DEVELOPMENT OF THE GUM ARABIC SUB-SECTOR IN KENYA

B. Chikamai[1], M. Muga[1] and M. Marangu[2]

[1]Kenya Forestry Research Institute (KEFRI) and Network for Natural Gums and Resins in Africa (NGARA), P.O. BOX 20412-00100, Nairobi. Email: director@kefri.org or benchikamai@ngara.organd meshackmuga@ngara.org or meshackmuga@hotmail.com

[2]Kenya Gum Arabic and Resins limited (KGARL). Email: mutu@888mail.net

Keynote paper presented during the conference on "New Developments in Acacia Gums Research, Products and Processes" held at Glyndwr University, UK, September 20-22, 2010.

Abstract

Kenya was not known to produce gum Arabic before 1988. Following consultations with organizations working in northern Kenya, which had seen the species in the region and noted some activities, a reconnaissance was commissioned and confirmed the availability of the *Acacia senegal* resource and informal commercial activities through Somalia. This was followed by an initiative by one Non Governmental Organization (NGO) that organized communities to collect gum Arabic and the first commercial export from the country was done in 1990. Collaboration was then established between the NGO and a government agency, which started the development of the gum Arabic sector in the country by clarifying issues related to the resource and gum quality on the one hand and development of the external market on the other hand. However, a number of challenges emerged that slowed the base of commercialization. These were related to issues of quality of gum arabic and reliability of supply. Effort has gone into addressing these areas and interest in Kenyan gum Arabic has been renewed. A more structured approach to the development of the sub-sector has been put in place in the recent past. This paper highlights the evolution of the development of the sub-sector in the country and future prospects.

1. Background

Kenya has a land area of 569,140 Km^2. About 80% of this area is covered by the drylands with about 25% of the human population and slightly more than 50% of the livestock population. These dryland ecosystems are endowed with a rich diversity of flora and fauna that the local people have depended upon for several generations. However, due to historical reasons, communities in these areas continue to rely heavily on pastoral livestock production systems. There is lack of diversity in commercialization of other dryland resources found in the area for development of alternative livelihoods.

The future for sustainable development of the drylands lies in the rational use of natural resources. This entails recognizing and developing the potential that exists in the vegetation resources for production of economically valuable products. A commitment by the government to address ASAL challenges has been made in the National Policy for the Sustainable Development of the Arid and Semi Arid Lands (Draft), Strategy for Revitalisation of Agriculture (SRA), Vision 2030 and Forest Policy, among others. Gum arabic is one the key dryland commodities.

Knowledge on Kenya's potential in gum arabic production came to the fore in 1988 when a consultative forum of government and non-governmental organizations was convened by Ford Foundation in Nairobi. Recommendations of this meeting formally launched research on gum arabic and gum resins using Isiolo district as a pilot area. In 1989 a reconnaissance survey was commissioned and the study confirmed availability of *A. senegal* resources and informal commercial activities through Somalia (Chikamai and Gachathi, 1994). The current commercial production of these commodities in Kenya is the result, in part, of the initiatives by KEFRI in consultation with Semi-Arid Lands

Training and Livestock Improvement Centres of Kenya (SALTLICK). In 1990 SALTLICK established an office and collection centre in Northern Kenya and made the first export of gum arabic of about 10 MT to the United Kingdom. Other exporters then joined and peak production 464 MT was realized in 1995. However, production declined and sales have remained about 100 MT per year with internal consumption of about 30 MT and remainder exported through Mombasa and Ethiopia.

There are a number of constraints and opportunities related to this Sub-sector. Although gum arabic has been used and marketed for generations by local inhabitants in Kenya, these activities seem to have gone unnoticed on the part of the government for a long time. The activities continued to be carried out at informal level until well into the late 1980s when various organizations working in northern Kenya noticed their commercial significance and the manner in which merchants seemed to be exploiting the collectors that they sought for a concerted effort to develop the resources. The ignorance of the government on the commercial potential of the commodities and the informal nature in which the business was/is carried out are some of the reasons that have led to the current constraints. Major constraints include: lack of adequate data on the resources, lack of sound production practices, inadequate market information, and poor government involvement in the Sub-sector. A number of Opportunities also exist as Kenya has vast resources whose utilization currently stands at below 10%. Potential for increased gum production therefore exists from the existing resources. Estimates have shown that production volumes for gum arabic are in the order of about 3500 MT per year.

This paper papers gives an overview of the evolution of the development of the gum arabic sub-sector in the country and highlights some future prospects.

