Lesser-Known Plants of Potential Use in Agriculture and Forestry

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To help feed, clothe, and house an increasing population, to make marginal lands more productive, to meet challenging resource needs, and to reforest the devastated tropics, we need a revitalized worldwide investigation of little-known plant species. Such an effort would expand our agricultural resource base and ease our dangerous dependence on a relative handful of crops. It would build a more stable food supply for drought-stricken Africa and other parts of the Third World, and it would reclothe many of the barren lands where erosion now threatens disaster. Some plants that are now virtually unknown are likely to become mainstays of international agriculture and industry.

THESE DAYS RESEARCHERS ARE ENTHUSIASTIC ABOUT GEnetic engineering and the new products that it is likely to provide. It is right to praise the promise of this emerging technology, but enthusiasm for gene splicing must not be allowed to obscure the fact that huge numbers of nature's organisms have not yet been adequately studied or used. Some of these have a genetic makeup that is so outstanding that they should be included in the new genetic revolution, side by side with the "man-made organisms." They could help solve some of the world's most pressing resource problems.

The purpose of this article is to give a sense of the remarkable plants that still have not been exploited, as well as to highlight particular global problems where underexploited plants seem notably promising. It results from knowledge gained in a small program at the National Research Council, which for the past 15 years has been evaluating under-recognized resources that could help developing nations.

Food Crops

It might be supposed that a world short of food would be utilizing all available food crops. But that is not so. Throughout history mankind has used some 3000 plant species for food, but over the centuries the tendency has been to concentrate on fewer and fewer. Today, most of the world's food comes from a mere 20 or so species (Fig. 1). This means the vast majority of the world's edible plants have yet to be developed to their potential (*1*).

The lesser-known food crops that remain outside the fold of science have not been rejected because of any inherent inferiority. Many have been overlooked merely because they are native to the tropics, a region generally neglected because the world's research resources are concentrated in the temperate zones. In Central America, for instance, there is the pejibaye palm (*Guilielma gasipaes*), whose chestnut-like fruit contains carbohydrates, protein, oil, minerals, and vitamins in nearly perfect proportions for the human diet. It has been called "probably the most nutritionally balanced of all foods," but through neglect it remains unknown in the parts of the tropical world that are chronically malnourished (*1*).

Another unusual palm, *Jessenia polycarpa*, occurs in the rainforests of the Amazon. It bears large bunches of fruit containing an oil similar to olive oil in appearance, composition, and culinary quality. It is sold as an edible oil in Colombia, but is virtually unknown to the rest of the world. It, too, could become a major tropical crop if it were given agronomic attention (*1*). A century ago the African oil palm was about as obscure as this American oil palm is today; now it is one of the world's major resources although its oil is far inferior.

While many food crops are neglected because they are in the tropics, even more are neglected because they are scorned as "poor people's plants." Peanuts, potatoes, and many other common crops once suffered from this same discrimination. In the United States the peanut was considered to be "merely slave food" until little more than a century ago, and in the 1600's the English refused to eat potatoes because they considered them to be "Irish food." Cultural bias against peasant crops is a tragedy; the plants poor people grow are usually robust, productive, self-reliant, and useful—the very type needed to feed the hungriest parts of the planet.

A notable poor person's crop, still suffering unwarranted prejudice, is grain amaranth (*Amaranthus cruentus, A. caudatus*, and *A. hypochondriacus*). To Central and South American Indians amaranth was an important food 500 years ago. Both Aztecs and Incas revered the crop. When heated, the tiny seeds burst and take on a flavor reminiscent of popcorn. But, because Aztecs created idols out of popped amaranth and ate them in pagan ceremonies involving human sacrifice, the conquering Spaniards banned amaranth's cultivation and forced the crop into obscurity. Although this political act helped bring down the Aztec religion and culture, a few farmers in isolated mountain valleys of Mexico and South America carried on the ancient tradition of growing amaranth. In the 1970's, an Australian researcher, W. J. Downton, obtained a few amaranth seeds and learned that they have unusually high levels of both total protein and of the nutritionally essential amino acid, lysine. This amino acid is usually deficient in plant protein—including the protein in all common varieties of major cereal crops. Today, amaranth is beginning its comeback but most cereal researchers still have never heard of it (*2*).

