SHRUBS: THE FORGOTTEN RESOURCE

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Shrubs are the botanical resource without a constituency. Too tall for agriculture, too short for forestry, they fall between the disciplines. Agricultural textbooks do not discuss shrubs; forestry literature neither. Around the world institutes of agronomy and forestry research abound, but there is hardly one for shrub research. Shrubs are either too woody, too branchy, too thick, or not thick enough. And therefore they are scorned, and their potential as resources is overlooked.

However, shrubs are no less worthy than their smaller cousins the herbaceous plants or their larger ones the trees. They do not deserve neglect. It is not wise to turn our backs on shrubs merely because they do not fit into our twin pillar traditions of agronomy and forestry.

Actually, shrubs can provide many valuable resources: food for people; feed for animals; ingredients for drugs and medicines; wood for fuel; fiber for paper pulp; materials for housing, fencing, tools, and handicrafts; as well as industrial products such as rubber, resins, gums, oils, and rope. On top of that, shrubs are one of the most promising answers to the Third World's massive shortages of firewood.

Shrubs are small, many-branched trees. They are annuals or, perennials-just like other classes of plants. Many grow in the most derelict terrain. A number of them (notably legumes) fix nitrogen that aids soils and neighboring plants. They have particular promise for developing countries because shrubs are one of the most vigorous and tenacious of all life forms. Their often deep taproots and extensive lateral-root systems allow them to tolerate drought and barrenness. Without them, livestock and wildlife could not survive. This is because grasses die when the upper soil dries out, but the shrubs' deeper and more extensive root system reaches underground moisture and keeps them flourishing. "If you had to choose one life form that has the most security it would be shrubs," notes United States agronomist Charles Driver.

Shrubs have such exceptional promise that they deserve widespread international recognition and research attention. Here are some promising species to start with for food, fuel, forage, and industrial products.

FOOD

Only one world food crop is a shrub– cassava. But there are many other interesting species yet to be explored. Among them are chaya, pigeon pea, and ye-eb.

Chaya is a fast-growing Central American shrub that provides large amounts of nutritious greenery, requires little maintenance, and keeps yielding for years. Chaya plants tested in Puerto Rico outproduced all other leafy vegetables. From Mexico to Costa Rica these shrubs are often seen as attractive hedges from which the people pick their daily food.

Chaya comes in two species: *Cnidoscolus aconitifolis* is found from southern Mexico to Costa Rica; *Cnidoscolus chayamansa* is native to Mexico's Yucatan peninsula and to Belize. The young shoots and tender leaves of these shrubs are cooked and eaten like spinach. They are high in protein, calcium, iron, and vitamins. The plants are propagated from stem cuttings, which begin producing

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food in 2 or 3 months. They tolerate heavy rainfall and respond with luxurious growth. They also tolerate drought and recover well when the rain returns.

Pigeon pea is another neglected shrub that produces food-in this case a nutritious seed. It is one food-shrub that has received some research attention, but it is not nearly as well known or used as it should be.

One of the oldest of the world's food crops the pigeon pea *(Cajanus cajan)* was cultivated in ancient Egypt and has been used in Africa and Southeast Asia since prehistoric times. It is probably native to northeastern Africa but today more than 90 percent of the worls's production is in India. The crop is also very popular in the West Indies.

This woody shrub is a multipurpose crop extraordinarie. It produces food in about the same time as annual food crops –3 to 9 months– but then continues yielding for several years. Its seeds are cooked and eaten like other dry beans. In addition, its green seeds and the immature pods are eaten as fresh vegetables. Moreover, pods, husks, and foliage are fed to animals. And on top of that the shrub's stalks or side-branches provide firewood to cook the family's meals.

The living plant has uses also. It rapidly produces dense ground cover that protects soil from erosion. It is sometimes used as a windbreak and it makes a hedge that also provides food and fuel.

