INVESTING IN ACACIA SENEGAL -
LESSONS FROM THE SUDANESE
EXPERIENCE TO ERITREA

by
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ABSTRACT

The purpose of this paper is to survey the scanty literature presently available on the role of Acacia senegal tree in the ecology and economy of the Sahelian zone with special emphasis on the experience of the Sudan - the world's largest exporter of gum acacia, popularly known as "gum arabic". A brief discussion of the importance of Acacia senegal in the ecological stability of the Sahelian arid zone, especially in regard to its contribution to soil conservation and soil fertility maintenance, will first be presented. This will be followed by a cursory inquest into the Sudanese domestic market organisation and supply of gum arabic, along with a similar presentation of the structure of international demand for this particular primary commodity. In the last section of the paper, the environmental and economic value of Acacia senegal to Eritrea will be considered. Eritrea is a newly independent and sovereign African state whose natural resource base has largely been degraded through three decades of war-induced neglect and intermittent hostile climatic conditions, and whose economy at present time is in dire need of foreign exchange. The paper will the conclude by indicating some possible approaches open for the Eritrean government in rehabilitating and developing this immensely robust tree species.

ACACIA SENEGAL

There exist more 500 hundred species of the Acacia genus mainly growing in the arid and semi-arid habitats of Africa, the Middle East and the Sub-continent of India. Most of them yield natural gum of different types, but only those varieties produced by Acacia senegal and Acacia seyal are regarded to be of commercial interest. Acacia seyal, whose bark is characterised by a reddish-brown colour, produces an inferior quality of gum. The highest quality gum arabic, however, is obtained from the grey-barked Acacia senegal, which is a thorny leguminous tree producing pentaneous flowers and brownish, oblong pods. Though indigenous to the entire Sahelian zone, its growth is more rampant further north towards the edges of the Sahara desert. If the Acacia senegal bark is accidentally or deliberately cut or scarred, it displays gummosis, i.e., it exudes a water soluble carbohydrate called gum acacia. Gummosis in Acacia senegal occurs in quantities far more than the need to seal and protect the wound of the tree - a process whose exact nature is still not wholly understood. (Pearce, et. al., 1990: 130; Adamson and Bell, 1974: 1; Beshai, 1984: 371).

Acacia senegal is highly tolerant to rainfall and temperature variations. It grows mainly on sandy soils where yearly average precipitation falls between 280 mm and 450 mm iso-hyets; but, where the rainfall is less than 150 mm, the tree stock tends to be scarce. Growth clusters of Acacia senegal are also common in clay soils along river beds, and marsh lands of the Sahelian Zone where the annual rainfall ranges between 600 mm and 800 mm. The mean annual temperature in the Acacia senegal belt of the Sahelian zone is between 28 and 30 degrees centigrade. The growth and development of the tree is, therefore, more dependant on the amount of rainfall and the degree of temperature than on soil type. With deep tap roots and expansive remaining root system, Acacia senegal has about 40 per cent of its total biomass laying underground. It is this latter peculiar feature
of the tree which is of primary importance in the struggle against both water-born and wind-born soil erosion. In addition, *Acacia senegal* tree stock, growing in the northern cultivation limits of the Sahelian zone, act as wind-breakers and a buffer zone against the so-called “southward creeping deserts”. During the long dry periods, however, *Acacia senegal* is susceptible to attacks by white ants that damage the roots and cause eventual death of the plant. (Olsson, 1984: 7, 17, 30; Pearce, et. al., 1990: 130-33; Webb, 1985: 153).

*Acacia senegal* is characterised by active root noodles, which are organisms known for their nitrogen fixing capacity, and hence, is valuable for the maintenance of soil fertility and for grassy growth in its immediate vicinity; leaf and pod decomposition also increase the supply of protein to the surrounding soil. As such, this particular stock of trees are widely regarded as integral part of any program to rehabilitate pasture growth and, thereby, augment semi-pastoral development both in nomadic and sedentary agricultural systems. Furthermore, as a robust tree resisting extreme temperatures, *Acacia senegal* has a major contribution to the preservation and expansion of micro­climates occurring in hundreds of small and large pockets throughout the Sahelian zone. Of particular interest are those *Acacia senegal* dominated groves; in these groves, diverse vegetation indigenous to the ecology of the zone still remain standing shielded for ages by high mountains from on-coming hot north-easterly winds.

*Acacia senegal* is a favoured source of fodder for cattle, and browsed by sheep, goats and camel, which also eat the pods. In addition, the tree has several other domestic uses, such as for firewood, charcoal, and construction material for huts, water-wells, and fencing. But, above all, *Acacia senegal*, as a producer of gum arabic, provides an important source of seasonal employment and income for most inhabitants of the Sahelian region; especially in the Sudan, it is a major foreign exchange earner. (Olsson, 1984: 8; Pearce, 1990: 132–33; Larson & Bromley, 1991: 1292).

**GUM ARABIC PRODUCTION**

Gum arabic, correctly termed as Gum acacia, is an exudate which oozes through the acacia bark when the latter splits under the stress of hot desert winds of the Sahara. *Acacia senegal* produces the highest quality of gum arabic and provides the vast bulk of the world trade. Both rainfall and hot intense winds are crucial determinants of the amount of gum that exudes from the tree; the relationship, however, is somewhat complex. In the short-run, adequate rainfall, if not followed by hot weather conditions, results in a low level of natural gum exudation; this is mainly because an increased moisture content inside the tree prevents the bark from cracking as extensively as it otherwise would. Generally speaking, a season with a fair supply of rain followed by intense hot winds results in plentiful exudation; for if the rains are evenly spread, the trees keep on flowering, thereby, leaving little sap for conversion into gum. In other words, a specific sequence of seasons is required for the production of high gum output with good harvests following poor ones. Once defoliated by drought, locusts, goats, sheep, camels and other herbivorous wild animals, *Acacia senegal* ceases to produce gum during that season; but it quickly puts on fresh leaves during the ensuing season unless, of course, the causes of defoliation persist. Four or five years of consecutive drought will, however, arrest almost all exudation and may even damage the tree permanently. (Adamson & Bell, 1974: 10; Beshai, 1984: 373; Webb, 1985: 153; Olsson, 1984: 28).

