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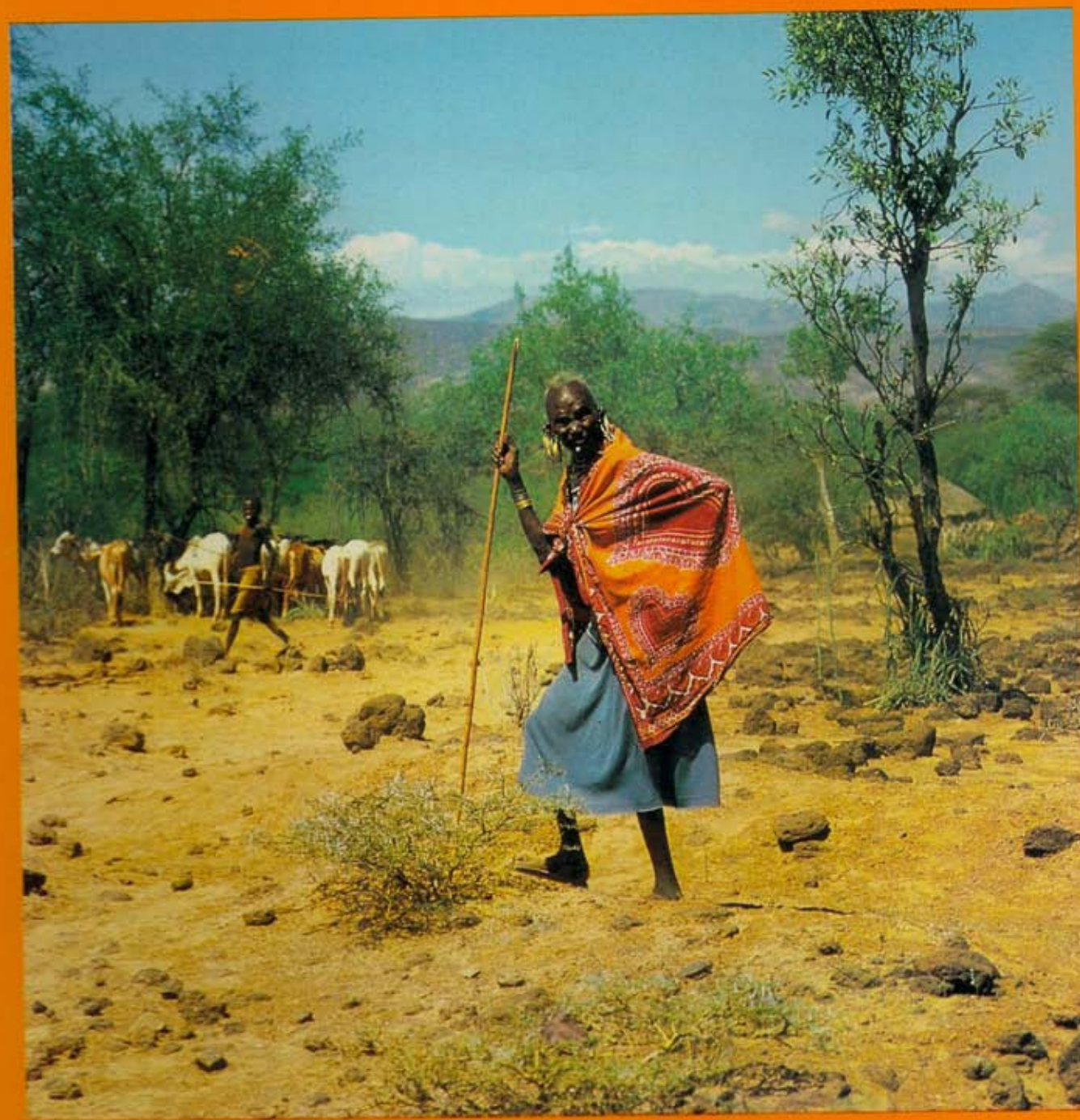


