Crop Improvement Association (ACIA)—the official seed-certification agency in the state.

To be certified, seed must meet inspection standards while still in the field, then laboratory physical standards and genetic purity standards. Strict limits are set on foreign matter, including weeds. Germination standards are 80 percent or higher, depending on the crop.

Seeds of 40 varieties of 11 crops were certified in 1978 by ACIA. Cottonseed for planting, which became part of the certification program in the last five years, grew on 34,578 acres out of the 47,873 that were certified in 1978. Seven varieties of cotton were grown for certified seed.

Eighteen million pounds of certified cotton seeds were shipped out of Arizona last year to help meet the demand for high quality seeds from farmers in other parts of the country. The potential is good for continued increases in this market.

Besides cotton, certified crops and numbers of varieties represented by ACIA are: wheat, 12 varieties; barley, 5; soybeans, 1; alfalfa, 3; bermudagrass, 1; okra, 5; safflower, 2; peanuts, 1; and millet, 3.

"Climate is the key factor in why Arizona can produce high quality planting seeds," said Sackett. "We can harvest without rain. Moisture could lower the quality of the seed by starting it germinating or rotting." He expects the certified seed program to continue growing in the state because it makes use of Arizona's special weather resources to produce a high-value product.

# Developing new crops is old idea in Arizona

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In 1895, chemist Robert H. Forbes wrote a prophetic statement of purpose in an Arizona Agricultural Experiment Station bulletin.

"An important part of agricultural experiment station work, especially in a new and developing country, consists in the study of native forms of animal and vegetable life with a view to their improvement into profitable crops and industries... It is believed that some of the unique forms of vegetable life found in the arid Southwest would repay investigation and cultivation. The trees and plants of this region, being indigenous, are well-adjusted to our peculiarities of soil and climate, and in certain instances it is to them rather than to the staples of other regions, that we must look for profit."

Forbes was not only remarkable in envisioning the potential value of native desert plants; he was also a capable promoter of such research. Serving as Dean of the School of Agriculture at the University of Arizona, and later as a representative in the state legislature, he never lost sight of the underestimated value of our indigenous resources.

Beginning with Forbes' pioneering work, the Arizona Agricultural Experiment Station has always been involved with native crops which can withstand extreme heat and produce economic harvests on minimal doses of water. Forbes, his colleagues and followers have evaluated native beans, mesquite, canaigre, guayule, jojoba, plus gourds and other oilseeds for their economic products.

Although these plants are little known outside arid zones, they have the potential for reshaping desert agriculture worldwide. Arizona's Sonora Desert is being recognized for its vast reservoir of potential crops. Nearly 400 wild species have been utilized as food by the desert Indians, and at least 500 species were historically processed for medicine, fiber, and other uses.

### Altering the environment

The reason for considering the cultivation of native plants for desert agriculture is that fitting a crop to the harsh environment costs less than modifying the environment to suit the crop.

The dropping levels of ground water and the rising cost of pumping it have made this increasingly evident. For in Arizona, irrigation not only functions in providing plant roots with needed moisture, it is also used to cool down the field environment and to flush out salts which chronically accumulate in desert soils. Farmers have therefore been paying to make the entire crop environment more moderate in order to grow selections derived directly from temperate climates. These prices are now

**UA plant breeder Dr. David Rubis (left) and Ed Houser of the Firestone Tire and Rubber Company check flats of guayule seedlings at the UA Campbell Avenue Farm greenhouse.**

prohibitive in certain parts of the Southwest, so that we are again "looking for profit" in our indigenous plants that do not require so much environmental modification.

Fortunately, these experimental crops need not compete directly with conventional crops. They will not necessarily usurp good farmland from our current major crops, since there is enough abandoned land in marginal agricultural areas with which to experiment. Additionally, some of the native plants render products which are so unique that they will not even be marketed on the same terms as our customary crops.

For example, the current demand for a heat-stable lubricant like jojoba's liquid wax far exceeds the supply. Buffalo gourds yield a root starch with unusual physical properties of interest to several industries. Guayule and other hydrocarbon-rich plants are renewable sources of raw materials that we now extract primarily from foreign sources.