In the *Acacia senegal* belt of the Sahel zone, most natural gum exudation normally takes place when the north-easterly winds blow with full force during the months of March, April and May; in some areas exudation may even extend up to the month of June. Opinions differ on the productivity of *Acacia senegal*; some writers report that initial gum harvest begins on four or five years old acacia trees, and that seven to twelve years old are the most productive. They also state that *Acacia senegal* trees older than 15 years are unlikely to be economically useful gum producers and may be of interest only for other purposes. Other researchers, on the other hand, hold a different view stating that gum yield is basically a function of the amount of precipitation, wind intensity, and level of temperature, and that age and size of the tree are of no major significance. They maintain that, as long as rainfall roughly lies between 280 mm and 450 mm and the average annual temperature falls in the range of 27–30 degrees centigrade, *Acacia senegal* thrives and exudes adequate gum arabic. (Pearce, et. al. 1990: 132–33; Larson and Bromley, 1991: 1292; Olsson, 1984: 30).

When the gum exudes from the bark, it dries forming amber-coloured balls having diameters ranging between 1 cm. and 5 cm. These gum balls are scraped from the bark with a hand-held knife or a knife attached to a pole; scraping the gum is an unpleasant job, as the dense growth of the tree
Acacia senegal has spiny foliage that scratches the harvester. Cutting the bark of the tree before it naturally breaks under the stress of hot desert winds is called “tapping”, which is an action intended to increase the process of exudation; but over-scarring the bark may permanently damage the tree. In northern Sudan, mainly in Gorgofan and Darfur provinces, tapping of Acacia senegal normally begins as early as October or November, just after the rainy season which occurs between June and August. Gum harvesting takes place during the dry season, 30 or 40 days after tapping, and the continues at intervals of one or two weeks until the coming of the next rains. Depending on the climatic conditions, the annual average gum yield per tree is reported to be in the range of 100–300 gm; other writers put it up to 800 gm per tree per year, and still others estimate it to be in the range of one kilogram. In sparsely wooded areas, the average daily gum production per person is estimated to be approximately 1–3 kg. In areas with medium density of Acacia senegal stands, it is possible to collect 24–32 kg of gum arabic per hectare, while on densely wooded stands the yield could be as high as 80 kg per hectare. However, gum harvests from wild Acacia senegal are not as dependable as those from the “gum gardens” in northern Sudan. These “gum gardens” are areas where Acacia senegal are cultivated and tended as cash-crop trees by private farmers; they were first established in 1913 in the Gorgofan province of the Sudan. Successful Acacia senegal seedling beds and demonstration plots were established during those early colonial years. Presently, certain parts of Gorgofan province still constitute a project area, falling under the program of the United Nations Sudano-Sahelian Office (UNSO), to rehabilitate the acacia stock in the region. The project activities include efforts to make Acacia senegal plantation an integral part of the production system both by distributing seeds and seedlings of the tree, and through managing various trials and demonstration plots in appropriate locations. (Webb, 1985: 154–55; Larson & Bromley, 1991: 1295–96; Beshai, 1984: 373; Olsson, 1984: 14).

USES OF GUM ARABIC

Gum arabic is polysacharic matter and unique among other natural hydro-colloids because of its extremely high viscosity and solubility in cold water. It is capable of forming water solutions at concentrations up to 50 per cent, whereas most other gums dissolve in water at concentration levels of less than 5 per cent. This unique physical characteristic gave gum arabic its hallmark as an emulsifier, thickener, and stabiliser of food and medical products for about 2,000 years. Ancient Egyptian writing refer to gum arabic as “kami”, and was used as adhesive for pigmentatian and for mummifying. Eventually it was exported through various Arabian ports and, hence, acquired the name “gum arabic”.

Gum arabic is an excellent emulsifier of water-insoluble materials; in food stuffs, for instance, it is used as an additive to help the formation of uniform dispersion of edible oil by modifying the surface tension of the latter. Having a film-forming characteristic, it provides a protective coat around oil droplets, thus, reducing their average diameter. In water emulsions, when two oil droplets come in contact of each other, they immediately form a larger oil globule. This process, called coalescence, is prevented by the protective film provided by gum arabic as an additive; thus, it acts not only as an emulsifier but also as a stabiliser of emulsion. Furthermore the protective colloid of gum arabic decreases the particle size of the oil droplets, thereby increasing the amount of fluid immobilised; this results in higher viscosity of food suspensions in water-oil emulsions. In other words, gum arabic, as an additive, is also a thickener of water insoluble materials. An added advantage is that gum arabic is non-polluting, non-toxic, odourless, colourless and tasteless, and does not affect the colour, odour, or taste of other materials with which it comes in contact. Gum arabic has an extremely wide variety of uses of which the following is only a brief review.

Food

The principal use of gum arabic is in food industry where it gives foodstuffs desired qualities through its influence on their viscosity, body and texture. The biggest single user of gum arabic in this industry is the confectionery branch. First, it retards the crystallisation of sugar in confectioneries whose sugar content is high and moisture content low. Second, having a protective colloid action, it prevents the fat in confectioneries from oozing out to the surface and form a greasy layer. As emulsifying, stabilising and thickening agent, gum arabic is applied in the preparation of
fruit syrups, jellies, salad dressings, mayonnaise, sauces and in many other canned food items. It has vital function in the preparation of bakers emulsions of citrus and of other essential food oils. Its water absorbing capacity is also helpful in retarding the formation of ice crystals when preparing food products bound to be frozen. (Pearce, et. al., 1990: 132; Adamson & Bell, 1974: 23–4).

**Beverages**

In soft drinks manufacture, gum arabic is widely used as a stabiliser of many flavour emulsion concentrates; besides giving body to the soft drink, it keeps the droplets of flavour-oil apart, thus, preventing them from coming together to form an oily ring around the bottle. It also acts as a fixative for over-time stability of dried or powdered soft drink flavours. Most of the dried flavours are prepared by spray-drying process in which a solution of gum-in-water, with a flavour suspended in it, is forced through a fine nozzle at very high temperatures; the water, then, evaporates leaving the dry particles of flavour protected by a film of gum arabic. This process seals the flavour until it is released on re-immersion in water during the final preparation of the soft drink. (Beshai, 1984: 371–3).

In brewing industry, gum arabic is used to stabilise beer foam, and is responsible for the “lace curtain” effect on the sides of the glass when beer is consumed. About 1–1.5 kg of gum arabic is normally sufficient to stabilise 50 barrels of beer. It also serves as wine stabiliser in wine industries. (Adamson & Bell, 1974: 24).