The pigeon pea reflects the shrubs' general propensity for vigorous and robust growth. It is one of the best nitrogen-fixing legumes and survives on lands unsuitable for other crops due to infertility. Some cultivars tolerate toxic soils that have excess salt, soluble aluminum, or manganese. Its deep roots find moisture and keep it productive when other food crops have succumbed to drought.

But it is not the most drought-tolerant food-shrub. That distinction probably goes to ye-eb.

One of the most endangered plants in the world ye-eb is a shrub that could contribute to the world's arid zones the way macadamia and cashew do to the humid zones. It produces an edible nut. Native to a semi-desert region in the Horn of Africa ye-eb *(Cordeauxia edulis)* survives where rainfall is sometimes only a meager 150-200 mm a year. A dwarfed, many-stemmed shrub, usually only about 1.6m tall, it has long root that reach deep soil moisture allowing it to remain green year-round.

Ye-eb seed is a nutritious and tasty nut with a chestnut-like flavor. Destitute peasants living in the Somali hinterland rely on it for subsistence. In season, it is a staple of the poorer nomads; during drought it is sometimes the only food plant left surviving in the parched and baking Ogaden Desert. Eaten raw or cooked the seeds have a smooth consistency and taste that one author likens to that of cashew. The are much relished, being often preferred to the usual diet of rice and dates. For arid regions they make an unusually nourishing and balanced food, containing substantial amounts of starch, sugar, protein, fat, and various minerals.

In the dry hinterland of Somalia the ye-eb once grew profusely. (In 1929 it was reported to constitute up to half the woody vegetation in many areas.) Today it is threatened with extinction because of war and over-harvesting caused by drought.

Ye-eb has only recently been grown outside its native habitat. After experiments at Kew Gardens in London, it is now growing well in trial plots in Kenya, Sudan, Yemen, and India. The plant holds the promise of providing a valuable food for local use in hot, dry areas with low uncertain rainfall and possibly for export. It may prove useful in many dry countries where irrigation is not possible, and where rainfall is too low for the cultivation of more conventional crops.

FIREWOOD

Ye-eb, pigeon pea, and chaya show that shrubs have an important role to play in providing food, but shrubs can also provide the fuel to cook food with. As is now well known, the Third World has vast shortages of firewood. However, what is only now being recognized is that the firewood crisis cannot be solved by planting trees alone. Poor people cannot afford to wait for a tree to grow, let alone the expense of plantation-grown wood. To reach the people most in need shrubs are one major answer.

The pigeon pea is an example of a shrub that already produces fuel. And there are more examples. Two are dhaincha and calliandra.

Dhaincha is a shrub that is so quick-growing it can produce firewood in only 6 months. A native of the Indian subcontinent, dhaincha *(Sesbania bispinosa,* also known as *S. aculeata)* has been distributed to parts of tropical Africa; Southeast Asia, China, and the West Indies. To researchers outside of two or three laboratories in India and Pakistan, however, it is little known.

The wood is light, but it can be produced quickly and in high yield. In northern Pakistan and in Vietnam it is used as a firewood crop. (Pakistani villagers commonly use it for evaporating water from sugar.) It matures so rapidly that two harvests a year are possible. Vietnamese farmers grow it to

fertilize rice fields and gather its stems for firewood before the rice crop is planted.

Dhaincha, too, is a multipurpose species. All parts of the plant are useful and the crop appears easy to produce on large scale with little care or investment. Its seeds contain a water-soluble gum that produces a smooth, light colored, coherent, and elastic film useful for sizing textiles and paper and for products such as the mud used in oil drilling. Also it can be used as a rotation crop to fertilize and improve soil for food crops. The living plant is used to provide windbreaks, hedges, erosion control, and shade and cover for crops. Its foliage is used to increase soil fertility, especially on saline and wet soils. It also reportedly makes good cattle fodder.