Forgotten Crops of the Incas

A remarkable collection of poor people's crops also suffering rejection is to be found in the highlands of South America. The Indians there are among the poorest people in the Western Hemi-

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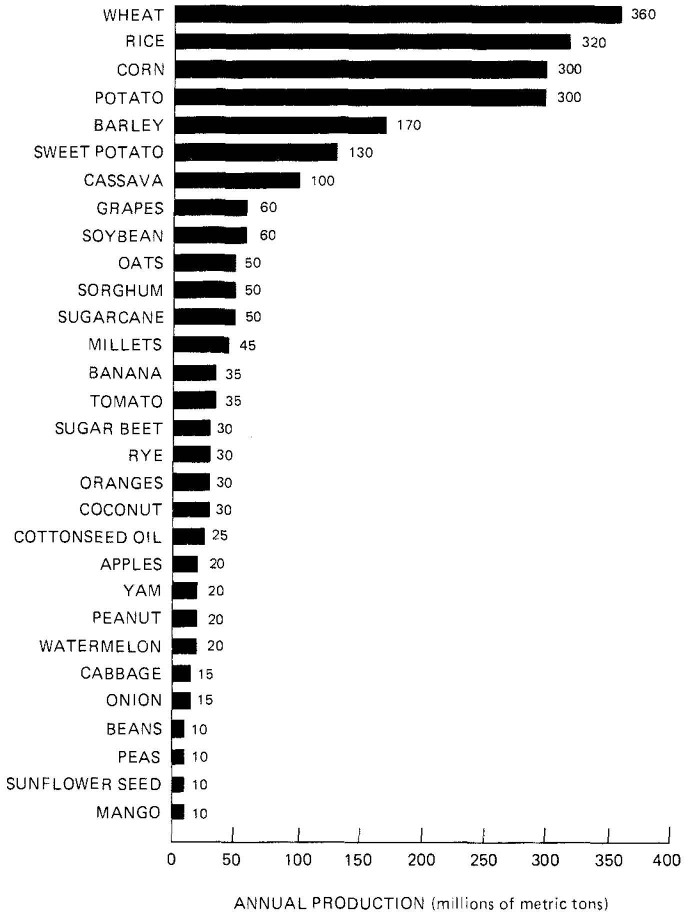

Fig. 1. Although more than 20,000 edible plants are known, and perhaps 3,000 have been used by mankind throughout history, a mere handful of crops now dominate the world's food supply. This is a dangerously small larder from which to feed a whole planet.

sphere and, except for the potato, their crops remain outside the mainstream of agronomic science.

When Francisco Pizarro and the Conquistadors invaded Peru in 1531 they initiated events that 70 years later brought the potato to Europe. However, they ignored (even scorned) several dozen other crops and these were virtually lost in the collapse of the Inca culture.

Today remnants of the Inca past remain, and among the "forgotten" crops is oca (*Oxalis tuberosa*). This exceptionally hardy plant is second only to the potato in importance as a root crop in the Andes. Its many varieties (never systematically collected) include some with a high sugar content and others with a pleasant sourish taste. Oca has become a commercial crop in New Zealand (under the misnomer "yam") and would likely sweep around the world if given modern agronomic attention (*3*).

Another Inca root, arracacha (*Arracacia xanthorrhiza*), could also follow the potato into the realm of international resources. A member of the Umbelliferae family, it is related to both carrots and celery. The plant actually looks like celery, and its stalks can be eaten in the same way. Its roots are boiled or fried as a table vegetable. They have a crisp texture and a delicate flavor combining the tastes of celery, cabbage, and roasted chestnuts. Andean peasants often grow arracacha because it is cheaper to produce than potatoes. The crop has now begun to show its potential for more widespread cultivation: in São Paulo and the other major cities of southern Brazil it has become a popular vegetable (under the name mandioquiña salsa) since its introduction at the beginning of the century (*1*).

The long lost legacy of the Incas is hardly restricted to roots. Andean peoples, like most in Latin America, depend on beans for much of their nourishment. However, at extreme altitudes water boils at too low a temperature to cook beans in a reasonable time. There, Inca farmers raised nuñas, a variety of common bean (*Phaseolus vulgaris*). Dropped into hot oil, nuñas burst out of the seed coat. The resulting food—the bean counterpart of popcorn—has a soft consistency and a flavor similar to that of roasted peanuts. Given research attention, these "popping beans" could be a new and nutritious food for the world (*4*).

Beyond roots and beans there is the grain called quinoa (*Chenopodium quinoa*) (Fig. 2). An annual, broad-leaved herb, quinoa's abundance of white or pink seeds occur in large sorghum-like clusters. The seeds, containing 12 to 19 percent protein, are one of the richest sources of protein among grain crops. Moreover, their protein, like that of amaranth, possesses an exceptionally attractive amino acid balance for human nutrition because of its high levels of lysine and methionine (*5*).

These are just four examples of more than 20 roots, legumes, grains, and fruits that are "lost crops of the Incas." Applying modern knowledge to these is an excellent way to improve the lot of the destitute descendants of that great Indian civilization. It is also a way to increase agricultural diversity throughout temperate zones because even though these plants are found at tropical latitudes, they grow on cool mountainsides and represent one of the most concentrated sources for new crops for the temperate climates.