**Pharmaceuticals**

Gum arabic is used as a mitigating and sedative agent and as a colloid in medical mixtures, such as cough syrups, and in the preparation of low-sugar and salt-restricted dietary stuff. In cosmetic industries, it is used as suspending and stabilising agent for cream lotions, ointment pastes, face creams etc. An important advantage of gum arabic in these uses is its non-toxicity and freedom from dermatological and allergic reactions. In addition, gum arabic has a valuable quality of dissolving and neutralising a range of poisonous chemicals. (Beshai, 1984: 372).

**Industrial Uses**

In non-food and non-medical usage, gum arabic is equally varied. It is used in the manufacture of different types of stationaries, e.g. adhesive tapes, glues, re-instateable products such as stamps and envelopes. Its stabilising and protective colloid action is useful in the preparation of high quality, waxed and coated papers. Similarly, in printing industry, gum arabic makes lithographic plates more light sensitive and rust free. It is also employed in iron foundries, fireworks manufacture, and in the production of ink, paints and matches. Textile industries also make extensive use of gum arabic as sizing and finishing material. Lastly, it is suspected that a large amount of gum arabic is consumed in other industrial activities of confidential nature. (Adamson & Bell, 1974: 25; Beshai, 1984: 373).

**SUBSTITUTES FOR GUM ARABIC**

Having an established quality superiority, gum arabic does not face significant competition from other types of natural gums; however, it shares a common disadvantage with them. First, its purity is not always uniform; and second, its supply, being a function of climatic conditions, is often unreliable. As result, its market is constantly being threatened by the development of a variety of synthetic substitutes and the emergence of modified natural gums. A brief review of some of the major substitutes is, therefore, in order.
Modified Natural Gums

Natural gum modification is, almost always, undertaken using starch and cellulose pulp. The three prominent advantages which modified gums have over natural gums are uniform properties, stable prices, and reliable supply. However, aside from the high cost of modification, modified gums are often required to pass an expensive testing procedure before they are permitted as additives in food and medical products; this reduces their competitive capacity against natural gum arabic. Nonetheless, modified gums have been noted to gain a significant market share in confectionery, beverage, and flavouring industries. The two commercially significant modified gums are sodium carboxy-methyl-cellulose (SMC) and methyl-cellulose (MC).

SMC, whose modifying agent is extracted from wood pulp, is largely used in the production of detergents; but, it also finds significant application in industries such as food, beverages, textiles, paper, paints, and pharmacy. It should be noted, however, that the average market price of SMC is about one and a half times that of natural gum arabic; this price differential occurs mainly due to the need for a large wood pulp industry to provide the required base modifying agent - cellulose.

MC, on the other hand, is a strong cellulose-based emulsifying agents whose major application is in food industry; but it also has considerable use in cosmetics, paints, paper, and textile industries. The average international market price of MC is reported to be about twice that of gum arabic.

Other starch-based modified gums include dextrins, gelatines, and pectins, all of which can, to some extent, substitute natural gum arabic. Dextrins, besides being supplied in form that can be used in direct production, have a price advantage over gum arabic and, therefore, present an effective threat to the latter.

Synthetic Gums

These are a range of artificial gums which are entirely synthesised from chemical substances; they are usually categorised in two groups: synthetic polymers and carbopolms. Generally speaking, they have the same advantages and disadvantages displayed by modified gums in relation to natural gum arabic. Their main use is in brewery, paper and adhesive tapes, lithography and paints, textiles, and cosmetics. Synthetic gums are noted for their high production costs which tends to inhibit their market share as substitutes for natural gum arabic.

Nonetheless, gum arabic, in many of its uses, still maintains its performance superiority over even the most effective substitute; above all, it is free from chemical elements contained in synthetic gums whose effects on human health are often uncertain when used as additives in food stuffs. (Pearce, et. al., 1990: 132; Adamson & Bell, 1974: 26–34; Larson & Bromley, 1991: 1295).

DOMESTIC SUPPLY STRUCTURE

Exporters of gum arabic from the Sahel zone include, in order of importance, the Sudan, Nigeria, the former French colonies of West Africa, and Tanzania. But, as indicated earlier, the only country where gum arabic collection on substantial scale exists is in the Sudan, particularly in the northern provinces of Gordofoo and Darfur. The Sudan currently dominates the world market of gum arabic by supplying more than 80 per cent of the world's annual requirements. About 10 per cent of the Sudanese foreign exchange earnings come from the export of this commodity. Apart from the relatively abundant population of wild Acacia senegal stands, plantation of the specie is also undertaken on government lands and private holdings – the “gum gardens”. Considerable wild gum collection is practised in the Sudan, with the quantity collected depending on the relative attractiveness of other crops to the collectors, particularly on the success of the dura crop. Gum arabic is collected on a more systematic basis in the Sudan than elsewhere; in the “gum gardens”, the trees are continually restocked and regularly tapped. Throughout the Sahelian region, Acacia seyal, also grows; but, the gum obtained from this specie, known in the Sudan as “talca” or “talha” or “tali”, is considerably less soluble in water than the exudate from Acacia senegal. Hence, tapping is not a common practice on the Acacia seyal, and only its natural exudate is collected by the local population.

Sudanese gum arabic is generally accepted as being of highest quality in the world market, and the standards of gums from other sources are set with reference to it. Gum arabic from Acacia senegal,
in the Sudan known as “hashab”, is available in four different grades. The natural grade is that raw gum arabic containing all the associated impurities; it is normally not exported in that form because of the importing countries lack the skilled cheap labour for sorting and grading. A better grade is that gum arabic whose impurities such as bark, twigs, dust, and sand, are removed by passing it through a mesh of a particular size. The cleaned and sifted grade is then bleached by exposing it to the sun for several days, sometimes for weeks, during the hottest times of the year. When exposed to sunlight and heat, the gum imparts its moisture content and acquires virtually white or colourless appearance; the bulk of the gum is exported in this cleaned form. The top-grade, however, is that gum arabic specially selected by hand-picking, and which consists of the bigger and better pieces of gum exudates. After passing the process of bleaching, this grade, though exported in small quantities, fetches the highest price in international markets. The lowest grade gum arabic is the dust left over as powder after the process of hand-picking and cleaning is completed; this grade is also exported, albeit, at relatively low world prices.