2. Research and Development

A number of research and development initiatives have been undertaken since the 1990s through various projects. Some of the key areas of focus have been: Taxonomic and ecological characterization of the producing species, chemical characterization of the gum, resource assessment and mapping, production and management of *Acacia Senegal* trees and training and capacity building. Each of these is briefly described below.

2.1 Taxonomic and Ecological Characterization of *Acacia senegal*

The key gum arabic producing species Acacia *senegal* and *Acacia seyal are* both present in Kenya. Both species have been characterized in terms of their taxonomy and ecology (Gachathi, 1994 and Ckikamai, 2001 and). The potential adulterants have also been characterized. *Acacia senegal* has three varieties namely: *Acacia senegal* var. kerensis, *Acacia senegal* var. senegal and *A. senegal var. leiorhachis* (Figure 1). *Acacia senegal* var. *kerensis*, is the main source of commercial gum arabic in Kenya. *Variety senegal* occurs in areas of relatively higher rainfall, produces gum on tapping in some areas but not been developed commercially. Variety *leiorhachis* is more restricted but its potential for gum production has not been established.

(a) var. s*enegal* (b) *var*. *kerensis* (c) var. *leiorhachis* (c) var. *leiorhachis*

Figure 1: Varieties of *Acacia senegal*

Var. *senegal* is recognized as a tree with a flat or rounded crown and rough non-papery and non-peeling bark commonly growing on sandy alluvial loamy soils in plains or at the foot of hills in semi-humid to semi-arid areas of Nakuru, West Pokot, Kajiado, Kitui, Isiolo and Baringo Districts. Var. *kerensis* grows as several-stemmed shrub with lateral branches from near the base and with smooth yellowish-brown peeling bark on the stem. It is found in the very dry areas, common on rocky limestone hills and ridges and on sandy plains frequently forming almost pure stands over large stretches of land in Turkana, Samburu, Isiolo, Marsabit, Wajir, Garissa and Mandera Districts. Most common in areas with 300-550 mm rainfall.

Var. *leiorhachis* exhibits two growth forms; either as a straggling slender tree starting with a very branched bushy base then thinning out to 1-4 slender whippy erect tall stems with peeling bark or a well grown tree with open rounded spreading crown and yellowish papery and peeling bark on the main trunk. The whippy form occurs in clusters of small populations on extremely rocky gneiss-derived sandy soils in semi-arid to arid areas in plains. Populations of this variety are found at Marti in Baragoi Division of Samburu District, along Magadi road in Kajiado and in Garba Tula. The tree with round crown formation (synonym *A. circummarginata* Chiov.) occurs on red deep sandy soils along drainage lines and areas with high water table. It is common in Wajir, Marsabit and Samburu Districts.

Acacia seyal is recognized by its smooth stem, which is covered with whitish, greenish yellow or orange-red powdery layer, bright yellow flowers in heads and the sickle-shaped dehiscent pods that are constricted between the seeds. The species has two varieties: var. *seyal* (Schweinf.) Oliv. and var. *fistula* Oliv (Figure 2). Var. seyal is characterized by

reddish or reddish brown and occasionally green back. Spines are sharply pointed, more or less straight, in pairs and normal. Var. fistula has pairs of spines fused at the base forming pseudo-galls often called ant-galls because they are often associated with ants. Bark is typically white or greenish yellow.

Acacia seyal Tree

var. *seyal*

var. *fistula*

Figure 2. Varieties of *Acacia seyal*

2.2 Chemical Characterization

The main source of gum Arabic from Kenya is *Acacia senegal* var *kerensis*. Its gum is characterized by a slightly higher negative optical rotation, protein and viscosity compared to var. *senegal*. The third variety i.e. var. *leiorhachis* is said to be comparable to var. *kerensis* in viscosity and protein but has a more negative optical rotation (Table 1).

Table 1: Analytical data of gum Arabic from three varieties of *Acacia senegal*

	Var. kerenisis (Kenya)[1]	*Var. Senegal* (Sudan)[2]	*Var. leiorhachis* (Tanzania)[3]
Loss on drying (%)	14.7	13.0	13.8
Total ash (%)	3.0	3.6	4.2
Specific rotation (deg)	-34	-30	-50
Nitrogen (%)	0.44	0.34	0.44
Hence Protein	2.9	2.3	2.9
Intristic Viscosity(ml/g)	21.9	16.0	23
Equivalent weight	995	1050	1583
UAA(%)	18	17	0
Tanin (2% solution)	0	0	0
Gel (25% solution)	+		nd
PH (25% solution)	4.4	4.4	nd
Sugar composition (%)			nd
Gluculonic acid	18	17	nd
Galactose	39	44	nd
Arabinose	28	25	nd
Rhamnose	16	14	nd

Mean values are quoted in all cases, + gel present; **nd**-not determined
Source: [1] Chikamai and Banks, 1993
[2]Anderson *et al* (1990)
[3] Mhinzi and Mrosso, 1997

When the molecular characteristics are examined the two varieties i.e. var *senegal* and *kerensis* show the same chemical species typical of *Acacia senegal* though var. *kerensis* shows a more enhanced absorbance peaks of the UV profile caused by the high protein content (Figure 3).