Overlooked Legumes

Of all food plants man uses, only grasses are more important than legumes. However, while enormous resources have been expended on grasses such as rice, wheat, and maize, among the legumes only soybeans and peanuts have received much attention. Yet in developing countries, especially, the cultivation of legumes is the best and quickest way to augment the production of food proteins (*6*).

Many legume species have on their roots peppercorn-sized swellings in which bacteria convert nitrogen gas from the air into soluble compounds that the plant absorbs and utilizes. Thus, leguminous plants usually require little or no nitrogenous fertilizer, they can survive on barren sites that are nitrogen-deficient, and their residues leave the soils enriched with nitrogen.

With about 18,000 species, the legume family is one of the largest in the plant world (*6*). It contains outstanding little-known species. People seldom think of legumes as root crops, for instance, even though at least 25 leguminous roots are eaten in various parts of the world. One of them, the groundnut (*Apios americana*), was once an important Indian food over the entire eastern half of North America. The Pilgrims survived their first winters by living on the good-tasting, golf-ball–sized tubers of this viny relative of the soybean. Its swollen roots contain several times the protein of potatoes, and in preliminary trials at Louisiana State University some plants have annually yielded more than a kilogram of tubers (*7*).

This finding suggests that the 25 or more edible legume tubers are an important resource to be further explored. Other promising examples are the yam beans (*Pachyrhizus* species) of Central and South America whose large, swollen roots have been feeding people since the dawn of history. Palatable, nutritious, and productive, they also deserve scientific attention. One species, *Pachyrhizus erosus*, now appears in supermarkets across the United States under its Mexican name, jicama (*6*).

Beyond unusual legume root crops, there is a little-known poor-person's plant that is actually one of the major foods of the world. The bambara groundnut (*Voandzeia subterranea*) is grown by villagers throughout most of Africa south of the Sahara. Like peanuts it forms seeds underground. The seeds, although having less oil and protein than peanuts, are a well-balanced food with a calorific value equal to that of a high-quality grain. They also taste good, and Africans often prefer them to peanuts. The bambara groundnut can thrive in arid soils where peanuts fail, it resists pests and diseases, and, if managed well, can give high yields. Yet it has received almost no research attention (*6*).

This demonstrates that importance to people does not necessarily translate into importance to science—a fact borne out additionally by the plight of the winged bean (*Psophocarpus tetragonolobus*). An ancient peasant crop of Southeast Asia, this vigorous pole bean produces four-sided pods with wings projecting from each corner. It is an exotically shaped, succulent green vegetable that can be eaten raw, steamed, boiled, or stir-fried. Indeed, the winged bean yields so many different edible items it has been called "the supermarket on a stalk." Its flowers, tendrils, pods, leaves, seeds, and tubers are all edible. The seeds are comparable to soybeans in composition, the tuberous roots have exceptional amounts of protein, yet, like the bambara groundnut, the winged bean is not commonly included in mainstream agronomic research programs (*8*).

This is discouraging because, despite its current obscurity, such a crop could rise rapidly into prominence. A mere 50 years ago the soybean was known mainly in Japan, China, and other Asian nations. It was so unappreciated in the United States that it was not listed in our national agricultural statistics. Now it is our major oilseed and third largest crop.

Today, Japan's second most important bean, the adzuki bean (*Vigna angularis*), gets about as little recognition here as the soybean got in the 1920's. These small, reddish-colored, oblong beans have been popular in the Japanese diet for at least 1500 years. A paste made from adzuki beans and sugar goes into pastries, confections, ice cream toppings, and even into a soft drink widely sold in Japanese vending machines. Given attention, the adzuki bean might rise spectacularly like the soybean (*9*).

Many crops (including the soybean) are important commercially only because of the efforts of "crop champions," people who dedicate their talents, energies, and emotions to advancing them. With underdeveloped crops, huge advances can be made by such individuals. An example is the narrowleaf lupin (*Lupinus angustifolius*). Three decades ago this legume was a wild plant with an almost worthless seed. Its seeds look like smooth white peas and taste like the split peas used in soups. Currently they are used in rations for poultry, pigs, sheep, and cattle. However, it seems likely they will also become a significant food for humans. If so, the narrowleaf lupin will be the first major field crop domesticated for food in modern times.

This remarkable result is due to Western Australian scientist John S. Gladstones. Starting in the mid-1950's, Gladstones sorted through millions of lupin plants looking for low-alkaloid varieties with seeds that were not bitter. During a 20-year search he eventually found "sweet" types with white flowers and white seeds (useful as genetic markers because the bitter types are blue-flowered and dark-seeded), nonshattering seed heads (to hold the seed so that it does not fall wastefully onto the ground), and early maturity (so that they set seed before being shriveled by Western Australia's sporadic summer droughts). By combining all these characteristics he produced the first sweet narrowleaf lupin varieties suitable for large-scale production. Now Western Australian farmers are tending it in fields covering several hundred thousand hectares; in 1984 their production totaled 500,000 tonnes. This man-made crop is a possible forerunner of a collection of food crops belonging to the genus *Lupinus* that will one day be commercially produced in many parts of the world (*10*).

