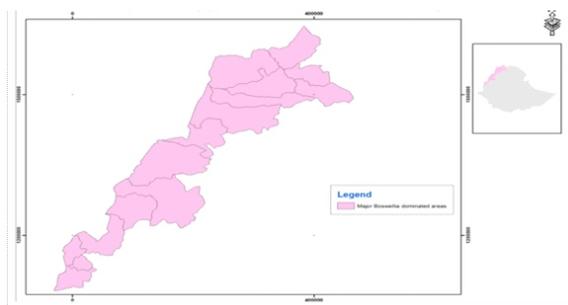


Fig. 1. Major *Boswellia papyrifera* pe-dominated woodlands area in Ethiopia.

1. Current role and contribution of the *Boswellia* pre-dominated woodland

It is now possible to illustrate the role of *Boswellia* dominated woodlands in rural livelihoods in Ethiopia. For some of these benefits there is an abundance of information from frequent case studies, whilst in other instances information is scarce. In instances of the former, we have not, in the interests of brevity, attempted to summarize all the information, but have used selected works and information to illustrate the point of links between the woodland role and livelihood contribution or poverty reduction in rural livelihoods of Ethiopia.

1.1. Contribution within the total household economy

Studies to examine the contribution of the *Boswellia* pre-dominated woodland to household economy were very scant. The contribution or use of *Boswellia* pre-dominated woodlands have examined from the livelihood perspectives and estimated or measured the proportion of total income streams of households Dejene *et al.*, 7 that can be ascribed to forest goods only (Table 1).

Table 1: Forest goods commonly collected by the local communities from the *Boswellia* pre-dominated woodland.

Product Type	Purpose	
	Subsistence use	Income generation
Fuelwood	✓	
Honey	✓	✓
Grass	✓	
Frankincense	✓	

The aggregated contribution of the *Boswellia* pre-dominated woodlands in Metema area to the gross household income as compared to crop production was only 15.49% of the total, which is 18.32 fold less than the income from agriculture (Dejene *et al.* 7). The net mean annual income generated for the households from agriculture and

forest products was 5945.67 and 1089.25 ETB per household and year, respectively. In this result indeed, agriculture contributes much of the households' annual income. Three main reasons could be attributed for the lower contribution from the *Boswellia* pre-dominated woodland.

1. The **limited access** and use of the woodland for livelihood by the local communities, which is largely limited to honey production. Much of the forest products collected from the woodlands are used by the local farmers only for household consumption (Table 1) and thus rarely sold or traded to generate cash income (Mulugeta *et al.*, 18; Dejene *et al.*, 7).

2. Relatively good **availability of land** for farming and pasture for grazing (Abeje *et al.*, 1; Mulugeta *et al.*, 18; Dejene *et al.*, 7).

3. The **cultural taboo** that relates dependence on the forest to poverty; thus it is considered a lowly occupation (Abeje *et al.*, 1; Mulugeta *et al.*, 18).

4. The **frankincense production is dominantly occupied by companies** who are involved in frankincense production and marketing. As a result the local communities are totally excluded from generating income from frankincense production (Dejene *et al.*, 7; Mulugeta *et al.*, 18; ILRI, 10).

These main reasons undermine the roles that the *Boswellia* woodland could play in the house economy of the local communities in the rural area of Ethiopia.

1.1.1. Scaling up the value of the woodland to the livelihood of the local community

In his work, Dejene *et al.* (7) also showed the total financial value of the *Boswellia* pre-dominated woodland to the local livelihoods. The calculation was based on the mean value derived per household and year from the woodland and the total number of households that probably are forest users. These comprise those households living close by or inside the *Boswellia*

pre-dominated woodland in Metema. Accordingly, the total financial contribution of the *Boswellia* pre-dominated woodland (forest) to the local community estimated at 776,834 ETB/year (Table 2).

Table 2: Values of *Boswellia* pre-dominated woodland to the livelihoods of the local community of Metema area.

Forest	Area of forest (ha)	Total No of House-holds	Mean HH income from forests (ETB)	Total Local livelihoods value (ETB) (B:C)
<i>Boswellia</i> pre-dominat ed woodland	1932.13	713	1089.53	776834.89

It is important to note that this value does not imply a sustainable economic extraction from the woodland rather it is an estimate based on the current level of use in the Metema area. However, this result indicated that the value of the *Boswellia* pre-dominated woodland to the livelihood of the local community is significantly higher and represents the potential returns from the *Boswellia* pre-dominated woodland if the woodland were under community ownership management and marketing of the products by locals be facilitated.