**Guayule shrubs are native to the semi-arid regions of southwestern Texas and north-central Mexico. Cultivated guayule can yield 1,200 to 1,500 pounds per acre of rubber with chemical and physical properties virtually identical to that from rubber trees. Dr. Rubis and other guayule researchers are working on shortening the plant's 4- to 5-year maturation period.**

### Selection is key

Yet most cultivated crop plants were developed over centuries, even millenia.

Is it possible to suddenly bring a wild plant into cultivation, and expect immediate profits?

The answers are no, and yes. Without selecting superior genetic lines of a wild species, and improving its response to cultivation, the answer is no. Such a non-scientific approach is bound to fail. On the other hand, if research efforts are geared to speeding up the plant domestication process which has guided the evolution of all crops, the answer is yes.

Imagine the chances for success which will be missed if we do not screen the variable wild populations for their most valuable individual plants. At the 1978 Jojoba Conference at Riverside, California, veteran desert botonist Howard Scott Gentry of Phoenix waxed eloquent on the range of potential present within jojoba:

"Her fruits are small, round or long; some are large but never large enough; some are one-seeded, two-seeded, or three-seeded; some grow singly, twinned or clustered; some dehisce easily or not at all. Her seeds vary from pea-size (2,000 per pound) to peanut-size (400 per pound). The oil content varies from 37 percent to 54 percent. Some seeds grow into plants without hesitation, but others start and die from frost or other unknown causes."



Unless the range of plants yielding similar products is evaluated thoroughly, an industry may be too quickly founded on the wrong choice.

During World War II, a shortage of cordage fiber stimulated the government to evaluate several Southwestern plants for the tensile strength of their leaf fiber. Since yuccas had previously been imported and utilized by Germany, much time and energy was invested in experiments with soaptree yucca. At the same time, the fibers of beargrass and century plants got only cursory attention.

Although the wartime yucca fiber industry soon atrophied, broom manufacturers took note of the possibility of using beargrass as cheap fiber. Today, along the U.S.-Mexico border, a multimillion dollar industry is based on this renewable resource, even though it was largely overlooked during the war. The soaring prices of broomcorn sorghum have made beargrass an important native plant industry in the Southwest. As times change, so do the values of various resources.

### Genetic improvement

After identifying the wild plant species or varities with the most valuable products and traits, it is necessary to investigate their potential for genetic improvement. The University's buffalo gourd team led by Dr. W. P. Bemis is evaluating the inheritance of oil and protein quality in this promising oilseed crop. The nutritional quality of certain hybrids will probably surpass the highest quality known from any wild populations.

**Buffalo gourd grows wild in much of the arid Southwest. Seeds from the baseball-size gourds contain high-quality food oil and protein. The large, fleshy roots yield starch that has properties some food processors want. The perennial plant grows and fruits in hot areas with average rainfall of 10 to 12 inches. The UA Buffalo Gourd Research Team headed by breeder Dr. William Bemis and food scentists Drs. James Berry and Charles Weber plans to assemble data for a growers-users conference next winter.**

**Dr. LeMoyne Hogan, leader of the UA College of Agriculture's research on jojoba, examines boxes of cuttings with various soil and fertilizer preparations. The unsaturated liquid wax from jojoba seeds is similar enough to the oil of the endangered sperm whale that it can be used as a replacement for the whale oil for the complete range of uses of sperm whale oil, from fine lubrication to foam control in penicillin production. The wax may have other uses, too, and the seeds are edible. The perennial, evergreen shrub grows on well-drained, coarse soils with 5 to 18 inches of rain a year. Substantial investments in commercial jojoba plantations have already been made, though the plants require 3 to 7 years to produce commercial crops.**



A variety of breeding strategies must be considered, too. With guayule, plant breeders are able to develop hybrids that combine several favorable characteristics such as high rubber content and good cold tolerance. Yet after hybridization, it may be best to induce "apomicts" from a select hybrid. Apomicts are forms that produce seeds that are genetically identical to the parent. This strategy allows replication of the favorable characters of the hybrid, generation after generation. On the other hand, if there is any latent genetic vulnerability in the selected hybrid, such as susceptibility to disease, it could quickly threaten an entire field of genetically identical plants. Thus the tradeoffs of one breeding strategy versus another must be weighed.

Finally, after improved selections or hybrids are produced, field trials must follow. If a plant is not well-adapted to a particular environment and dies before flowering, the hypothetical value of its seeds is irrelevant.