Tropical Fruits

Like legumes, tropical fruits are an enormous reservoir of plants with which important developments can be accomplished by lone individuals selecting elite types. About 3000 different fruit species are found in Africa, Asia, Latin America, the Caribbean, and the Pacific islands. Only four—bananas, pineapple, papaya, and mango—have been developed into major crops.

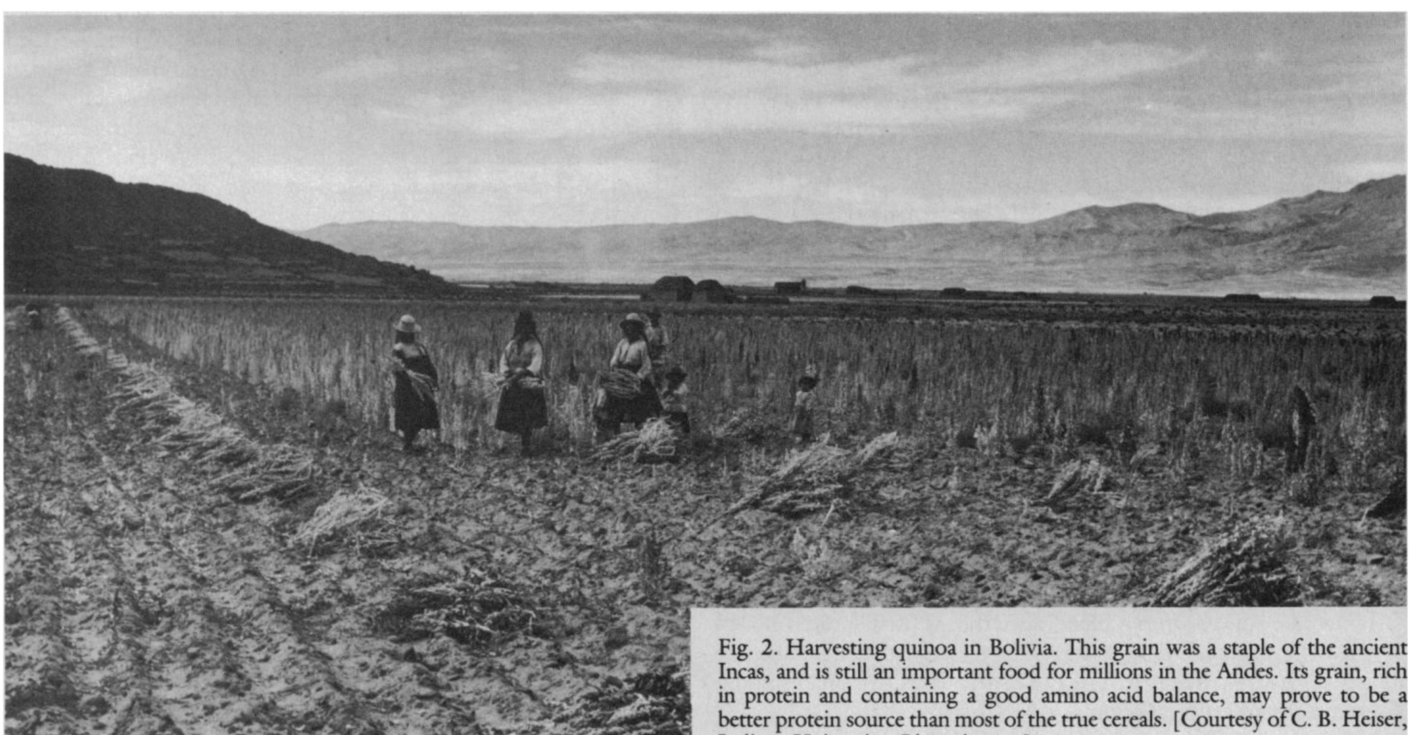

Fig. 2. Harvesting quinoa in Bolivia. This grain was a staple of the ancient Incas, and is still an important food for millions in the Andes. Its grain, rich in protein and containing a good amino acid balance, may prove to be a better protein source than most of the true cereals. [Courtesy of C. B. Heiser, Indiana University, Bloomington]

Fig. 3. Marama bean. This legume of the Kalahari Desert in southern Africa has a juicy sweet tuber and seeds that are roasted like almonds or pistachios. The seeds contain more oil than soybeans and more protein than peanuts. The plant is adapted to extremely dry areas but its domestication has not yet been attempted. [Courtesy of A. S. Wehmeyer, National Research Institute, Pretoria, South Africa]