Use of the forest resource would diversify the economy, and potentially minimize the risks associated with frequent crop and fodder failures as a result of recurring drought. For instance, a study on the economic contribution of gum and resin resources in Liban woreda (Mulugeta and Demel, 19) indicated that forest based income mainly the gum and resin collection contributes one-third (33%) of the household annual subsistence. This helped the local communities in such a way to minimize the risks due to frequent crop and fodder failures as a result of drought. This implies that sustainable harvesting and collection of NTFP would have positive implications for the households' livelihood and the economic incentives

provided by woodland are potentially high if policy environments are made upright.

1.2. Contribution to the supply of household subsistence goods

The *Boswellia* pre-dominated woodland has been used in many different ways. It has long served as the subsistence base for the majority of local communities found near and around the forest as a timber extraction, or used for traditional subsistence activities (e.g., extraction of NTFP). There is considerable information reporting the wide spread use of the woodland resources. However, this report focuses on few specific products which have a direct household provisioning to the local community of the *Boswellia* pre-dominated woodland.

1.2.1. Fuel-wood and Charcoal

Fuel-wood and charcoal are the preferred fuel for domestic use for the majority of the population in and around the woodland in Ethiopia. The local people use particularly the *Acacia species* for fuel wood and charcoal for subsistence because of its high quality, but other species are also used as well.

Based on the estimate from the field inventory of the woodland, the average fuel wood yield that can be collected/harvested from a hectare of the woodland was estimated to be 4.5 loads ('Shekim'). There is strong seasonality in the collection of fuel wood in the dryland area of the country. For instance, the period December – February is the peak time when farmers collect and stack fuelwoods (Fig. 2). This is because they assume that at this time the dead wood are available for harvesting, and as a result, all farmers collect for



Fig. 2: Fuelwood collections from the forest, and stored around the homestead.¹

¹Photo by Dejene T., 2008.

annual use. It is estimated that fuelwood consumption for an individual in Metema area was estimated to be 0.864 tone (1Shekim =18kg)/year. However, there is still an increasing demand for charcoal and fuel wood materials in the study area immensely.

1.2.2. Honey

Traditional apiculture is the only non-timber forest product that the local community in around the woodland could generate income. According to Dejene et al. (7), a 100x100 m of *Boswellia* woodland, could support a certain number of beehives. Honey production was also estimated to reach 105 kg ha⁻¹ yr⁻¹, as obtained from 5 hives ha⁻¹ × 7 kg/harvest × 3 harvests in a year. The average amount of honey that can be collected from a single beehive was estimated through interviews with farmers at household level. This in general indicated that the *Boswellia* woodland also important for supporting the honey production by the local people and play significant role for household economy.

1.2.3. Grass for forage and roof making

Livestock production is an integral part of the production system. Production of cattle (milk, meat), goat (meat) and poultry is a common practice. Cattle are exported to the Sudan while goats are mainly used for the local market. There is a small holder milk and butter production system mainly for the local market (ILRI, 10). Transhumance cattle production system is a common phenomenon with highland cattle moved to the low lands during the main rainy seasons from June to October in search of feeds. The area offers good opportunities for livestock rearing because of the good supply of grass and pasture. Almost all of the household in Metema area rear animals of various types, and the major domestic animals found in the area are cows, oxen, donkeys, goats and chickens (Table 3). The information on livestock number in the *Boswellia* dominated woodland is not reliable. However, the extrapolation from the existing data sources of ILRI (10) it is estimated that the total

livestock population in the area is about 166,247.00. This number did not include those livestock's in the newly settled households in the area.

Table 3: Types of animal and the corresponding average household numbers in the study area.

Type of animals	Average number/household
Cows	5
Oxen	2
Donkeys	1
Goats	6
Chickens	5

Free grazing is practiced on the study site in which the *Boswellia* woodland is used for grazing areas or rangeland. But, because of the annual burning of the vegetation and the introduction of a large population of cattle, shortage of animal feed during the dry season was common. As a result, villagers were forced to supplement the animal feed by providing their animals with dried grass and leaves of forage trees. Forage trees especially are the main supplementary animal feed when there is a delay in the onset of the rainy season.

Based on the estimate from the woodland, the average grass/forage yield that can be harvested from a hectare of *Boswellia* woodland was 132 loads ('Shekim') each year (Dejene *et al.*, 7). Therefore, the *Boswellia* woodland supports the livestock of the local people and therefore form the underlying security of the whole of the livestock supply food, milk, and animal products.