Chemists had chosen *Euphorbia lathyrus* as a quality hydrocarbon-producing plant to experiment with in the Tucson area. Unfortunately, in the summer of 1979, these plants succumbed to disease when brought into field cultivation. Often, diseases unknown to plants in the wild affect them dramatically when they are densely planted and flood irrigated. Promoters of new crops are quickly learning not to count their chickens before they are hatched out into commercial scale plantings.

### Fascinating challenge

Although these setbacks sound discouraging, they are to most scientists a fascinating challenge. Already, plant pathologists and agronomists have joined breeders to find ways to avoid, evade or solve such problems.

The real test for the new desert crops lies in their water use efficiency. Will Arizona farmers be able to produce an economic yield of these plants while irrigating less frequently or not at all?

Surprisingly, the native desert plants now under study do not necessarily produce more dry matter per unit of applied water than conventional crops in the same amount of time. Sorghum, for instance, can amass

**A wild tepary bean vine twines into a mesquite bush. Tepary is native to the Sonoran Desert. Indians of the area have used it as both a wild and cultivated source of food. Tepary reaches maturity with as little as 8 to 10 inches of water. Yields of 20 bushels of beans per acre have been obtained with three irrigations and no fertilizer in a region with only 4 inches of annual rainfall. The dry beans are used as pinto beans are, and are similarly rich in protein.**

more overall weight on less water over a growing season than most desert shrubs, trees and annual vines.

Recent investigations by USDA's Jack Mauney and ASU's Stan Szarek indicate that native desert plants are often conservative in their growth: when the plants suddenly get an abundance of water, they do not use it as efficiently as they do the meager moisture they are used to.

Does this mean that we would gain little water conservation by cultivating plants that have evolved in the desert? On the contrary, we have much to gain. Even though native tepary beans may amass the same overall weight per plant as great northern beans given the same amount of water monthly, they may mature in only two-thirds the time. By having a short growth cycle, they can save considerable water by quickly producing beans before drought sets in. In addition, teparies and other desert plants apparently put a higher proportion of their overall weight and energy into seeds (beans). Thus, tepary and great northern plants may weigh the same, but the tepary will likely have more beans. Finally, teparies continue to set pods during summer heat too extreme for great northern plants to produce in.

**Desert opportunities**

Certain desert plants such as the wild gourds use considerable amounts of water when irrigated regularly, but can survive long droughts without irrigation that would kill other non-adapted perennial plants. The root of the finger-leafed gourd is known to have survived a year and a half with no measurable precipitation in Baja, California.

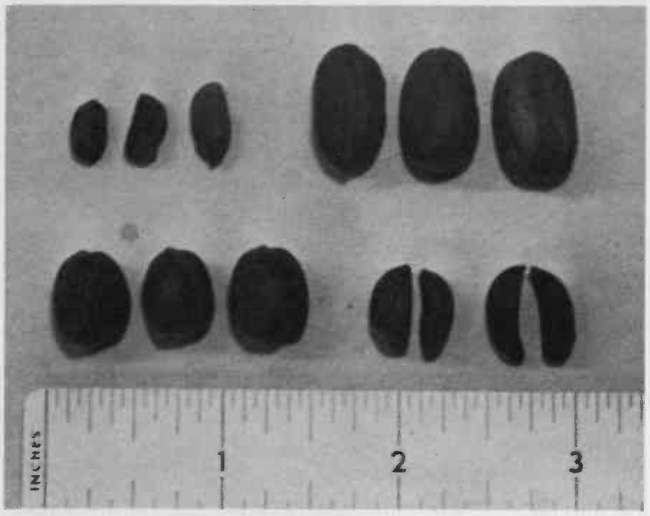
Many desert plants are in a sense opportunistic. They tolerate extremes, but when water is ample they utilize it liberally.

Thus the possibilities of crop failures due to drought are more remote with native desert plants. Few, however, can outproduce conventional crops when water is not a limiting factor.

But water *is* the limiting factor in the desert, and it is affecting economic activities in arid lands, too. Therefore, Arizona scientists are working to make desert crops economically advantageous to farmers, not simply environmentally suitable and technologically possible.

With luck, hard work and patience, we may soon see the day when some of Forbes' favorite indigenous plants have been transformed into profitable crops and industries.






**Jojoba beans vary in size and shape. Plant scientists are working on selection of the most productive varieties.**