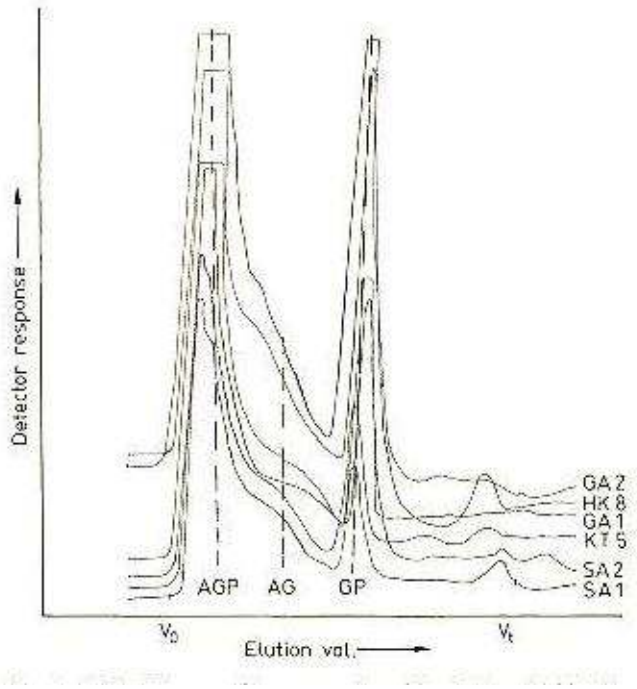

Figure 3: GPC elution profiles as monitored by UV
(Source: Chikamai *et al*. 1994)

These differences reflect the natural variability that exists in the different varieties and presents opportunities for the development of specific niche markets for each type of gum

2.3 Resource Assessment and Mapping

Resource assessment and mapping of gums and resins in Kenya was conducted in 2005 by the Regional Centre for Mapping of Resources for Development through the support of the Technical Cooperation Programme of FAO. This was a regional project in the framework of the Network for Natural Gums and Resins in Africa (NGARA) involving 15 countries. A GIS database comprising the AFRICOVER land use / land cover, elevation, soils, agro-ecological zones, administrative boundaries, Landsat satellite imagery, etc for the Eastern Africa countries was developed and backed up on a compact

disk (CD). Metadata for all project datasets was developed. A refined methodology for mapping gums and resins was also developed using Kenya's case.

A comprehensive digital database (comprising satellite data, GIS layers, field photographs) and hardcopy maps (at scales of 1:250,000 – 1:1,000,000 for national maps and 1:1,000,000 – 1:5,000,000 for regional maps) showing the locations of gums and resins producing species were produced. The probability map produced for gums and resins resources in Kenya is shown below (Figure 4)