1.2.4. Frankincense

The entire woodland had tree densities ranging between 200–300 individuals per ha. However, frankincense is collected naturally from the *Boswellia papyrifera* trees and for many collectors it is the principal source of income. Based on the inventory results, the average *Boswellia papyrifera* tree density and the quantity of frankincense collected were 225 trees per ha and



Fig. 3 : Grass collected from the forest and stored around homestead.²

²Photo by Abeje E. and Dejenes T., 2008.

67.5 kg per ha per annum, respectively (Wubalem *et al.*, 27; Asmamaw and Abeje, 3). The frankincense is usually used, in addition to religious rites, in the cosmetic industries, where it is an essential oil because of its clear and aromatic properties.

1.2.5. Medicinal plants

The uses of woodlands for making traditional medicines are well documented. It involves the use of different parts of the herbs, such as the roots, leaves, pods, resins,fruits etc. In Ethiopia people have always used traditional medicines to treat a wide range of illnesses. The indigenous tree species in the lowland area are widely used in Ethiopia for the treatment of a range of bacterial and viral diseases, as well as skinwounds, insect bites, etc.

1.2.6. Wild edible fruits and foods

The non-wood forest products from the *Boswellia* woodland include wild fruits which are consumed and widely traded by both the rural and urban communities in the lowland areas of the Ethiopia. Wild fruits mainly come from *Grewia species* and this includes *Grewia villosa*. In addition, there are trees whose fruits are collected, such as *Tamarindus indica*, *Z. spinacristy* and *Oncuba spp*. These fruits are important dietary components of the rural dwellers in Ethiopia and they are also sold in the local market by the local people.

1.3 Contribution in cultural and spiritual benefits

The cultural and spiritual benefits afforded by forests to rural communities are clear, but little

studied. This is partly because the notion of culture has different meanings and interpretations, and is frequently difficult to define or describe in tangible terms. However, embracing the definition of poverty, it is clear that satisfaction of social and spiritual dimensions to livelihoods is vital in reducing vulnerability and maintenance of an acceptable standard of living.

2. Threats to *Boswellia* dominated woodlands

The Combretum-Terminallia broad leaved deciduous woodlands in the north-western lowlands of Ethiopia is the largest remaining forests and plays essential environmental and socio-economic roles. These forests are renowned for their gum arabic, frankincense and myrrh products known to have wide range of local and international cultural and economic significances (FAO, 8, Lemenih, 14, Chikamai et al., 5). However, the woodland is being reported affected by interrelated factors through which its degradation is framed (Abiyu et al., 2). Some of the challenges include clearance for cropland expansion, over grazing, intensive and improper tapping, and increased frequency of forest fire (Abeje et al., 1; Mulugeta et al., 18). Of these factors, the conversion to agriculture land and lack of regeneration are discussed in detailed below.

2.1. Cropland expansion in the woodland

The major threatening factor for the degradation of the *Boswellia* dominated woodlands is assumed to be the continuous influx of immigrants from the highland part of the country. Such influxes are motivated by the existence of vast woodland with its fertile soil and favourable climate for the cultivation of cash crops like sesame and cotton. This has attracted thousands of immigrants from various parts of the country especially from the nearby highland area. The tendency by immigrants is to cultivate more areas and it appears that intensive land grabbing has been taking place in the area (Dejene et al., 7) and two types of land holding, customary and formal were identified in the lowland woodlands (Dejene et al., 7).

In the customary system land ownership is established by clearing from the woodland through what is called the ‘Mate Qedem’ literally meaning ‘marked first with axe’. In the ‘Mate Qedem’ (Fig. 4) system of claim, a person who for the first time put a mark on trees with an axe, regardless of the size of land marked, owns the territory he or she has marked. Such system is already deep-rooted in the customs of the people, on the other hand in the official system, the PA representatives allocate lands through official request to those who do not have, or need, more farmland.

According to Dejene et al. (7) much of the lands for farming in the woodland is obtained through informal land holding method and the implication is that “Mate Qedem” system is the deep rooted system for clearing the *Boswellia* woodland and convert to farmland for cultivation cash crops like sesame and cotton.



Fig. 4 : Mate Qedem system of claiming land in *B. papyrifera* dominated woodlands³.

³Mate Qedem is the unofficial land holding method through clearance of forest land.

Apart from this, farmers preferred lands inside *Boswellia* forest, as this is the best ecological niche for sesame and cotton cultivation and the existence of better economic returns from the pending land use options. These both may offer no incentive to the conservation of the woodland; rather, they instigate clearance of the woodlands and its conversion to other forms of land use, because this is a better option to benefit from the land resources.

