OPPORTUNITIES FOR PRODUCTION AND UTILIZATION OF AGROFORESTRY RESOURCES FROM THE ARID AND SEMI ARID LANDS OF KENYA

By

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1.0. Introduction

Kenya has an agricultural based economy that depends on agriculture and livestock for economic well being. Unfortunately, Agricultural Production is concentrated in the high potential area [HPA] which is only about 20% of the total land area but with 80% of the human population. The high population growth rate for the country at 4.2% (NFAP update, 1995) and probably higher for these areas has put tramendous pressure on the demand for land.

Meanwhile about 80% of the land area is classified as Arid and Semi Arid Lands (ASALs). They are characterised by low biological productivity resulting from scant and erratic rainfall, a high evaporative demand and poor soils. As a consequence the vegetation comprises of annual grass land, shrub land or bush land in most places. Nomadic pastoralism or range farming is thus the most commonly practiced mode of life and economic mainstay of these areas. They support about 20% of the human population and over half of the livestock [Weiss, 1987].

The increasing human population in the HPA has led to a shift towards the ASALs for Agricultural land. Farmers from high potential areas bring a long with them crops and farming systems that are sometimes not compatible with the ASALs which, are in their own nature, fragile ecosystems. On the other hand, the equally increasing human population among the local pastoral communities and desire to keep large herds of livestock put more pressure on the land. Consequently, the increasing human and livestock populations and improper farming systems are contributing to the degradation of the ASALs.

The future for sustainable development of the ASALs lies in the rational use of the existing resources. This entails minimising

over-dependence on livestock production and instead promote diversification and secondly develop sound methods of Management. Recognising and developing the potential that exists in the vegetation for production of other valuable products apart from browse and fodder is an important step towards sustainable development of the ASALs. Initiatives are already being undertaken in the production of plant gums and resins from the ASALs. The second, and perhaps more important step, is the introduction of agroforestry interventions in the Management of the resources. The present paper outlines opportunities that exist in the production and utilization of some of the agroforestry resources from the ASALs.

2.0. Acacia senegal and A. seyal and Production of Gum Arabic.

2.1. Economic Importance and Value.

Acacia senegal and A. seyal are the main sources of commercial gum arabic, an article of commerce for thousands of years. In Sudan, gum arabic from A. senegal is also commonly known as "gum hashab", in Nigeria as "Nigeria no. 1" and in French Speaking Producing African countries as "gomme dure" while gum from A. seyal is also known as "gum talha", Nigeria no. 2" and "gomme friable" respectively. The gum is used in the food, pharmaceutical and technical applications. Within the Food Industry, it is used in confectionery products either to prevent crystallization of sugar or act as an emulsifier. It is used in the soft drinks (Cola type) and alcoholic drinks as a stabilising or clouding agent. Use in the Pharmaceutical Industry is dependent on its properties as a binding agent but also as an emulsifying agent. Technical applications are in the Printing Industry where it is used as a protective coating to prevent oxidation of lithographic plates, certain types of inks to increase viscosity i.e. thickening agent and as adhesive in the adhesive industry.

Apart from gum arabic, the trees are also valuable in various ways. In the Sudan and West Africa, they have been used as buffer against desert encroachment by acting as Wind breaks and Stabilising sand dunes. They are useful in reducing Soil erosion and Stabilising the soils through their canopies which intercept rain drops while the tap root and extensive lateral roots prevent further soil loss. Additionally, they are natural soil improvers though the ability to fix nitrogen. The pods and foliage

provide good fodder, while flowers are a source of nectar for honey. Branches are usually cut for fencing livestock enclosures and when dry, as source of fuel wood. The wood yields excellent charcoal. These attributes make the species suitable candidates for agroforestry development in the ASALs of Kenya.

2.2. Plant Characteristics and Ecological Requirements.

Acacia senegal and A. seyal are members in the family Mimosaceae and Genus Acacia. They are distinguished at the level of sub-genus. The former belongs to the sub-genus aculeiferum characterised by prickles or spines of non-stipular type while A. seyal belongs to the sub-genus Acacia characterised by spines i.e. spinescent stipules (Vassal, 1972).

Three varieties of A. senegal are generally recognised and sometimes a fourth. A. senegal var. sengal Brenan is present through a belt some 300 km wide immediately south of the Sahara desert from Mauritania and Senegal in the west to Somalia in the Horn of Africa. From the Horn of Africa the range extends southwards to Tanzania (Giffard 1975, Brenan 1983). It is a shrub or small tree 2-12 m tall with bark yellow to light brown or grey, rough, fissured and flaking. A. senegal var. kerensis Schweinf. is restricted to eastern and north-eastern Africa. It is a shrub or bush 1-5 m tall, branching from the base or with a short trunk. Bark or trunk greyish to dark brown and sometimes peeling. A. senegal var. rostrata Brenan occurs across Southern Africa South of the Zambezi river. It is a shrub or bush up to 8 m tall. Bark on trunk creamy yellow to grey brown and flaking papery peel. The variety referred to as A. senegal var. leiorhachis Brenan apparently has a discontinuous range, being known in Ethiopia, Somalia, East Africa and south of the Zambezi river. It exhibits two growth forms; a well formed tree with a rounded crown and a form with long straggling branches. However, Hassan and Styles (1990) treat the former as of specific rank, as A. circummarginata Chiov. and the form with straggling branches as its synonym, the latter form commonly observed in Kenya, Tanzania and further south. Fig. 1 is the distribution map of Acacia senegal in Africa.