Among the plant families to be explored is the Solanaceae—the family of the potato. Strange as it may seem to those accustomed to the potato's culinary uses, solanaceous fruits have unusual and appealing flavors and are among the most popular fruits in Latin America. Naranjilla (*Solanum quitoense*) and cocona (*Solanum topiro*) are dessert fruits with refreshing juices that are highly esteemed in Peru, Colombia, Ecuador, and Guatemala. Pepino dulce (*Solanum muricatum*), a yellowish dessert fruit with jagged purple streaks, has flesh like a melon. Tree tomato (*Cyphomandra betacea*) is a tangy, dessert fruit with a red or yellow leathery skin and a fragrant distinctive flavor. And the cape gooseberry (*Physalis peruvianum*), a yellow, marble-sized berry, comes inside a papery husk. This family lends itself to tissue culture propagation, so improvements in these unusual fruits are likely to be profound and rapid (*11*).

Another popular fruit family is the Annonaceae. Its members bear fruits that are knobbly, heart-shaped, and have soft flesh tasting like a cross between pineapple and banana or strawberry. Just the names bring a flush of pleasure to travelers who have tasted them: cherimoya (*Annona cherimola*); guanabana or soursop (*Annona muricata*); sugar apple or sweetsop (*Annona squamosa*); and atemoya or custard apple (a hybrid between cherimoya and sugar apple).

The unusual nature of tropical fruits is exemplified by the carambola (*Averrhoa carambola*), an eye-catching yellow fruit whose cross sections have the shape of five-pointed stars. Its flesh is juicy and flavored from tart to sweet, depending on variety. This fruit has the promise to be another horticultural overachiever like the kiwifruit (*Actinidia chinensis*), which in less than two decades has risen to become a standard fruit on the dinner tables of many countries.

And forgotten fruits need not be eaten just for taste thrills. Although virtually ignored by science, the plantain (*Musa X paradisiaca*) is a staple of some 350 million people worldwide. This "cooking banana," green and larger than common bananas, is a carbohydrate source, with a bland taste that is usually eaten boiled or fried. Unfortunately, it is currently threatened by a pandemic fungal disease, sigatoka, that may destroy it as a crop, bringing disaster to many tropical regions.

In reviewing why some crops are obscure while others are common, one is struck by the fickleness of crop selection. Many crops are with us only because of coincidence and serendipity. The grapefruit, for instance, is still of uncertain origin, but is probably a mutant of the pummelo (*Citrus grandis*). The pummelo is highly prized throughout Southeast Asia, and samples had been taken to the Caribbean before the grapefruit mysteriously appeared in Barbados in about 1755. Pummelo, like its apparent mutant progeny, could become an important crop if superior cultivars from Asia (the best seem to be from southern Thailand) were produced elsewhere in the lowland tropics. It is extraordinary that the probable parent of a major world crop has yet to be internationally explored (*1*).

Crops for Arid Lands

If the tropics are a neglected area, so too are the arid zones—despite the fact that drylands present the world with one of its most seemingly intractable problems. The agony of drought-stricken Africa, for instance, never appears to end. Ten years ago skeletal babies stared with lifeless brown eyes through our television screens; last year the horrifying vision was repeated; and 10 years from now it is likely to be with us again.

With 70 million mouths to feed in roadless, mostly waterless regions stretching farther than from New York to Alaska, it is clear that Africans will have to develop better ways to feed themselves—in good years and in bad. Helping them find ways to achieve this is one of the most urgent problems facing all mankind.

Part of the solution undoubtedly lies in cultivating plants that are adapted to aridity. Thus, as a start, we should gather and evaluate all the crops of the world's desert regions. The crops of the Bushmen of the Kalahari, the Aborigines of Australia, the Indians of southwestern North America, and other native peoples of such dry zones should all be given intensive trials in several parts of the world. This would create a resource base of the world's most drought-tolerant useful plants.

Among leading candidates are various species of cactus (*Opuntia* and other species). If any single plant type can stop the relentless expansion of deserts, it is these bristly, water-filled natives of the New World's drylands. Cacti produce fruits, green vegetables, forage, gum for adhesives and thickening foods, and strong fibers. Moreover, the living plants provide fences, windbreaks, food, and cover for wildlife, and they suppress erosion and stabilize sand dunes. Yet cacti are largely ignored. The literature on their economic potential is sparse, old, fragmentary, and hard to find. And some cactus crops are not minor. Mexico alone produces more tunas (fruits of the prickly pear) than twice the whole world's tonnage of apricots, papayas, strawberries, or avocados (*12*).