Arid Land Plants for Economic Development and Desertification Control

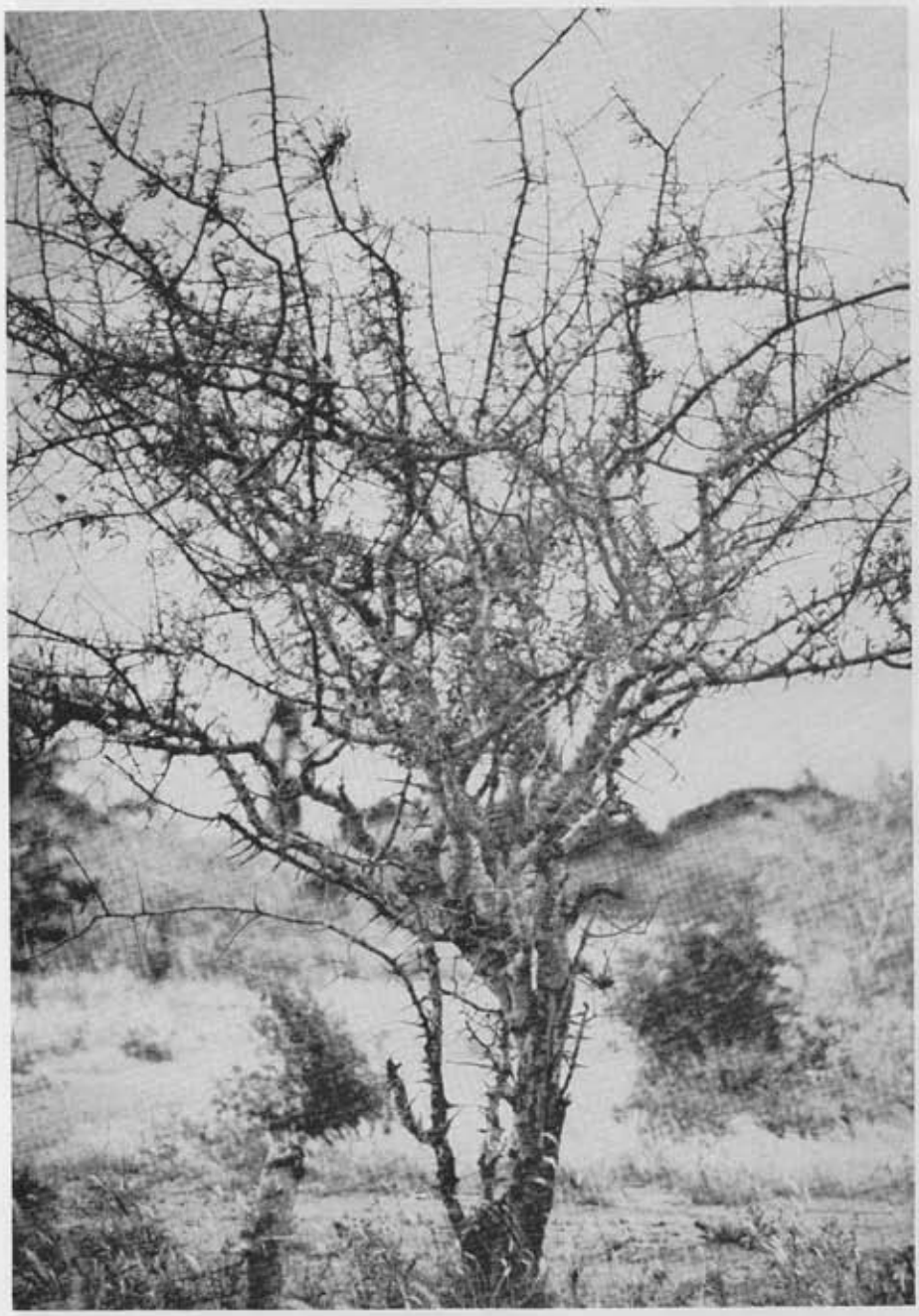
by
Daniel Stiles, Ph.D.
Desertification Control PAC
UNEP, Nairobi, Kenya.