Dhaincha stems can be processed to provide a jutelike cordage fiber, useful for items such as fishing nets, gunnysacks, and sails. They have an exciting potential as a new source of paper. The fibers are very similar to those of birch, one of the best hardwoods used for pulping. In Italy, one dhaincha crop yielded 15 bone-dry tons per hectare. In the tropics, where more than one crop can be harvested each year, the annual production could be even higher.

Dhaincha is just one member of a genus of shrubby legumes that deserve much greater development. In the Cameroons, villagers plant another fast-growing *Sesbania* shrub for firewood. And more species are known in other parts of Africa and Asia.

An example of a shrub's utility as a firewood source is provided by calliandra. This leguminous species is native to Central America, and its seeds were introduced to Indonesia in 1936. In Eastern Java calliandra *(Calliandra calothyrsus)* proved so successful as a village resource that in 1970 the Indonesian State Forest Enterprise (Perum Perhutani) began planting it on a large scale as a plantation crop, so that by early 1979 about 30,000 ha were under cultivation.

This small bush is unusually quick growing and when it is cut down it sprouts so vigorously that it produces firewood on an annual basis. In Indonesia it has been cut for fuel after only a year's growth and harvested each year for the next 20 years. In many parts of Java, calliandra branches have become a favorite fuelwood. It is used for cooking as well as in small industries; for example, those making lime, tiles, or bricks.

I the 1960s government officials noted that villagers had spontaneously adopted calliandra and were cultivating it for their firewood needs. Today Javanese cultivate calliandra widely, often intercropping it with fruit trees and vegetables. The shrub has become so popular in rural areas that "Kalliandra" is now a widely used name for children.

The plant's value is dramatically exemplified by the village of Toyomarto in East Java. There, land that was once grossly denuded and erosion-pocked is now covered with calliandra forest. Today, the villagers make a good living selling the firewood, actually earning more from it that from their food crops.

Calliandra's abundant nodulation enriches the soil in which it grows, making it useful for rejuvenating worn-out agricultural land. Some formerly abandoned agricultural areas now produce good sugarcane yields following four years of calliandra cultivation.

FORAGE

During drought or flood, or other periods when grasses are unavailable shrubs often supply the only forage. For example, during the severe six-month dry season in Brazilian savannas (cerrados), cattle get as much as 60 percent of their feed from shrubs and trees. In Ghana's savannas, the precentage is thought to be higher. And it has been judged that more animals are fed from shrubs than from man-made pastures. In fact, in many locales stock raising probably would not be possible without them. During the dry season they provide green feed (leaves, flowers, and fruits), often rich in proteins, vitamins, and valuable mineral elements. Wherever these shrubs and trees are absent, animals have only poor straw from native annual grasses. This very poor feed brings on avitaminosis and mineral deficiencies that generates deadly toxemias.

One leguminous plant (that comes in both a many-branched shrub and single-trunked tree forms) is leucaena, *Leucaena leucocephala.* A native of Central America, this species has an irrepressible vigor and has been much in the news in recent years. But so far researchers have concentrated most on its use as a tree crop. Its value for feeding animals is not so well known.

Yet, in the lowland tropics forage can be produced more efficiently and economically from leucaena than from virtually anything else. Because it is a shrub leucaena produces a pasture that is a block of forage rather than a sward-like pasture. A field of leucaena is almost 2m high. Cattle are lost among the bushes, only the tops of their heads are visible. But this gives an added dimension; cattle find forage from ground level to eye level, and the production is outstanding.

Cattle relish the leaflets and young stems and often leave the bushes stripped bare. But leucaena

quickly regrows new foiage, and within 2 weeks a "bare" field can be ready for grazing once more. So resilient is the plant that pastures near Brisbane, Australia, have been browsed almost continously for about 20 years without requiring replanting.

Leucaena leaves, similar to alfalfa in digestibility, protein content, and nutritional value, are particularly palatable to dairy cows, beef cattle, water buffalo, and goats. Cattle feeding on leucaena near Brisbane gained an average of almost 1 kg of weight each day for more than 200 days. That is about twice what is normally expected from animals grazing in tropical pastures, and approaches the weight increases normally obtained only in feedlots.