Aside from the short-term climatic variations already indicated above, three additional factors determine the level of gum arabic output. The primary determinant of gum output is the density of *Acacia senegal* stands which, in turn, depends on the rate of deforestation caused by human activities and by the long-term climatic changes in the Sahelian zone. The Sudanese government, as noted earlier, undertakes programs to augment the population of this particular tree specie by encouraging plantations and “gum gardens” in Gordoan and Darfur provinces. Second, gum arabic output is a function of the number and efficiency of collectors. The quantity of manpower for gum collection largely depends on the degree of internal seasonal migration, while performance efficiency of gum harvester is directly related to collection techniques. In the Sudan, gum tapping and collection has been recognised as cash generating side-line activity as far back as 1890. With about one hundred years of accumulated experience to draw from, the Sudanese peasants are considered to be adept gum tappers; and it has been established beyond doubt that correct tree tapping increases gum output. Gum collection is undertaken during the dry season when other farm work is at its lowest; and; hence, for both the habitual and casual collector, this activity occurs as a result of a trade off (marginal rate of substitution) between income and leisure. *Acacia senegal*, being indigenous to arid and semi-arid ecology, largely grows in surroundings where water scarcity poses significant problem. The distance and area that wild-gum collectors cover is limited by the amount of drinking water that they can carry along with them, and/or by the number of potable water sources existing in the *Acacia senegal* forest zone. The shortage of drinking water as a constraint to increased gum arabic output in northern Sudan has been recognised and given due attention as early as 1912 - a time when one of the earliest water conservation and development programs in Africa was launched by the then colonial government. The program included construction of bore holes, dams and cement pits mainly in hilly and arid districts of Gordoan and Darfur provinces. A third factor that determines the supply structure of gum arabic is the availability of subsistence crops; for rural residents to have gum collection as an established activity, it is important that they be able to produce subsistence crops in the vicinity where *Acacia senegal* grows in plenty. (Beshai, 1984: 373-79; Adamson & Bell, 1974: 12-13).

DOMESTIC MARKETING STRUCTURE

Generally speaking, the quantity and quality of marketable gum arabic depends on the degree of domestic market organisation, which differs considerably from country to country. *Acacia senegal* gum exudates obtained from different geographical areas show significant variations in structure and properties; but in the majority of cases, quality differences arise due the fact that many consignments include inferior gum from species other than *Acacia senegal*. This, clearly, is a marketing problem. The internal marketing system in the Sudan is, by far, the best organised in comparison to those in other gum exporting countries in the Sahel zone. Prior to the 1920s, the domestic marketing of gum arabic in the Sudan involved a system in which brokers, acting on the behalf of the private exporting firms, bought the gum from rural supplies or other small merchants. The supply structure during those years was characterised by marked irregularity and unpredictability. In 1922 however, gum arabic marketing in the country was reorganised when a system of government-supervised public auctions was introduced in several regional centres where buyers bid for gum of a single producer. At certain appointed times, the local collectors brought their supplies of gum to the nearby village markets for sale to small-scale traders on auction. Under that
system, the gum producers were not obliged to sell their supplies if the highest bid price was unacceptable. But, once sold to traders, the gum stock was transported to provincial towns to be bought by large-scale dealers who, in turn, dispatch it to Khartoum where it was graded and subsequently exported. El Obeid, in Gofidan province, was, and still is, the major domestic market centre in the Sudan since the 1920s. Although the introduction of a relatively structured gum arabic marketing system was part of the government policy to increase tax revenues for colonial administration, the system remained more or less intact for the 40 years that followed. Later in 1962, the government started intervening by fixing the floor prices of the commodity at public auctions; at the same time, the Gum Traders Association, composing of gum arabic exporters, was formed with the function of buying and storing what was left unbought by individual traders at auction prices. In October 1969, the Gum Arabic Company Ltd. (GAC) was established with a statutory monopoly over all gum arabic export trade in the country. The company, a parastatal entity, commenced with a registered capital of about one million Sudanese pounds; the government held a controlling interest while the rest of the shares were left free to be bought by private trading firms and by the public in general. However, the auction system, a legacy of the colonial past, remains relatively unchanged and in effective force up to the present day. The two major objectives of GAC are (a) to encourage gum arabic collection by adopting a guaranteed minimum price policy towards domestic gum producers and (b) to maximise the country’s benefits from the export of this commodity. The company is authorised to announce an export price at the beginning and during the gum collection season, and also to supervise a minimum floor price at local auction markets. The domestic wholesale dealers carry the responsibility of cleaning, grading and packing their gum merchandise according to certain specifications, and then transport it to Port Sudan to be sold to the GAC - the sole authorised exporter from the country. In later years, the government, in its attempts to simplify the marketing structure, decided that gum arabic be sold only on two grades, viz., cleaned and hand picked.

During the period 1960–67, the average annual gum arabic production in the Sudan was in the range of 50,000 tons; and the minimum producer price at El Obeid auction market during those years remained at an average of 64 Sudanese pounds per ton, which was about 45–55 per cent of the export price (f.o.b.). Throughout the 1960s, gum arabic was one of the country’s main export crop, accounting for an average of US$ 50 million annually, or about 10 per cent of the total foreign exchange earnings. Those were the years when, due to low producer prices of gum, the trees were least tapped, and the pressure on the acacia tree stock for domestic uses was most intense. In other words, peasant households were better off cutting the trees to sell as firewood and charcoal than tapping them for gum harvest. Thus, deforestation ensued, not because of some irrational behaviour on the part of the peasants, but because of the need to maintain a minimum level of household consumption. Ironically, deforestation was the “optimal” choice for the rural households in the gum belt. In the face of diminishing tree stock, the quality of the resource base tended to decline considerably losing its resiliency after periods of drought that were to appear during the later years. However, when in 1969 the government monopolised the export trade of this primary commodity, the minimum producer price was raised to 100 Sudanese pounds per ton, which was an increase of more than 56 per cent. The primary aim of the price increase was not only to provide an incentive for gum arabic collection and marketing, but, also to arrest the deforestation of the Acacia senegal by raising its value as a producer of gum arabic relative to its value for other purposes. Unfortunately, during the early 1970s, the Sahel zone was hit by a disastrous drought which robbed much of its natural vegetation and which brought about a sharp decline in the supply of gum arabic. And in the middle of drought in 1973, the GAC, in line with its previous policy, drastically raised the producer price of gum arabic from 103 to 185 Sudanese pounds per ton; this price was further increased to 340 pounds per ton during the 1974 season. Thus, the producer price rose by more than 300 per cent in nominal terms in just over two years’ time; in real terms, this was equivalent to an increase of approximately 130 per cent using the Sudan Consumer Price Index of 1970 as a base year.