In the United States, there are neglected desert species that should be in that world collection—the tepary bean (*Phaseolus acutifolius*), for instance. This legume has long been grown for food by the Indians of the southwestern United States and northwestern Mexico. It has the advantage of thriving in arid and hot regions, as well as in the poorest soil. Like the plants in Arizona's famous Painted Desert, it is an "ephemeral" that matures so quickly that one desert downpour is normally enough to get it to set its flowers and mature its seeds (*6, 13*).

The desert dwellers of the dry Kalahari region of southern Africa have their candidates, too. One, the marama bean (*Tylosema esculentum* or *Bauhinia esculenta*), has good-tasting seeds with more protein than peanuts and more than twice the oil in soybeans. Moreover, below ground this legume produces a sweet-tasting tuberous root the size of a sugar beet. Like the seeds, it is eagerly sought by tribesmen in the Kalahari Desert. Despite this, marama bean cultivation has not been systematically attempted (*6*) (Fig. 3).

To help the world's deserts, we should also be gathering salt-tolerant plants (halophytes). This is because salt is increasingly devastating irrigated dryland agriculture all over the globe. Moreover, many desert regions have beneath them large aquifers of saline water that could be used to cultivate halophytes.

Among the most promising halophytes are saltbushes (members of the genus *Atriplex*). These shrubs make useful forage, resist low temperatures, withstand heavy soils, and tolerate high salinity. In Israel, some experimental plots of Australian and North American saltbushes are now being grown with seawater pumped directly out of the Mediterranean (*14*).

Shrubs

Saltbushes are just one example of the usefulness and unfortunate obscurity of hundreds of potential shrub crops. Shrubs are a botanical resource without a constituency. Too tall for agriculture, too short for forestry, they fall between the disciplines and their potential as resources is overlooked.

Shrubs are no less worthy than herbaceous plants or trees. Indeed, they are a tenacious form of life often with especial characteristics for survival in arid regions. And shrubs also can provide many valuable resources: food for people; feed for animals; ingredients for drugs and medicines; fiber for paper pulp; materials for housing, fencing, tools, and handicrafts; and rubber, resins, gums, oils, and rope for industry. On top of that, shrubs are one of the most promising answers to the Third World's massive shortages of firewood (*15*).

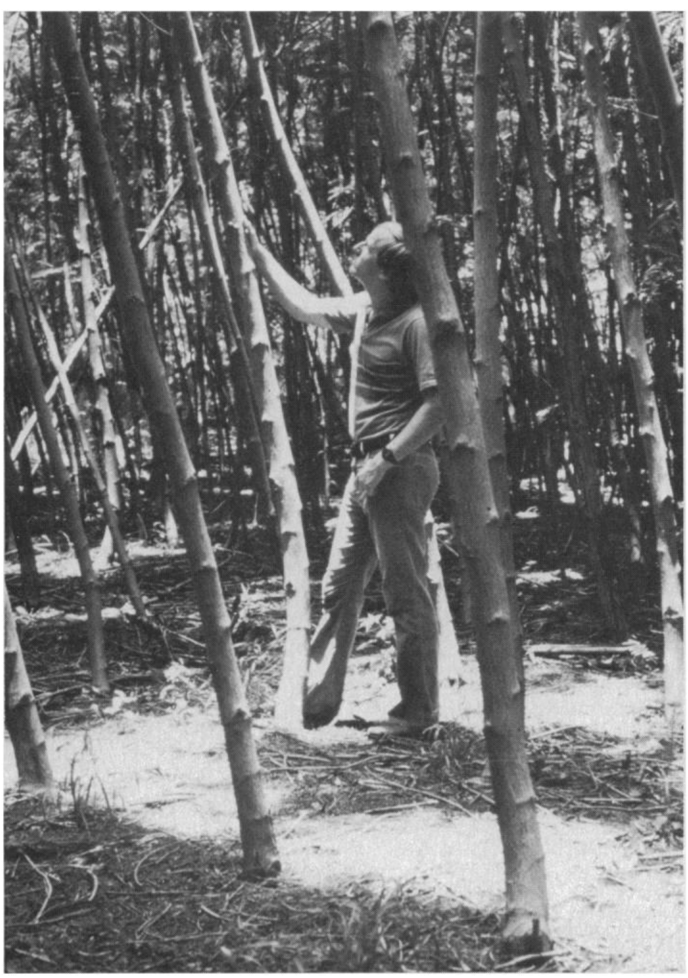

Fig. 4. Leucaena. A fast-growing tree, this nitrogen-fixing legume promises to provide wood and reforestation for much of the tropics. The trees shown here are 3 years old, grown at Waimanalo, Hawaii. [Courtesy of J. L. Brewbaker, University of Hawaii, Honolulu]

Among the shrubs that are promising for food are the chayas (*Cnidoscolus aconitifolius* and *C. chayamansa*). These fast-growing Central American bushes provide nutritious greenery, require little maintenance, and keep yielding for years. From Mexico to Costa Rica they appear as attractive hedges from which poor people pick their daily food. Chaya plants tested in Puerto Rico have outproduced all herbaceous leafy vegetables (*1*).