A. seyal comprises of two varieties. Var. seyal is characterised by reddish or reddish-brown and occasionally greenish bark. Spines

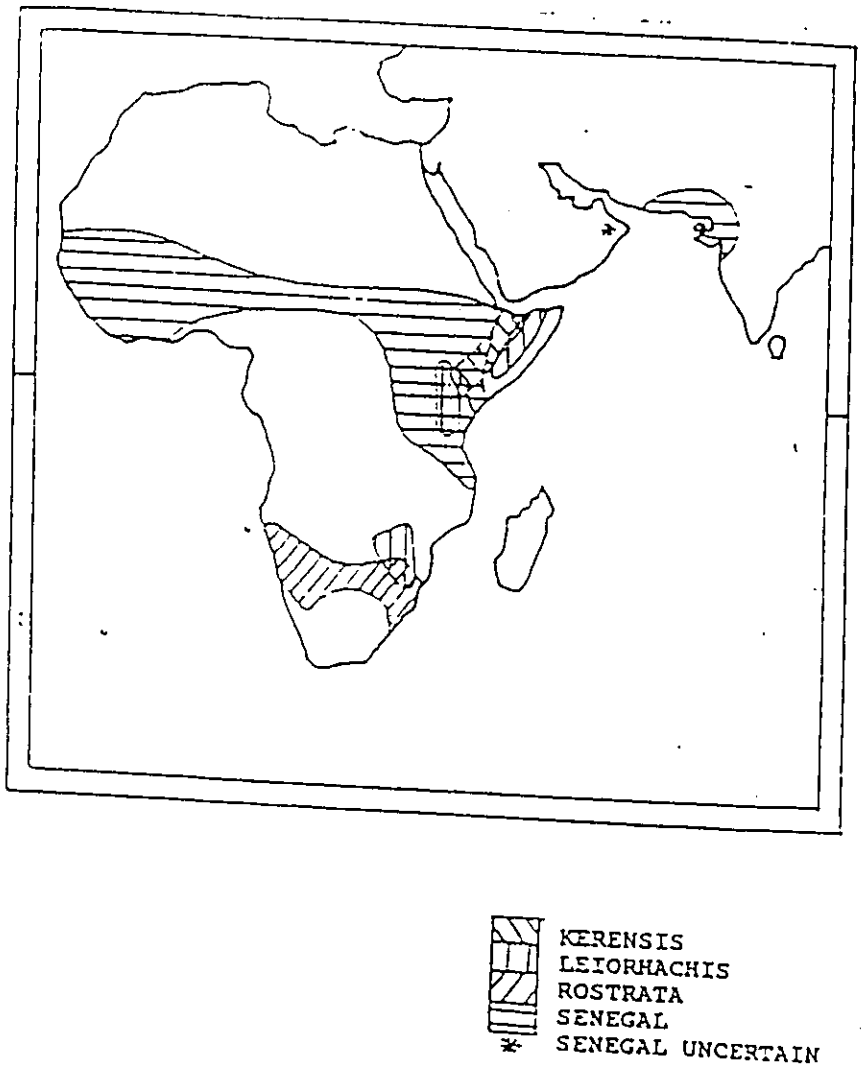

Figure 1: Map of Acacia senegal showing approximate distribution of the species and varieties. (Source: Brenan, 1983)

are sharply pointed, more or less straight, in pairs and normal. The distinguishing feature of var. fistula is the fusing together of some pairs of spines developing into Pseudo-galls, often called anti-galls because they are often associated with ants. Bark is typically white or greenish yellow. Otherwise both varieties have an open, spreading flat topped crown of horizontal or ascending branches though var. fistula tends to have a crown that is more irregular. Height varies considerably though a height of 9-10 m tall is the most common.

In terms of distribution var. seyal [Fig. 2] is much more extensive extending from Dakar in Senegal to Harrar in Ethiopia and then through Eastern Africa to Liwale in Tanzania [Hall and McAllan, 1993]. Var. fistula is confined to the Horn of Africa, Eastern and Central Africa [Fig. 2]. Within its natural range, A. seyal is found in areas with mean annual rainfall of 500-1200 mm and a single well defined dry season of 6-8 dry months. In drier environments (< 400 mm year- ; $\geq$ 8 dry months), the species is found in areas with additional moisture to direct rainfall e.g. basins of inland drainage, proximity to large rivers or discharge zones of mountain catchments. With respect to soils, the species is associated mostly with clays and loams as well as alluvials and especially areas of internal drainage or low relief. Impeded drainage is almost indicated for the species.