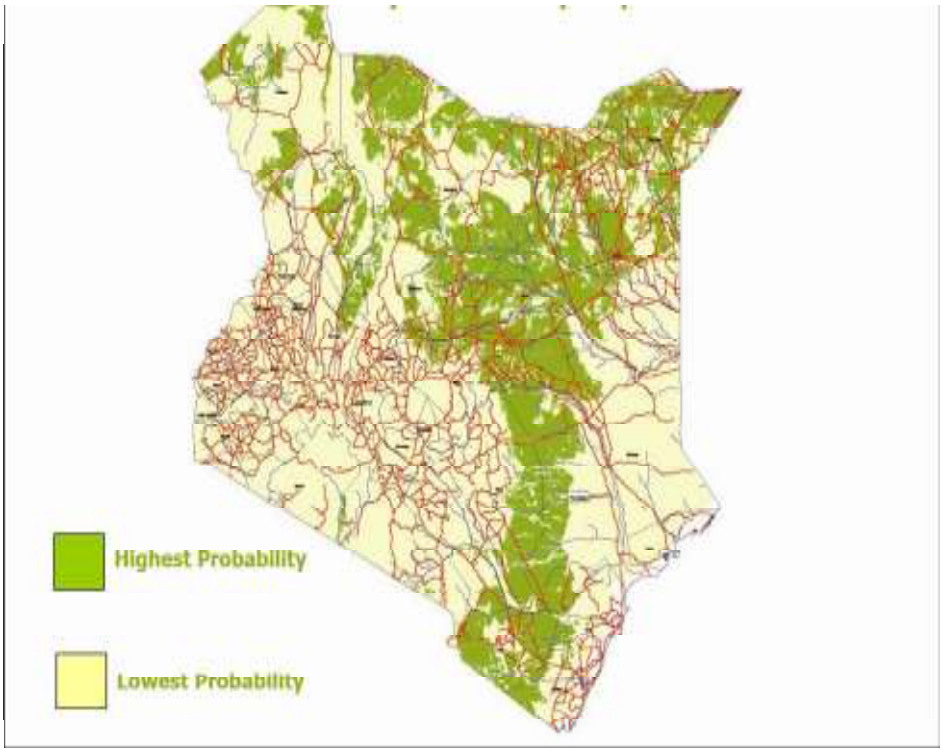

Figure 4: Probability map for gums and resins resources in Kenya (Source FAO: 2005)

2.4 **Plantation Production and management of Acacia gums**

Two key projects have been involved in the improved production and management of Acacia gums. These are Acacia Operation Project and Acacia Gum Projects. Acacia Operation Project (AOP), a pilot regional project, funded by the Italian Cooperation through FAO and implemented in Burkina Faso, Chad, Kenya, Niger, Senegal and Sudan, operated in 2004-2007. The goal of the project was to contribute to sustainable development; food security, poverty alleviation and desertification control through promotion and integration of gums and resins in rural economies in Africa. The project supported rural populations in the beneficiary countries to rehabilitate degraded lands by establishing agro-silvo-pastoral systems in the drylands based on mechanized water

harvesting *Vallerani Technology*. A number of pilot sites were established in Marsabit, Samburu and Kibwezi Districts of Kenya planted with *Acacia senegal* intercropped with agricultural crops and other suitable tree species. The communities in the pilot sites were empowered through training workshops on use and application of the mechanized water harvesting technology (Vallerani System), nursery establishment, agricultural production, gums and resins production, tapping and quality control including post harvest handling. A long term programme has been formulated and funding being sourced.

Acacia Gum project also is a regional project funded by European Union INCO-DEV programme and being implemented in Cameroon, Kenya, Niger and Senegal as from 2007 to 2011. The overall objective of the project is to enhance the sustainable management and use of natural *Acacia senegal* tree resources thereby supporting the environment and livelihoods in arid and semi-arid sub-Saharan Africa. The project has six work packages (WP) namely: Traditional ecological knowledge (WP1), Marketing networks (WP 2), Tree eco-physiology (WP 3), Genetic and gum quality (WP 4), WP 5 Tree-soil interactions (WP 5) and Dissemination and transfer of technologies (WP 6).

The traditional ecological knowledge and its application in the management of *Acacia senegal* trees in Isiolo and Samburu Districts of Kenya has been documented. The market chains of gum arabic, the stakeholders participating in the management and marketing of *Acacia senegal* products and the constraints to gum arabic production and collection within the Kenyan drylands have also been documented. Gum arabic yield in different varieties of *Acacia senegal* has also been studied. Studies on the genetic diversity of the Kenyan populations of *Acacia senegal* using nuclear and mitochondrial Microsatellite markers have also been carried out and higher genetic diversity and little population structuring detected. Morphological characterization of the Kenyan populations of *Acacia senegal* has also been completed and data analysis underway. Characterization of the populations using RAPD is on going. The effect of chemical properties of soils on gum elementary compositions from *Acacia senegal* variety *kerensis* in Samburu and Marsabit districts has also been studied**.** Soil analysis and microbial studies have also been initiated.

2.4 Training and Capacity Building

Considering that gum arabic and gum resins production and trade had been going on in the ASALs of northern Kenya since the 1990s albeit in a discontinuous manner, and that local communities had some idea about the activity, the need to develop the capacity of extension service providers and local communities for sound production and trade was identified as important activity in the country. In 1997 the national association, Gums and Resins Association (GARA) was formed. Since its formation GARA has helped to highlight critical issues affecting the gum and gum resin sector in the country. In 2005-2009 KEFRI in the framework of the Network for Natural Gums and Resins in Africa (NGARA) and in collaboration with GARA spearheaded the formation of at least 15 gum producer associations and carried out training of practitioners in the gum subsector. The trainings focused on the production, harvesting, post harvest handling and marketing of gum arabic with the ultimate objective of providing an alternative livelihood source (income generation) for the local community. The strategy was to carry out training of

trainers (ToTs) and then use the ToTs to train the local communities. The training programmes were supported by FAO through the Acacia Operation Project (AOP) and Technical Cooperation Programme (TCP), African Development Bank through Ewaso Ng'iro North Development Authority (ENNDA) and Swedish International Development Agency (SIDA) through the National Agriculture and Livestock Extension Programme (NALEP). Through these programmes about than 337 people have been trained as summarized in Table 2.