Paradoxically, one of the most endangered of all plants is a shrub that could contribute importantly to the world's arid zones. Ye-eb (*Cordeauxia edulis*) is native to the semidesert Horn of Africa. It survives where rainfall is as meager as 150 to 200 millimeters a year. Yet it produces tasty nuts with a potential that has been likened to that of macadamia and pistachio. During the recent African drought, ye-eb seeds were one of the few foods available in northern Somalia; nomads and their livestock devastated the few remaining native stands. This plant is now threatened with extinction and deserves urgent protection and concerted cultivation before it is lost (*6*).

Ye-eb provides both food and forage, and it is a characteristic of many shrubs that they can provide several products. This multipurpose character is a most important quality for Third World villagers. The more products a peasant can harvest the more valuable a plant is to him. Having the flexibility to harvest several products spreads the risk of failure and enhances the economic viability of his small land area. Unhappily, modern crops are almost all unipurpose species, one of the reasons why they are sometimes not adopted readily in developing countries.

An example of multipurpose shrubby legume, of which there are hundreds, is dhaincha (*Sesbania bispinosa*). Its seeds contain a water-soluble gum that produces a smooth, light-colored, coherent, and elastic film useful for sizing textiles and paper, as well as for stabilizing the mud used in oil drilling. The plant can be grown as a rotation crop to fertilize and improve soil. It also provides windbreaks, hedges, erosion control, and shade for crops. It reportedly makes good cattle fodder, and appears easy to produce on a large scale with little care or investment. Moreover, dhaincha shows remarkable survival on saline and wet soils. Amazingly, agronomists outside the Indian subcontinent have so far paid it little heed (*6*).

Nitrogen-Fixing Trees

Beyond dhaincha there are many woody plants with the legume family advantage: the root nodules whose bacteria provide nitrogenous compounds and enrich soil. These special attributes make leguminous trees particularly promising for combating the devastating tropical deforestation, one of the most pressing and difficult environmental problems in the world.

Despite the fact that there are thousands of different tropical tree species, some 87 percent of tropical forestry employs only three tree types—pines, eucalyptus, and teak (*16*). None of these trees fixes nitrogen.

Nevertheless, nitrogen fixation would be especially valuable in forestry because tree growing is seldom sufficiently profitable to warrant much fertilization (especially in poor countries) and tree growing is usually relegated to sites too infertile for agriculture.

To North Americans, the best-known nitrogen-fixing trees are black locust and honey locust. In the tropics the one that is creating the most enthusiasm is leucaena (*Leucaena leucocephala*) (*17*) (Fig. 4). This species is so productive that on the sites that suit it best it has reached heights of almost 6 meters in its first year and 20 meters in 6 years. And a cut leucaena sprouts with such vigor that it is said to "defy the woodcutter." The tree can even feed animals: when young specimens are grazed, the plant's vigor appears as masses of lush shoots that make useful livestock feed. Indeed, the highest weight gains ever recorded in the tropics were measured on cattle browsing a mixture of leucaena and grass in northern Australia.

But like all crops, leucaena has its limitations. It is currently restricted to alkaline soils, and in the past year a psillid insect has spread out of the Caribbean to defoliate it in Asia and the Pacific the way gypsy moths are defoliating trees in eastern North America.

This pest outbreak makes it vital to study leucaena as well as to advance other fast-growing, nitrogen-fixing trees as possible replacements. There are many candidates. One is mangium (*Acacia mangium*).

In 1966 an Australian forester, D. I. Nicholson, introduced mangium to Sabah, Malaysia, from its native habitat, the tropical rainforests of Queensland. Nicholson thought it would be worth testing because of its straight trunk and high-quality wood. Sabah foresters found that mangium was even more useful than expected. On good sites it matched growth with fast-growing pine and eucalyptus species; on degraded lateritic soils and worn-out agricultural lands it outyielded all other trees. Similar experiences in Thailand and the Philippines now make it seem likely that mangium is a major new nitrogen-fixing tree resource. It will not feed cows or defy woodcutters, but its timber has the high quality of walnut (*18*)!

Another candidate with promise is the leguminous tree called bracatinga (*Mimosa scabrella*). Before World War II, railroad companies in southern Brazil grew it to fuel wood-burning locomotives. In 1930, an enthusiastic forester reported amazing growth rates (6 to 7 meters in 2 years, 15 meters in 3 years), but then for almost 50 years the plant was virtually forgotten. Recently, however, Brazilian foresters have begun once more exploring its use, and in 1981 Costa Rican student José Campos gathered seed and introduced bracatinga to Central America. In Costa Rica's uplands, this species has grown so well over the past 2 years that it is now considered the fastest growing tree in the country (*15, 19*).