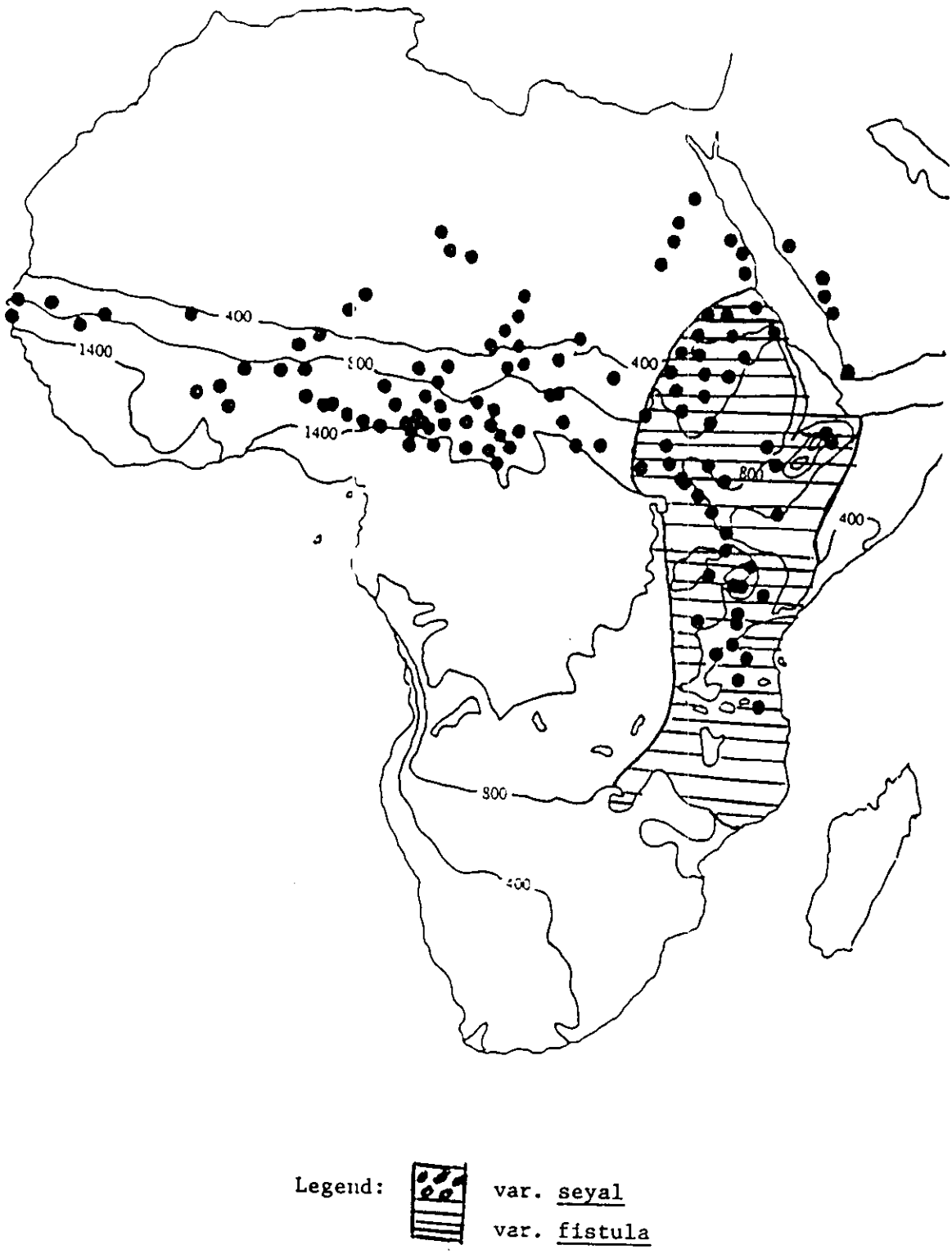

Figure 2: Map of Acacia seyal showing approximate distribution of the species and varieties.
(Source: Hall and McAllan, 1993)