Table 2: Training on production, harvesting and marketing of gum arabic

Project	**Development partner (s)**	**Year**	**Number of TOTs trained**	**Number of local communities trained**	**Total number trained**
AOP/ TCP	FAO and Italian Cooperation	2004-2006	20	60	80
ENNDA	ADB	2007-2008	80	120	200
NALEP	SIDA	2009	57	-	57
Total			157	180	**337**

5 national staff have also been trained in the use of Remote Sensing, GIS and GPS technologies in natural resource mapping and monitoring and have applied these skills in resource assessment and mapping within and outside the country.

A number of lessons have been learnt during the training programmes which will be useful in organizing subsequent training programmes.

Apart from the training programmes, the capacity of a number of producer associations has been enhanced through the construction of stores through the support of ENNDA, CETRAD and African Wild Life Foundation.

3.0 Structured Approach to sub-sector Development through Public Private Partnership.

Public Private Partnership (PPP) concept is quickly being embraced in the country in a number of development initiatives. KEFRI has piloted a PPP with the Kenya Gums and Resins Company Limited (KGARL) with very good results. The two institutions jointly carried out a study aimed at generating information for commercialization of the gum arabic sub-sector. The study covered 13 districts: Isiolo, Laikipia, Meru North, Tharaka, Mwingi, Kitui, Tana River, Garissa, Wajir, Mandera, Moyale, Marsabit and Samburu Wekesa *et al*, 2010). A total of 198 temporary sample plots were marked in all areas of occurrence of the resources using GPS to assess their densities and distribution. About 100 members of the local communities were interviewed alongside gum collectors, traders and their agents. The data on gum and resin resources is being analyzed and once completed will provide a very clear indication of the potential for gum arabic and resins production in the country. Samples of gum arabic have also been collected and are undergoing analysis.

Major constraints

Major constraints limiting increased collection and marketing of gums and gum resins include: Lack of clear policy on the development of gums and resins, lack of reliable markets, poor prices, harsh and difficult terrain, frequent droughts, insecurity, animal and human damage, Lack of access to adequate capital, famine and poverty, disease and poor health facilities, poor production practices, land tenure issues, lack of adequate data on the resources and Socio-cultural perceptions. There is room for increased collection and marketing of gums and gum resins through intervention of the above constraints and diversification of the sub-sector.

References

Anderson, D.M.W.;Douglas; D.B., Morrison; N.A., Weiping, W. 1990: Food Additives and Contaminants, 7: 303

Anderson, D. M. W.; Weiping, W.1990: Food Hydrocolloids 3:475

Chikamai, B.N.; Banks, W.B.; 1993: Food Hydrocolloids, 7:521

Chikamai, B.N; Gachathi, N; 1994: Gum and resin resources in Isiolo District, Kenya: Ethnobotanical and Reconnaissance survey; E. Afr agric, For. J (1994) 59(4), 345-351

Chikamai, B.N.; Osman, M.E.; Menzies, A.R.; Banks, W.B.; 1994: An evaluation of methods for characterizing and monitoring gum arabic of commerce and related Acacia gums; Wood Science and Technology 30 (1995) 49-61.

Chikamai, B.N; Hall, J.B; 1995: Survey of *Acacia senegal* resources for gum Arabic in Northern Kenya. Commonwealth Forestry Review 74 (3), 1995

Chikama, B.N.; 2001: Taxonomic and ecological characteristics of the Acacia Gum tree; Paper presented at the Symposium on "Acacia Gum: Food ingredient for the future.", Nefta, Tunisia: 21st to 23rd February 2001

Gachathi, F.N.M. 1994. Variation in *Acacia senegal* and its Relationship with *Acacia circummaginata* and *Acacia thomasii* in Kenya. Msc. Thesis in Pure and Applied Fungal Taxonomy, University of Reading, Reading.

FAO. 2005. Mapping gums and resins in Eastern Africa. TCP/2914 Project Report.

Wekesa, L., Gathathi F., Somo A. and Maitha, D. (2010). Feasibility Study On Gum Arabic And Gum Resin Resources in Kenya and status of markets for commercialization. Survey Report. Nairobi, Kenya.