In Nigeria, domestic gum arabic marketing is presently conducted only by private enterprises; the gum collected by peasant farmers is sold to local merchants who, after cleaning it, in turn sell it to a few major exporting companies in the main cities. In the ex-French colonies, on the other hand, the marketing organisation differs from country to country, but the general tendency is towards government supervision and control. (Beshai, 1984: 373–76; Adamson & Bell, 1974: 17–18; Larson & Bromley, 1991: 1290).
INTERNATIONAL MARKETING STRUCTURE

As stated earlier, the Sudan presently holds an uncontestably dominant position in the supply of gum arabic to the world market. On its establishment in 1969, the GAC adopted a policy of setting fixed export prices of gum arabic at which the government was willing to sell to anyone provided the purchase orders were more than ten tons. Ever since then, Gordafan clean-gum price quotations remained the norm for all dealing in the international gum arabic markets. Up to the end of 1960s, the export price of this grade was relatively stable, i.e., in the range of US$ 500–600 per ton. During the 1960s, an average of 55,000–66,000 tons of gum arabic was annually traded in the international markets, the major importers being the European Community, the United States, The Scandinavian countries, and Japan. Together these four market areas accounted for approximately 83 per cent of the world market, with Sudan as the major exporter accounting for 80–85 per cent of the total trade. India and Australia are also significant importers of the commodity. However, the severe drought in the Sahel zone that started in 1972, and persisted until 1975, changed both the supply and demand structure of gum arabic.

Prior to the creation of the GAC, gum arabic trade in the importing countries was largely handled by companies acting as middlemen between the sellers and the buyers. Later with the “minimum ten-tons” sales policy of the GAC, end-users of gum arabic were encouraged to buy directly from the Sudan, thus avoiding the service cost charged by the importing middlemen. Nonetheless, though most of these importing broker-companies were largely made redundant, some still retained their business with regard to small-scale end-users of unprocessed or processed gum arabic. Firms using a few tons of gum arabic a year were willing to pay a premium to merchant processors instead of investing in costly pulverising mills. The demand for processed gum arabic depends very much on the use to which it is ultimately put. For instance, the dry powder form of gum for use in pharmaceutical and food industries must conform to strict standard specifications, and so only the hand-picked selected grade is demanded. Powdered gum arabic dissolves almost immediately, while lumps of gum can take up to 24 hours to dissolve in cold water. The coarse granulated form (kibbled gum), on the other hand, is demanded by industries where speedy gum dissolution is either undesirable or of no significant importance. (Adamson & Bell, 1974: 20, 35–37).

In 1972, the Sudanese government, desperately in need of foreign exchange, dramatically increased the c.i.f. export price of cleaned gum arabic from US$ 600 to US$ 3,000 per ton. With drought still in place in 1974, gum arabic supply was virtually unobtainable; and as a result, the GAC, in its attempts to exploit its dominant position, quoted the c.i.f. prices of cleaned gum in excess of US$ 4,000 per ton. Initially, the international demand, being price inelastic, remained stable. However, this spectacular price hike, later, became the major cause for the decline of gum arabic demand in the world market, and eventually led to the development of a variety of artificial (chemical) substitutes. In the United States alone, a level of annual demand of about 13,500 tons in 1971 fell to a bare 2,700 tons in 1975; similarly, the Japanese demand declined from 3,560 tons to 1,600 tons for the same years. By the beginning of 1975, the GAC brought down the export price of cleaned gum, first to US$ 2,100 and then to US $1,200 (f.o.b.) per ton - a price level which was maintained up to 1978. The Sudanese gum arabic production remained at 43,000 tons in 1975; this was largely due to the steady increases in producer prices made by the GAC, i.e. from 165 to 840 Sudanese pound per ton of gum arabic in 1969 and 1975 respectively. The demand for gum arabic in the world market, nonetheless, kept on shrinking, causing the Sudanese gum exports to drop from 39,000 tons in 1971 to 16,000 tons in 1975; in other words, by the end of 1975, the Sudan had an unsold stock of about 27,000 tons of gum arabic in its inventories. (Adamson & Bell, 1975: 75, 80; Larson & Bromley, 1991: 1294–95; Pearce et. al., 1990: 132).

The drought-induced supply shortage of gum arabic accompanied by artificially high export prices set by the GAC instigated a search for and the use of a wide range of other substitutes; but, more important was the impact of high prices of gum arabic on the rate of deforestation of the Acacia senegal stands. High domestic prices of gum arabic was originally designed not only to provide the required stimulus for increased gum collection, but also to slow down the rate of use (deforestation) of the tree stock for other purposes. The rise in producer prices had indeed resulted in an increase in the total marketed gum arabic output; however, by the end of the 1980s, about 80 per cent of the natural stands were estimated to have been destroyed by drought in west Africa. Although the extent of deforestation in the Sudan is not documented, the decline of the natural Acacia senegal tree stock was reported to have been considerable. Furthermore, in the Sudan, the depletion of this particular tree species by the effects of drought was accentuated by two additional factors. First, in
response to increased price incentives, trees were overtapped and killed in the process; this is an example of a market-oriented incentive culminating in environmentally destructive activities. The second factor responsible for the increased deforestation of the *Acacia senegal* was related to the composite economic concepts of time preference and of expectations of the gum harvesters. For many years prior to the establishment of the GAC, the nominal producer prices of gum arabic had been kept extremely low; hence, the drastic price increases that occurred in 1973 and 1974 were presumably viewed by the gum collectors as temporary phenomena and, therefore, untenable. In other words, future gum prices were generally expected to show a declining trend, which implied that the value of the *Acacia senegal* has not fundamentally changed. Hence the effect of price increases tended to create a strong incentive to intensify gum arabic collection for short-run returns. This resulted in excessive tapping for gum arabic and frustrated the incentive to plant new *Acacia senegal* trees whose gestation period, as stated above, is in the order of five years. And, thus, the GAC, pressed by the threat of substitutes and deforestation, begun to contemplate adopting a market-clearing export price level of gum arabic. (Larson & Bromley, 1991: 1294; Pearce, et. al, 1990: 132.).