The recent histories of bracatinga and mangium again show how the efforts of a single individual can rescue an overlooked resource. The case of calliandra (*Calliandra calothyrsus*) is similar. In 1936, a Dutch forester introduced to Indonesia the seeds of this leguminous bush, which is a native of Central America. In Eastern Java, calliandra has proved so quick-growing and successful that many villages now employ it as their major source of fuel. Villagers even cut their trees on a 1-year cycle: the stumps sprout so vigorously that in about a year they reach heights of 5 or 6 meters—some have been harvested annually for more than 20 years. Since 1970, calliandra has been planted as a plantation crop; by early 1979 about 30,000 hectares were under cultivation. Villagers appreciate the plant so much that Kaliandra has become a common name for children. But still this versatile, user-friendly tree is little known elsewhere (*20*).

Fast-growing leguminous trees such as these are obviously important weapons for the battle against the rampant deforestation in tropical areas. They are among nature's nitrogen-fixers that colonize newly cleared land. This gives them the innate pioneering abilities needed for revegetating marginal terrain, halting erosion, and providing a protective ground cover under which native or conventional forestry trees can regenerate. Some can meet many everyday village wood requirements, so their cultivation is likely to help spare the last remnants of the natural forests. Despite this, however, leguminous trees are just beginning to receive recognition from forestry institutions.

Conclusion

In this article I have sampled only a tiny fraction of the thousands of underexploited members of the plant kingdom. Other researchers would have different, equally deserving, lists of candidates, perhaps emphasizing underexploited plants for energy, pharmaceuticals, food colorings, perfumes, industrial raw materials, and other valuable products.

Nature's storehouse has hardly been touched. We should begin exploring it and sampling its offerings. This is especially so because we may be losing species and genotypes through the rapid loss of native habitats in the tropics and deserts.

Given the power of biotechnology, rummaging through that storehouse is more vital today than ever. Biotechnology can enhance nature's genetic resources by highlighting and teasing out the unusually promising genetic traits. Thus, economic botany and biotechnology should be proceeding hand in hand. In this powerful combination are the potential solutions to many of the world's most pressing problems.

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3. N. D. Vietmeyer, *Ceres* 99, 37 (1985). Copies are available from the author.
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9. Researchers at the University of Minnesota have begun studies of adzuki bean. Contacts are L. Hardman, extension agronomist and W. Breene, food scientist.
10. Other promising lupin species include *Lupinus alba, L. luteus*, and *L. mutabilis*. J. S. Gladstones is at the Western Australia Department of Agriculture, Jarrah Road, South Perth, Western Australia.
11. A group formed to disseminate information and seeds of rare solanaceous species publishes *Solanaceae Enthusiasts Quarterly* (c/o J. M. Riley, 3370 Princeton Court, Santa Clara, CA 95051).
12. Recently a collection of economic cacti from throughout the Americas has been established by C. Russell at Texas A & I University, Kingsville, Texas, but is in danger of being destroyed.
13. This crop has seen a minor renaissance in recent years. A contact is G. Nabhan, Native Seeds/SEARCH, 3950 West New York Drive, Tucson, AZ 85745.
14. A remarkable collection of halophytes has been made by D. Pasternak and J. Aronson at the Ben Gurion University of the Negev, Beer Sheva, Israel. Other collections are at the University of Arizona, University of California at Davis, the University of Delaware, and the Western Australia Department of Agriculture.
15. National Research Council, *Firewood Crops: Shrub and Tree Species for Energy Production* (National Academy of Sciences, Washington, DC, 1980), vol. 1.
16. J. Evans, *Plantation Forestry in the Tropics* (Clarendon, Oxford, 1982).
17. National Research Council, *Leucaena: Promising Forage and Tree Crop for the Tropics* (National Academy of Sciences, Washington, DC, ed. 2, 1984).
18. National Research Council, *Mangium and Other Fast-Growing Acacias for the Humid Tropics* (National Academy of Sciences, Washington, DC, 1983).
19. Information from J. Campos Lopez and G. Budowski, CATIE, Turrialba, Costa Rica.
20. National Research Council, *Calliandra: A Versatile Small Tree for the Humid Tropics* (National Academy of Sciences, Washington, DC, 1983).

21. For each of these plants there are a few researchers who have seen the light. I wish to thank those colleagues and friends who, over the past 15 years, have supplied information on their favorite species. Many of these friends spend lives of frustration wondering why the world can't see the promise that to them seems so obvious. The National Research Council program, from which this article is drawn, has been largely sponsored by the Agency for International Development.