2.2. Regeneration lacking by frankincense producing tree species

From the population structure analysis of the

species *B. papyrifera*, it is found that there is under representation of individuals in lower diameter classes. Such structure is repeatedly reported by several studies from similar and different geographical regions, e.g. Ogbazghi *et al.* (20) and Rijkers *et al.* (22) from Eritrea, Kindeya (12) and Kindeya *et al.* (13) from Tigray (Ethiopia), Abeje *et al.* (1) and Mulugeta *et al.* (18) from Metema (Ethiopia). The most striking result from the stem diameter size distributions of *B. papyrifera* in all the above mentioned geographical regions is the under-representation of individuals in the lower diameter classes and the over-representation of individuals in the higher diameter classes. The extremely low density of individuals in the lower diameter classes suggests that recent regeneration is severely lacking and that the population is under serious threat in the long term.

3. Summary and Conclusions

Dry woodlands provide important sources of livelihood income for rural people particular for those rural households who depend on woodland resources to meet their subsistence needs and forest product trade can be an important source of income. However, the situation for *Boswellia* dominated woodland is different.

The *Boswellia* dominated woodland is influenced by a number of factors such as farmers or local people do not have the legal right for access or use the forest produce, e.g. production of frankincense, timber or both and forest products are little traded on the market or not at all, i.e. because they apparently are a free commodity, it might be difficult for farmers to assume their real economic importance. On the other hand, the contribution of the woodland for house hold economy also found to be less as compared to the agricultural alternative options as a result the farmers continue to clear forest land and to convert it into cropland. Therefore, the main conclusion of this study is that the *Boswellia* woodland, although worthy of sustainable management and utilization even on the basis of economic criteria, is continuing to suffer conversion to other land uses (e.g. cropland) which

offer benefits in the short term and in which farmers have more confidence in terms of economic benefits and ownership rights of the land. Therefore, the following recommendations were made to assist improving the management and utilization of the *Boswellia* woodlands in northwest part of Ethiopia.

To maximize the actual value of the *Boswellia* dominated woodland, policies and institutions that govern access to and use of forest resources and their management need to be revised in such a way that the locals will have the legal right and the confidence to own or co-own the forest resources in their vicinity, and will continue to manage and utilize it;

The economic valuation need to consider the value of various products and services provided by the woodlands to comprehend the multiple value of forest and what such values mean in monetary terms

To make the forest based utilization of the woodland competent with the alternatives; market information and market link are needed.

Researches on the economic benefits of intercropping *Boswellia* tree with agricultural crops to diversify the income from the *Boswellia* woodland to minimize the degradation are required.

REFERENCES

1. Abeje E., Demele T. and Hakan H. (2005). The socio-economic importance and status of populations of *Boswellia papyrifera* (Del.) Hochst.in Northern Ethiopia: the case of North Gonder Zone. *Forests, Trees and Livelihoods* **15**: 55–74.
2. Abiyu A. Bongres, F., Eshete A., Gebrehiwot G., Kindu M. Lemenih M. Moges Y. Ogbazghi W. and Sterk J.K. (2010). Incense woodlands in