Although the price gum arabic was made to stabilise by mid-1970s, due to sunk cost involved in the production of substitutes, importers were initially cautious about reverting to the natural commodity. In 1978, the GAC offered about 250 Sudanese pounds per ton of gum arabic to producers and, thus, secured a total output of about 28,500 tons; the total gum export during that year, however, rose to 35,000 tons, indicating that the GAC was selling out its stock reserves. In 1979, the GAC export volume grew to 43,500 tons. The producer price offered by the company in 1981 increased again to 422 Sudanese pound per ton; although the price increase stimulated an output of 40,000 tons during that season, the volume of exports showed a fall back to the level of 1978, i.e., 35,000 tons. Such a decline in the export volume of gum arabic was primarily a reflection of the market share lost to a wide variety of synthetic and modified-starch substitutes. Gum arabic begun to regain its market share after 1981; by that time, however, the structure of international markets had already changed, with continued improvements of substitute products retaining a portion of the market even after the GAC lowered its export price quotations. In 1983, Sudanese gum arabic exports stood at 38,000 tons generating an inflow of about US$ 57 million into the country; this accounted for approximately 8 per cent of the total national export earnings. However, as a result of the severe drought that hit the Sahelian region during the 1983/84 season, gum production in the Sudan for the year 1985 dropped to a record low of 10,000 tons. During that year, the Sudanese government, in its attempts to upgrade its general export performance, devalued its currency. Subsequently, the country's gum export earnings registered 66 million Sudanese pounds; but due to the depreciated domestic currency, this amount meant only US$ 28.8 million, i.e., 7.9 per cent of the total foreign exchange earnings. However, in 1989 about 313 million Sudanese pounds were generated from gum arabic exports, which at that time, was equivalent to US$ 63.9 million; this implied a share of more than 10 per cent in the total national export earnings. This sharp rise in gum arabic export earning was attributed mainly to two major reasons: (a) the relatively high producer price that prevailed during that season, i.e., 890 (US$ 182) Sudanese pounds per ton, and (b) the comparatively low export price quoted by the GAC, i.e., US$ 252 per ton. In other words, gum producers in the Sudan received about 72 per cent of the international export prices - an incentive that ostensibly boosted the domestic gum output. Of more significant interest is, however, the fact that such a high level of foreign exchange earning form the sale of gum arabic occurred in spite of the devaluation of the domestic currency from 0.9 to 4.9 Sudanese pound to the dollar between 1982 and 1989 respectively. One additional reason for the success of the Sudanese government to secure a relatively high gum arabic export earnings in 1989 was partially related to the shadow of doubt cast on the desirability of synthetic substitutes as additives in food and pharmaceutical products. During the late 1980s, synthetic substitutes for gum, previously approved in haste, were questioned mainly on grounds of health and taste. Hence, food and pharmaceutical industries were increasingly dismayed from artificial substitutes and tended to prefer natural gum arabic as long as the “price was right”. Furthermore, the gum arabic market expanded as additional uses of the commodity were progressively discovered during the course of years. (EIU/QER, 1971–89; Africa Development Indicators, UNDP/World Bank: 219).

In 1990 the Sudan succeeded in increasing its total gum arabic output to 40,000 tons, but export statistics are not available to the writer. And the two years that followed, the country is reported to have slowly gained its previous dominant world market share, thereby, steadily increasing its revenue from, the export of this particular primary commodity. The demand for gum arabic in the
world market is nowadays still facing considerable threat from industrial substitutes, but its prospects as a foreign exchange earner is largely unaffected both in terms of quantity marketed and in price trends. The GAC's policy of holding buffer stock in order to stabilise the variability of gum arabic supply has, by and large been successful; but, the company was clearly unable to withstand the impact of the shock brought about by the 1984/85 drought.

Although a rise in producer price leads to increased tree tapping and gum arabic collection, the use of domestic market incentives require a thorough knowledge of the producers expectations and time preferences in regard to the use of *Acacia senegal* as an economic resource. Experiences from the Sudan have demonstrated that gum arabic domestic pricing policies often tend to mask serious environment-poverty trap. Similarly, identifying the optimum price at which importers show their loyalty to gum arabic is an even more complex issue. During the mid-1980s, it was reported (Beshai, 1984: 380) that the price elasticity of demand for gum arabic was low, while the elasticity of supply was high; but, such a conclusion obviously requires a re-assessment in light of later development of domestic and foreign markets of the commodity. One can, therefore, state that the present and future value of the tree, as reflected in the level and trend of the prices of gum arabic, both domestic and international, are the ultimate determinants of the manner and degree of exploitation of this robust camel-plant of the Sahelian zone. In most of the western parts of the Sahel zone, the acacia stock is reported to have been depleted in favour of agricultural land for more attractive cash crops like peanuts and sesame. Hence, at present time, the supply of gum arabic to the world market exclusively depends on the actual and potential production capacity of the region that encompasses northern Sudan, a large part of Eritrea, northern Ethiopia, and some areas of Djibouti and Somalia. However, the Sudan will, without doubt remain *par excellence*, the leading world producer and supplier of the commodity for a long time to come. Yet, one word of caution is in order; though the efforts made by the Sudanese GAC to regain some of the market lost to substitutes were commendable, delinquent pricing policies, as manifested during the 1970s, may, if repeated, prove to be detrimental to the development of *Acacia senegal* both for its environmental value and for the alternative income generating activities that it provides to the inhabitants of the region. (Pearce, et al., 1990: 133-35; EIU/QER: Country Profile - Sudan, 1991-92: 31; Larson & Bromley, 1991: 1294-96; Webb, 1985: 168).

ACACIA SENEGAL IN ERITREA

**General Features**

Comprehensive and detailed description of the physical and climatic features of Eritrea is almost non-existent; nonetheless, a short overview is in order, mostly based on the writer's extensive travels in western parts of the country during the mid-1970s.