For some time researchers have worried about mimosine, an uncommon amino acid that comprises about 5 percent of the protein of the leaflets, but now it is known that cattle, goats, and water buffalo in most parts of the world have stomach microbes that detoxify mimosine. Only in Australia, Papua New Guinea and perhaps a few other countries is mimosine likely to be a concern.

Leucaena's promise is for the humid tropics, but fodder shrubs find their most outstanding promise in arid lands. Here their deep roots keep them green and productive when grasses are shrivelled and desiccated. A family of shrubs with notable promise for drylands is the saltbushes.

Saltbushes (members of the genus *Atriplex)* grow throughout the world. They are highly salt tolerant, and many are perennial shrubs that remain green all year. They make useful forage in arid zones of the world. They resist low temperatures, withstand heavily textured soils, and tolerate salinity in soil or water.

Old man saltbush *(Atriplex nummularia)* is an important forage plant in arid and semiarid areas of Australia. It should be among the first to be introduced into regions with similar climate. One of the most palatable of the atriplexes, it is also highly drought resistant. It has been introduced into Israel, South Africa, North Africa, and several South American countries for testing as a forage plant; yields reportedly have been high.

Atriplexes are salt tolerant. Laboratory experiments have demonstrated that *Atriplex halimus,* for instance, will grow when irrigated with saline solution containing about as much salt as sea water. They actually excrete the salt through their leaves. This is done by forming small salt-filled bubbles on the leaf surfaces. When full, the bubbles burst, releasing the salt to the wind.

INDUSTRIAL PRODUCTS

Another shrub that has been much in the headlines is jojoba *(Simmondsia chinensis).* The seeds of this North American desert shrub contain a vegetable oil unlike any other to be found in the vegetable kingdom. It is potentially an important industrial oil with potential uses in quenching and cold-rolling of steel, in leather dressing, in lubricating high-speed machinery and precision instruments, and in the textile industry.

Already some 16,000 hectares of jojoba plantations have been established in the arid southwestern regions of the United States and plantations are springing up in Mexico, Israel, Australia, South Africa, Sudan, Argentina, Brazil, Costa Rica, and elsewhere. The crop's future is still not clear, but this is one little-known shrub that is "taking off".

A second promising North American shrub is guayule *(Parthenium argentatum).* It contains a rubber that, when purified, is virtually indistinguishable from natural rubber from the rubber tree. A potential source of exports for arid lands, it grows in poor desert soils in otherwise unused marginal areas.

The rubber is contained within cells throughout the entire guayule plant, and to obtain it the whole plant is harvested, and the rubber extracted with solvent or floatation in water. Yields of up to 12 percent (dry weight) have been obtained from wild plants and over 20 percent from improved varieties. Guayule can be planted, harvested, and processed with equipment already developed for other crops.

Guayule, jojoba, saltbushes, leucaena, calliandra, dhaincha, ye-eb, pigeon pea, and chaya are just nine examples of the exciting promise of shrubs. Others include tamarugo *(Prosopis tamarugo),* a salt-resistant, drought resistant forage of the Chilean desert; *Cassia sturtii,* an Australian shrub that is proving a valuable forage source in Israel; *Desmodium discolor,* which along with other woody *Desmodium* species are promising forages for tropical zones; sunnhemp *(Crotolaria juncea),* a nitrogen-fixing shrub of India that produces a high quality fiber for cordage or paper; vasaka *(adhatoda vasica),* a goat-proof evergreen shrub of India promising for firewood, insecticides and perhaps medicinals; and candelilla *(Euphorbia antisyphilitica),* a native of Mexican desert this leafless shrub is covered with a high-melting wax that is used to coat candies and goes into many industrial products.

Most of the world's agricultural and forestry researchers have never heard of these species. That is the tragedy of the subject of shrubs. It is a situation that must not continue.