Introduction

One third of Africa is desert. Another third is semi-arid and arid. One of the most intractible problems facing African governments and donor aid agencies has been how to make this land productive, able to support people and contribute to national economies. The current trend is for this land to decrease in productivity and eventually be abandoned through a process called desertification. With rising population growth and shrinking land resources, the prognosis for Africa is not good.

Vast areas that used to be vegetated by dryland *Acacia-Commiphora* bush in the Sudano-Sahelian region — and longer ago in the past in what is today the Sahara — have been and are being degraded by the actions of man, aided by drought. The weak soils are blown and washed away due to poor land management and population pressures, leaving desert. This trend must stop and be reversed.

It is possible that thornbush country previously thought almost worthless could in fact be natural resource gold mines. The *Acacia, Commiphora, Boswellia, Sterculia* and many other trees and shrubs in these drylands produce gums, resins, oils and other extracts that are currently in demand in many of today's industries. There is great potential to develop more products that would make use of these renewable resources. The benefits to Africa could be enormous: the creation of employment and new industries, foreign exchange earnings and land conservation and rehabilitation.



Boswellia, *a prickly dryland tree, produces the valuable frankincense (olibanum). (UNEP/Daniel Stiles)*

Ten thousand years ago in Africa a massive area stretching from approximately 20 N. down to about 12 N. in the west and running through the Horn and down into southern Africa in the east was made up of *Acacia-Commiphora* bushland. Early explorers and African oral traditions refer to these forests as recently as 100 years ago in areas of the Sahel that today are desert. Parts of eastern Africa show today what much of this *Acacia-Commiphora* zone stretching more than 5000 km. across Africa must have looked like in the past. In Kenya it is called *nyika* and is considered by most as almost useless bushland, used today by nomadic pastoralists and, as population pressures mount, by marginal farmers. This type of bush, and less dense versions of it in the north of the country, occupy some 70% of Kenya's land surface. Although much

reduced in extent, this bushland and remnants of it still cover some 15 million sq. km. of Africa, about 50% of the continent.

Many of the indigenous tree and shrub species of this vegetation type hold known or potential promise as producers of economically valuable products, principally resins, gums, oils and extracts. Gum arabic, frankincense, myrrh, henna and aloe are some of the better known of these, but an even greater potential lies in developments to be made through research in the pharmaceutical, fragrance and flavour, food technology, epoxy resin/plastics and industrial coatings industries. These are each multi-billion dollar industries which make use of, and are constantly searching for, natural products from trees and shrubs.

The *nyika* of eastern Africa is going in the same way that it did in the Sudano-Sahelian region in previous centuries. Senegal, Mali, Burkina Faso, Niger, Chad, etc. only have sparse remnants of this vegetation left, most of it having been destroyed for use as firewood, charcoal, livestock enclosures, building materials and intentionally cleared off to make way for grazingland or cultivation. This type of vegetation usually develops under an average annual rainfall regime of between 100 to 600 mm (4 to 24 in.) and under high temperatures, thus the soils associated with it are generally not well developed. When the trees are destroyed and the ground cover removed by overgrazing or cultivation, the fragile soils are very susceptible to erosion by wind and water. This has happened over vast areas of the Sudano-Sahelian zone, leaving sand and more resistant surfaces (B/C horizons or bedrock) in their wake. This process, called "desertification", results in lowering productivity of the land and decreases in food production. During drought periods the process speeds up dramatically and results in famine and the environmental refugee. Land becomes desert and deserts do not produce food without high inputs.

Since populations continue to increase and people must have land to survive, what is the solution?

Kenya can serve as a test case for the possible solution which is proposed here to investigate in the study outlined here.

Strategy

The problem is twofold: (1) How to make *Acacia-Commiphora* bushland sustainably productive and capable of supporting increasing population and (2) How to halt destruction of this land and the resource base it represents?