The central plateau in Eritrea is the northern extension of the high massifs of central Ethiopia; it starts from the relatively elevated land mass around Mt. Soira in Akele-Ghuzai province, covering a large part of Hamasisen and Senhit provinces, extending through the rugged and deeply dissected terrain of the Sahel province, and stretching all the way north to Alghena mountain chain at the border with the Sudan. This mountainous ridge provides a natural dividing line between and a water shed for the western and eastern lowlands of the country. It is high enough to capture rains from the moisture-laden north-east trade winds blowing from the Arabian peninsula across the Red Sea into Eritrea. The rains usually occur during June, July and August and are extremely unreliable, varying between 300 mm and 800 mm annually. The type of vegetation in this highland area also varies considerably from locality to locality, though in the drier parts, acacia trees and shrubs accompanied by short and sparse grasses are the predominant growth. The relatively high concentration of population exerts intense pressure on the arable land, with overgrazing adding more to the problem. In some parts, the soil depth, being less than 10 cm., is too shallow to support meaningful agricultural activities, while in others it is simply eroded down to the bare rock. Devastating drought which occurred in 1972/73, 1984/85 and 1989/90 agricultural seasons have brought about a considerable reduction in the total amount of plant biomass in highland Eritrea. This decrease in vegetative cover, which often leads to high water run-off, was followed by the torrential rains which appeared in 1991 and 1992. Undoubtedly, the subsequent acceleration of soil erosion was extensive, though data to assess the exact extent of its impact is not
available; however, in 1992, the massive floods of silt-laden waters that swept down the eastern escarpment into the Red Sea, thus causing considerable infrastructural damage to the country's main port, Mitzuwa, is no small indicator.

Along the escarpment facing the Red Sea, there exist two separate stretches of small microclimate areas where Mediterranean type of vegetation growth is exhibited in marked contrast to their surroundings. These areas, known in Tigrigna as the northern and southern "Bahris", are characterised by relatively dense and luxuriant growth of bush, forest trees and grassy vegetative cover all the year round. Other tiny micro-climates of different nature are also numerous in lowland Eritrea, often located in sheltered valleys where dense dry forest flora of great richness still persist. On the plains adjoining the escarpment, the prominent natural vegetation is grass, short shrubs, and flat-topped thorny acacia trees. In these low plains, the dry season is long, and both rainfall and vegetation decrease rapidly as one proceeds eastwards to the coastal desert belt. The coastal plains of Semhar and Sahel provinces, and almost the entire province of Danakil constitute part of the Sahara desert, having an annual average rainfall below 260 mm. The scanty rains fall in thunder showers during the hottest parts of the year. Due to clear skies and virtual absence of vegetative cover, the area is subject to quick heating and quick radiation; as a result, the range of temperature, especially between day and night, is considerable.

Excluding the narrow coastal desert corridor, the flat plains of Sahel province fall under semi-desert vegetation regime, which assumes a variety of forms. But, it is mainly characterised by the predominance of shrubs and tufty annual grasses with trees occurring sporadically, either scattered or in clumps; where the rainfall is scanty, the soil is mostly bare, with the only vegetation consisting of scattered acacia stands and succulents, i.e. fleshy water-storing plants such as cacti. Intermittent, sometimes persistent, periods of drought, which coincide with the cool season, is a distinguishing feature of the area. For the greater part of the year, the vegetation, mostly grey or brown in colour, looks all but dead; after the rains, the grasses burst forth into new growth and hurry through their often short life-cycle. With decreasing rainfall and a lengthening of dry period, this semi-desert ecology gradually merges into the desolate coastal desert sands.

The whole of Barka and Senhit provinces, including the western and southern parts of Serae provinces, e.g. the vicinity of Dembelas, essentially depict typical savannah ecology akin to the rest of the Sahelian zone (not to be confused with the Sahel province of Eritrea). The savannah vegetation is rather dense in the southern parts of Barka province, notably around the Setit and Ghash river basins where relatively tall grasses, palm trees ("arkokobai") along with a variety of umbrella-shaped acacia species occur in an open park-like growth. In this area, though the Acacia senegal stands are relatively scarce, the climate, is not particularly hostile to the growth and development of the specie. Further north along and around the Anseba and Barka river basins, the scenario of natural vegetation basically remains unchanged, but with Acacia senegal gaining increased dominance. As one moves up the gentle slopes of Senhit province, the savannah grassland becomes sparse, and Acacia senegal manifests a prominent exposure, often in rather dense growth pattern.

Project/Program Idea

Much has been written about the Sahel zone in regard to issues related to "invading deserts", "plant specie extinction", "natural resource degradation", "ecological stability", "development sustainability" etc. The field is vast and well trodden; and hence, in the following short paragraphs, such concepts can only be partially borrowed in an attempt to present a brief assessment of the contribution of Acacia senegal to the ecology and economy of Eritrea. Eritrea is a newly independent African sovereign state struggling to emerge from the impasse of a devastated economy resulting from a 30-year war against two successive Ethiopian regimes. Its natural resource base has been exposed to a prolonged and severe process of degradation to such an extent that, in some areas, the threshold of resilience has long been crossed and the state of irreversibility set in. No estimate exists on the amount of fertile soil annually being washed away by more than 15 ephemeral rapids swiftly flowing down the eastern escarpment and into the Red Sea; neither do we have any assessment of the extent of soil erosion associated with the drainage system in the western lowlands, nor of any wind blown erosion. But, we have proxy indicators. As mentioned above, droughts, over-cultivation, over-grazing, forest clear-cutting has caused mass vegetative destruction, increased water run-off, and thus, intensified the process of soil erosion. In highland
Eritrea, the surface of basalt plateau has been subjected, for decades, to intense soil erosion that, in some areas, only the bare hard rock mass stand out. The amount of top soil eroded by the seasonal rapids in the eastern escarpment and silted in the coastal plains of Semhar and Sahel provinces (Shiib, Ghedged, Abarara, Mersa-Tecklai, Mersa-Ghulbub, etc.) bear a glaring witness to the severity of the problem. But, above all, the vast amount of water-born fertile soils annually discharged by Barka-Anseba rivers and accumulated at their inland drainage in the region of Tokar in the Sudan is a standing reminder of the urgency of soil erosion currently occurring in Eritrea.

During the later years of the war of independence, the Eritrean Popular Liberation Front (EPLF) made modest beginnings of soil and water conservation and afforestation programs in areas under its control. These activities gained momentum after the de facto independence of the country in 1991, with the government's short- and long-term commitment to national food security goals receiving due attention at strategic level. The program is currently in operation, supported by meagre international funds, and based on the principle of voluntary participation of farmers' committees in all stages of planning and implementation. Construction of terraces, dams, earth-bunds, and afforestation activities are presently being undertaken by farmers' associations and members of the Eritrean Liberation Army. Of particular concern to the government are (a) the agricultural areas in the central highlands (b) the escarpment descending sharply towards the coastal plains of Semhar and Sahel provinces and which stretches for more than 500 km. parallel to the Red Sea, and (c) the catchment areas of the rivers of Anseba-Barka, Mereb/Ghash, and Hadas-Alighide.