2.3. Management for Gum Production

Management of A. senegal and A. seyal for Gum Production is well formalised in Sudan where production of gum arabic is more or less a way of life among certain communities. The Management aspects are going to be used here as a model of good husbandry practices. Gum arabic from A. senegal is derived from both natural stands and established plantations and collected by tapping while gum from A. seyal is mainly from natural stands and through natural exudation. Areas with natural stands have been mapped adequately and the stands managed sustainably through rotational bush fallow cultivation system in the more traditional gum areas of Kordofan and Darfur. Regeneration is usually from natural seed fall but also occasionally through coppicing. The number of stems per stump is between 2-4 at the early stages and thinned to between 1-2 when tapping starts depending on the growth conditions. Stocking in the stands is manipulated to leave a standing tree crop of 400-500 stems per feddan (acre). Plantations are established from either direct sowing of seeds (Mostly in the clay soils) or transplanting of seedlings (Practiced on Sandy soils). In this case the source of the seed is important. Most seeds are collected from selected seed trees. The seeds or seedlings are established at an optimum spacing developed through research of 4 x 4 m. During early stages of growth, trees are protected from hazards of fire either through strip or spot hoeing and from browsing by keeping off livestock from planted areas. Today, more than 50% of gum arabic produced in Sudan is from plantations.

Trees from naturally regenerated stands by coppicing or seedlings are due for tapping after 3-4 years and 4-5 years from plantations established through seed. Tapping begins when the trees are starting to shed their leaves (October/November) and the timing is very crucial to good gum production. Older methods which involved making incisions into the tree with an axe used to result in tree damage. They have been replaced with a specially designed tool "a Sunki" which only removes a small strip of bark longitudinally from the wood. The gum exudes as clear viscous fluid which looses water and hardens to a nodule. After 5 weeks, the first collections are made with further collections from the same tree after every 2 weeks until the end of the dry season. As far as possible the nodules are picked by hand rather than knocking them to

the ground where they can pick dirt. They are placed in open baskets and not plastic sacks that often result in increased moisture build up and hence mold formation.

Yield increases up to the age of 15 years, levels out to 20 years and begins to decline thereafter. At 25 years, trees are no longer productive and can be replaced either through coppicing for natural stands or replaced with a new tree crop after a suitable period of rest time.

2.4. Considerations for agroforestry development in Kenya

One of the main constraints affecting management of Acacia senegal and A. seyal for gum arabic production is lack of sufficient knowledge on the occurence and extent of distribution of the resources in the country, and in particular, gum producing areas. Except for some initiatives in research to identify varieties of A. senegal (Gachathi, 1994) and mapping of gum arabic resources in Isiolo, Marsabit and Turkana Districts [Chikamai et al, 1995] the Status of gum arabic resources in the country is still unknown except for information that might be in the hands of individual groups/organisations and has not been documented for public consumption.

Immediate priority should therefore be given to systematic mapping of gum arabic resources to adequately characterise source locations, type and quality of the resource. This should be followed by developing suitable methods of the woodlands for gum production. This can take the form of manipulating the stand through thinning or enrichment planting to attain the required stocking. Because of the bushy nature of the A. senegal var. kerensis there is need to develop suitable methods of pruning to make it easier to access the tree for tapping and collecting gum.

Meanwhile during resource survey and mapping suitable seed source areas should be identified. The seeds are to be used for provenance screening of the local germplasm with respect to growth performance, yield and quality of the gum. Provenance testing is important, particularly for quality since chemical analysis of the gum has revealed variation

in quality to be influenced, among others, by different geographical locations [Chikamai and Banks, 1993]. Where a given provenance is found to posses superior characteristics, domestication and propagation of the provenance should be undertaken with related tree improvement work. There is also need to examine whether var. senegal indigenous in Kenya has potential for production of gum arabic on a commercial scale. Additionally, superior germplasm from A. senegal var. senegal from Sudan should be procured and tested in this country.

Once information on provenance testing has established suitable provenances (Indigenous and exotic), extension to local communities should be undertaken using proven agroforestry technologies. Farmer participation (as immediate beneficiaries) is crucial for successful afforestation programme and hence the right methods for doing so will need to be explored. Methods of gum production as practiced in Sudan will need to be tested and those proven successful adopted.

Literature Cited.

Brenan, J.P.M. 1983. Manual on taxonomy of Acacia species, FAO, Rome.

Chikamai, B.N., Hall, J.B. and Banks, W.B. 1995. Commonwealth Forestry Review, 74(3): 246-252.

Chikamai, B.N. and Banks, W.B. 1993. Food Hydrocolloids, 7(6): 521-534.

Gachathi, F.N.M. 1994. M.Sc. Thesis, University of Reading.

Giffard, P.L. 1975. Rev. Bois et Forets Tropiques, 161: 3-21.

Hassan, A.S. and Styles, B.T. 1990. National resources Institute for Oxford Forestry Institute and Overseas Development Administration, UK.

NFAP, Update. 1995. National Forestry Action Plan. FAO, 32.

Vassal, J. 1972. Trav. Lab. Forest, Toulouse Tome, 1, 8, Art, 17.

Weiss, E. 1987. Guide to Plants tolerant of Arid and Semi Arid conditions. Ministry of Agriculture, Kenya.