The two problems are interrelated and require a common solution. The solution proposed here is to find out whether the trees and shrubs which grow in this ecosystem produce products which have economic value and for which a viable market exists or can be created. Except for the annual shrubs, the techniques used to extract these products are non-destructive and thus will render the bushland a renewable resource. Because of the economic value of the trees and shrubs people will cease destroying them, thus conserving the land. Plantations of the more economically valuable species can be established, preferably in agro-forestry configurations (possibly with food crops), which can rehabilitate degraded land.

The foregoing strategy can be used in conjunction with the development approach being taken today. Today, research and development for the drylands is concentrating on breeding fast growing, drought resistant food crops for rainfed agriculture, small and large scale irrigation projects for food and cash crops, the introduction of more productive livestock, subsidiary cash-earning schemes (bee-keeping, handicrafts, tanneries, poultry, etc.) and alternative sources of energy. Afforestation and agro-forestry projects are also widespread, using mainly exotics which grow faster than most indigenous species. Up to the present, a great deal of money has been spent and success has been limited, to say the least. Per capita income and food production have been decreasing in almost all African countries since 1970, particularly those with large areas of semi-arid and arid lands. Land continues to be destroyed by overexploitation. A new approach is needed.

Using Kenya as a test case, six research areas need to be addressed:

Acacia senegal, *which produces the much sought after gum arabic, could be grown in agro-forestry configurations with other trees and shrubs to create economically viable dryland agro-industries. (UNEP/Daniel Stiles)*

1. Taxonomic identification of the trees and shrubs of interest down to the subspecies/variety level and a survey of the distribution and densities of these plants, noting the environmental parameters under which they occur, i.e. soil, porosity, slope, altitude, rainfall and associated vegetation community.
2. Tapping/collecting trials of the gums and resins produced by the trees to gain estimates of yield and potential *supply* to industry. For some of the shrubs (see below), growing trials will have to be carried out and tests conducted.
3. Chemical analysis of the gums, resins and oils to assess quality and to research possible new products that can be derived from them.
4. A detailed study of potential markets for the products. This would include contacting the buyers and end-users to ascertain market volume, quality requirements, product variability to assess potential for developing agro-processing industries in-country, sources and availability of the products from elsewhere, and basically all of the *demand* information necessary to know before emarking on any economic development project.
5. Socio-economic study. There are many different ways development of these resources could be done, and probably several would occur. To ensure that this agro-industry would be properly managed studies need to be carried out to recommend how best to plan development under the different contexts. The contexts are: (i) wild bush on communal land under pastoral land-use; (ii) communal land under primarily cultivation land-use; (iii) small-holder private land; (iv) large privately owned group or individual ranches. The land tenure and land rights systems must be ascertained, along with decision-making mechanisms at the local level. These must be integrated with government policy and plans at the higher level. A study of local uses of the plants should also be carried out.
6. Growing trials eventually will need to be carried out to test how best to propogate and produce the products desired. Different spacing and species combinations will have to be tried under various conditions in different areas to develop the best agro-systems.

Sterculia, *another tree adapted to arid lands, produces a gum with great economic potential already being exploited in India. (UNEP/Daniel Stiles)*

The countries in Africa for which this study has relevance are:

Burkina Faso	Gambia	Mozambique	Somalia
Cape Verde	Kenya	Namibia	Sudan
Chad	Mali	Niger	Tanzania
Ethiopia	Mauritania	Senegal	Uganda

Trees, Shrubs and Products

Listed below are the trees and shrubs of interest at present along with their products and current or potential uses in industry.