Currently the Eritrean government appears to be conscious of the need to be prudent in its attempts to maintain a balance between achieving self-sufficiency in food production and engaging in extensive rehabilitation of the agricultural resource base. Such a bi-focal strategy, obviously requires considerable government intervention, since in private sector economy, exploitation of natural resources is undertaken within the context of individual short-term benefits, while environmental impact tends to be in the long-run. However, the government, infant as it is, stands limited by lack of adequate funds required to launch a large-scale public investment program in this line of national activity. It is, therefore, self-evident for the Eritrean government to look into the possibility of rehabilitating the sturdy Acacia senegal tree both for its lucrative export crop (gum arabic) and for its value as soil stabiliser as well as a source of firewood.

This paper, therefore, proposes the creation of a national program for the rehabilitation and development of Acacia senegal tree in Eritrea with the aim of increasing (1) income of rural residents from gum arabic sales (2) government tax revenues from domestic gum arabic transactions (3) foreign exchange earnings from the export of gum arabic, (4) soil stability and pasture growth, and (5) source of firewood. The program would, obviously, have two major components.

The first component of the program is related to the benefits to be gained from a planned management of the Acacia senegal tree stock. It is highly recommended that the existing national afforestation program in Eritrea include the planting of this particular tree species in ecological zones favourable for its growth and development. At the same time, efforts should be made to incorporate the tree species as an integral part of the sedentary agricultural production system in the "arid zone" of Eritrea. As mentioned earlier, Acacia senegal finds favourable climate in most areas of lowland Eritrea, but its growth is more rampant in the western and southern parts of Sahel, the eastern parts of Barka, and almost the whole of Senhit provinces. The exact ecological boundaries for the implementation of the proposed program could be demarcated later during project/program formulation stage. It would, however, seem more feasible to commence with small-scale pilot projects in specific areas already demonstrating high potential for a favourable growth and development of Acacia senegal. If that approach be adopted, then Senhit province followed by the eastern parts of Barka province would provide the ideal starting point for the whole program; tentatively, five related reasons can be presented in favour of giving priority to this area: (a) the present Acacia senegal stands are relatively dense in this surroundings, (b) the climate is amiable to the tree species, (c) the existing transport infrastructure in the area is better in comparison with that available in the rest of lowland Eritrea, (d) there already exist a reasonable past experience of gum arabic collection and trade in some parts of the area, and (e) the area embraces two provincial towns connected by an all-weather road, i.e. Agordet (Barka province) and Keren (Senhit province), and lies close to the town of Afaabet (Sahel) and Asmara, the capital city. These pilot projects would serve as testing grounds for innovative ideas, and for gaining field experience which could be replicated elsewhere as the program expands to cover wider geographical scope. The main components of these projects would include (a) an Acacia senegal trial plots and research centre (b) numerous Acacia senegal seedling production beds, (c) an effective seedling distribution network, (d)
several planting demonstration fields, and (e) an extension service designed to stimulate the planting of the tree species on terrace edges to enhance soil stability, and around crop fields as a source of gum arabic and firewood. In addition, these pilot projects could become the source of regular supply of *Acacia senegal* seedlings required in the country's general afforestation program covering wider and open landscape.

The second aspect of the proposed program for the rehabilitation and development of *Acacia senegal* would deal with the creation of domestic market infrastructure for gum arabic, and with the entrance of Eritrea into the world market as a major supplier of this commodity. In this field of activity the experience of the Sudan is extremely instructive. Gum arabic collecting, grading and exporting is not new in Eritrea; it has been in place, albeit modestly, since the 1960s, with towns of Keren and Asmara acting as centres for sorting cleaning and warehousing. Generally speaking, *Acacia senegal* trees in Eritrea grow in inaccessible areas where shortage of potable water is often acute during a large part of the year, and where settled agricultural communities are either small and far apart or altogether non-existent. This is the single most pressing hindrance to wild gum arabic collection and marketing. Clearly, structural constraints of this nature are tackled within the context of a wider government rural development plans and programs demanding substantial amounts of capital investment, particularly in relation to settlement schemes, feeder-roads construction and water development expenditure. Nonetheless, a full-scale deployment of all the required resources is not a precondition for the commencement of the program, especially in light of the fact that the rural residents effectively criss-cross most of the lowlands by camel. In regard to the promotion of gum arabic output and its domestic marketing, the program could start by (a) providing remunerative price incentives for wild gum collectors (b) creating the basic marketing infrastructure, viz., a chain of storehouses, weighing facilities, sacks, and other gum arabic handling equipment, (c) facilitate transport services from village gum arabic market places to central warehouses (d) establishing new warehouses and facilities for sorting and grading of gum arabic in provincial towns nearest to the production areas; the existing ones could also be expanded, and (e) creating a strong national agency responsible for gum arabic marketing and export, probably similar to the GAC in the Sudan. The legal status and detailed functions of the proposed central agency could be specified during project/program formulation stage; four approaches can, however, be cited. The first option is to completely leave the domestic marketing and export of gum arabic in private hands, with one ordinary business firm licensed to conduct export activities on monopoly basis. Second, the proposed agency could be established as a public corporation, similar to the GAC in the Sudan, but, with the Eritrean government holding a controlling share. Third, it could be organised as a self-financing autonomous or semi-autonomous government agency, falling under the general jurisdiction of some appropriate ministry. Fourth, it could appear as an ordinary department in one of the government ministries. And finally, an independent statutory authority in charge of directing and managing domestic and foreign marketing of gum arabic could be created submitting its revenues to, and drawing its annual budget from, the national treasury.

Recorded experience of gum arabic collecting, marketing and export prior to the country's independence, presumably still available in the government archives, would be the ideal point of departure for the preparation of a project/program identification document; this document, which would essentially deal with feasibility analysis, should eventually lead to the formulation of detailed plans and a strategy for implementing the proposed program. Possibilities of securing international bilateral development aid and multilateral sources of funds and technical assistance, including the UNSO, should be carefully considered. A Program of this nature, if properly formulated, would no doubt attract favourable attention by the World Bank whose loan policy to underdeveloped countries has, for long, been dominated by the encouragement of cash crop production for export.
BIBLIOGRAPHY