- Ethiopia and Eritrea: regeneration problem and restoration possibilities. In *Degraded forests in Eastern Africa: management and restoration*, Bongers F, Tennigkeit T (eds.), pp. 133-152, Earthscan Publ.
3. Asmamaw, Alemu and Abeje Eshetie (2007). The effect of tapping intensity and tree diameter (size) on frankincense yield of *Boswellia papyrifera* (Del.) Hochst: a key dry land species in northern Ethiopia. (Unpublished)
 4. Azene, Bekele-Tesemma, Birnie, A. and Tengnas, B. (1993). Useful Trees and Shrubs for Ethiopia. Identification, Propagation and Management for Agricultural and Pastoral Communities. Regional Soil Conservation Unit, SIDA, Nairobi.
 5. Chikamai B., Tchatat M., Tieguhong, J. and Ndoye, O. (2009). Forest Management for Non-Wood Forest Products and Services in Sub-Saharan Africa. *Discovery and Innovation*, Vol. 21. [Online]: <http://www.ajol.info/index.php/dai/article/view/48213>.
 7. Dejene T., Lemenih M. and Bongers F. (2012). Manage or convert *Boswellia* woodlands? Can frankincense production payoff? *J. Arid Environ.* (in press). [ttp://dx.doi.org/10.1016/j.jaridenv.2012.09.010](http://dx.doi.org/10.1016/j.jaridenv.2012.09.010)
 8. FAO (1995). Role of *Acacia species* in the Rural Economy of Dry Africa and the Near East, by Wickens, G.E. *FAO Conservation Guide* 27, Rome, Italy.
 9. Girmay, Fitwi (2000). The status of Gum *Arabica* and Resins in Ethiopia. Report of the meeting of the network for natural gum and resin in Africa (NGARA) 29th-31st may, Kenya.
 10. ILRI (2005). Metema pilot learning site diagnosis and program design. International Livestock Research Institute (Unpublished data). Addis Ababa.
 11. Janzen, D.H. (1988). Tropical dry forests: the most endangered major tropical ecosystem. In: Wilson, E.O., Peter, F.M. (eds.), *Biodiversity*. National Academy Press. Washington, DC. USA. pp. 130-137.
 12. Kindeya Gebrehiwot (2003). Ecology and management of *Boswellia papyrifera* (Del.) Hochst. Dry Forests in Tigray, Northern Ethiopia: *Doctorial thesis*, Georg-University of Gottingen.
 13. Kindeya Gedrehiwot, Muys, B., Haile, M. and Mitloenher, R. (2005). The use of plant water relations to characterize tree species and sites in the drylands of northern Ethiopia. *J. Arid Environ.* 60(4): 581-592.
 14. Lemenih, M. (2005). Production and Marketing of Gums and Gum Resins in Ethiopia. In *Production and Marketing of Gum Resins: Frankincense, Myrrh and Opoponax* Ben C, Enrico C (eds), pp. 55-70, FAO/NGARA, Nairobi, Kenya.
 15. Lemenih, M. and Kassa, H. (2010). Socio-economic and Environmental Significance of Dry Land Resources of Ethiopia and their Development Challenges. *J. Agri. Dev.*, 1: 71-91.
 16. Murphy, P.G. and Lugo, A.E. (1986). Ecology of tropical dry forest. *Annual Rev. Eco. and Systemat*, 17: 67-88.
 17. Mulugeta Lementh and Demel, Teketay (2004). Natural Gum and Resin Resources: Opportunity to Integrate Production with Conservation of Biodiversity, Control of Desertification and Adapt to Climate Change in the Drylands of Ethiopia. Paper Presented to the First National Workshop on Conservation of Genetic Resources of Non Timber Forest Products (NTFPs) in Ethiopia, 5–6 April 2004. Addis Ababa.
 18. Mulugeta, L., Feleke, S. and Tadesse, W. (2007). Constraints to smallholders production of frankincense in Metema district, North-western Ethiopia. *J. Arid Environ.*, 71: 393–403.
 19. Mulugeta, Lemenen and Demel Teketay (2003). Frankincense and myrrh resources of Ethiopia: I Distribution, production, opportunities for dryland development and research needs. *Sinet: Ethiop. J. Sci.*, 26(1):63–72.
 20. Ogbazghi, W., Bongers, F., Rijkers, T. and Wessel, M. (2006). Population structure and morphology of the frankincense tree *Boswellia papyrifera* along an altitude gradient in Eritrea. *J. Drylands*, 1: 85–94.

21. Paumgarten F. and Shackleton, C.M. (2009). Wealth differentiation in household use and trade in non-timber forest products in South Africa. *Ecol. Econ.* **68**:2950-2959.
22. Rijkers, T., Ogbazghi, W., Wessel, M. and Bonzers F. (2006). The effect of tapping for frankincense on sexual reproduction in *Boswellia papyrifera*. *J. Appl. Ecol.*, **43**: 1188–1195.
23. Sunderland T. and Ndoye O. (2004). Forest Products, Livelihoods and Conservation: Case studies of Non-timber forest products systems. Volume 2- Africa. CIFOR, Bogor, Indonesia.
24. Shackleton S. Cambell B., Lotz-Sisitka H. and Shackleton C. (2008). Links between the local trade in natural products, livelihoods and poverty alleviation in a semi-arid region of South Africa. *World Development*, **36**:505-526.
25. Tefera M., Demel T., Hulten, H. and Yonas Y. (2005). The role of enclosures in the recovery of woody vegetation in degraded dryland hillsides of Central and Northern Ethiopia. *J. Arid Environ.*, **60**: 259–281.
26. WBISPPs (2004). Forest Resources of Ethiopia. MoARD, Addis Ababa, Ethiopia. Woldemariam M. 1985. The social consequences of famine. In Changing Rural Poverty FasilGebre-Kiro (ed), Trenton: Africa World Press.
27. Wubalem Tadesse, Sisay Feleke and Teshome Eshete (2004). Comparative study of traditional and new tapping method on frankincense yield of *Boswellia papyrifera*. *Ethiop J. Natural Resour.*, **6**: 287–299.