Name	*Product*	*Use*
Acacia senegal	Gum arabic	Emulsifier/stabiliser in processed foods and beverages, ink, paper, textiles, pharmaceuticals, glues, etc.
A. mellifera	Gum	Possibly same as above
Astragalus sp.	Gum	Possibly same as gum tragacanth, processed foods (very valuable)
Boswellia sp.	Frankincense, olibanum	Incense, perfumes, food and beverage flavouring
Commiphora myrrha	Myrrh	Incense, pharmaceuticals, perfumes and flavouring
Commiphora sp.	Opopanax, opopanom	Perfumes and flavouring
Lawsonia sp.	Henna	Shampoos, soaps and cosmetics
Sterculia sp.	Gum karaya	Pharmaceuticals, paper and processed foods
Vernonia galamensis	Oil	Epoxies for adhesives, plasticizers, industrial coatings, varnishes and paints. Meets EPA regulations to replace solvents as a reactive diluent in resin systems.

*There are several species of **Commiphora** which produce resins which can be used in the flavouring and fragrance industries and which have great potential in the pharmaceuticals field. (UNEP/Daniel Stiles)*

In more detail, these plants are:

Acacia senegal — produces gum arabic, used as an emulsifier in foods, diet drinks, ink and used in textiles, paper, adhesives and paints. 80% of the world's production comes from the Sudan. Production has dropped because of desertification and demand is high. Large scale restocking programmes are underway in Sudan, Mali, Senegal and Burkina Faso, but success rates are low because of weak infrastructure and adverse governmental control. Many parts of Kenya have *A. senegal* trees. The different varieties need to be identified and tested for gum quantity and quality production. Trees in various parts of the country should be tested, and seeds planted in test plots and monitored over time. Tapping can begin at five years of age. The global market is virtually unlimited if the price is not too high, as it currently is because of shortage of supply. *A.mellifera* produces a similar gum.

Commiphora myrrha — produces the resin myrrh, used as an incense, in perfumes, a flavouring additive in soft drinks and sweets and has potential in pharmaceuticals. It is currently exported from Kenya, mainly by Somalis. The main research needed is in the field of marketing and in myrrh quality. There is also the possibility of distilling myrrh into an essential oil or a resinoid, but the potential market for these products needs to be researched.

Commiphora hortziana — produces opopanax, a "bisabol" myrrh, similar to but of lower value than true myrrh. Similar uses as myrrh. The same research needs to be conducted as with myrrh.

Commiphora sp. — There are several other species which have potential in pharmaceuticals, flavourings, etc., but research is needed.

Boswellia neglecta — produces frankincense, also known as olibanum. Used as a scenting agent in perfumes, lotions, etc. Same research needed as with myrrh.

Astragalus sp. — produces gum tragacanth, used in processed foods, of high value in today's market. The commercial tragacanth today comes from Turkey, Iran and Syria. Little is in the literature about its propagation. There are several *Astragalus* species in Kenya which should be tested for gum production. If one does contain gum, propagation trials should be made.

Sesbania sesban — produces a gum similar to guar, used in the food industry. Tests need to be conducted to see if commerciable quantities are produced from this species, and what the quality is: It has even better nitrogen-fixing properties than *A. senegal.*

Sterculia sp. — produces a gum which currently is exported in small quantities from Kenya to go into a laxative. *S. urens* gum karaya from India is used as a substitute for *A. senegal* gum arabic and gum tragacanth. It has considerable economic potential in pharmaceuticals as well.

Vernonia galamensis — produces an oil which can be used in the manufacture of polyvinyl chloride (PVC), adhesives, plasticizers, industrial coatings, varnishes and paints. The Agricultural Research Service of the U.S. Department of Agriculture has conducted tests on it and judges it to have a very high potential for Commercial exploitation. Growing trials need to be carried out on the various sub-species, followed by oil extraction and use tests.

All of the plants listed above are indigenous to Kenya. There are hundreds of thousands or millions of individuals of each species listed in the country. There are also many exotic species which would probably do well in the country, but why introduce them if the indigenous plants, already well adapted to local conditions and important for ecosystem functioning, are available and of economic value?

Conclusions

An approach to economic development briefly discussed here could have significant consequences for land use policy and planning in future in Africa. Of critical importance in the initial stages is determining what market potential exists and what the quality and quantity of product supply would be.