CROPS

Traditional Crops

Traditional cotton, wheat, alfalfa, lettuce, citrus and barley are not desert plants but through irrigation they form the foundation of economically important crops grown in Arizona and other dry areas of the world. But dwindling water supplies, soaring energy costs, and foreign competition, threaten farmers who depend on traditional crops and production practices.

The greatest challenge confronting farmers in Arizona is striking a balance between limited water supplies and maximum returns. The challenge to UA researchers is to make crops more water and energy efficient by breeding new varieties and developing farming techniques that conserve water to the last drop.

Cotton

Cotton is the centerfold of Arizona agriculture. More acres are planted in cotton and greater returns received from cotton than any other crop. Arizona farmers have maintained the highest average yield per acre in the United States. But cotton requires water to grow and irrigation is an energy intensive practice, representing a major part of the total energy used in desert farming operations.

The problems of increasing the overall efficiency of water use and achieving maximum yield are so complex that no single discipline can be expected to provide the final solution. Thus, a working team consisting of researchers from the Departments of Plant Sciences, Soils and Water, Engineering, Entomology, and Agricultural Economics have tackled this program. Their evaluation of drip irrigation show it to markedly reduce overall water use as compared with conventional irrigation methods.

By eliminating the soil moisture extremes inherent with furrow irrigation, the plant root system is exposed to more uniform and favorable soil conditions which allows for superior growth and development. Our experience with drip irrigation has shown it to reduce the use of valuable water resources by about 40 percent, a remarkable feat in itself.

Making the Desert Bloom

Yield increases associated with drip irrigation tests the past four years have been exciting. A top drip irrigation treatment had a yield of 2,612 pounds lint per acre, which is a major breakthrough. It is the first time yields greater than five bales per acre have been reported by university scientists. In contrast, cotton yields of about 1,100 pounds lint per acre in the irrigated deserts have remained static for the last 30 years. Indeed drip irrigation brings new optimism to desert agriculture. (Departments of Plant Sciences, Soil and Water, Engineering, Entomology, Agricultural Economics and Plant Pathology).

Sorghum

More than half the world's population consumes sorghum directly as a food. This grain is relatively more productive under limited or sporadic rainfall than most other commonly used field crops. Nevertheless, UA research is aimed at making sorghum even more water efficient in arid regions.

In a cooperative program with INSORMIL-AID UA researchers utilize a sprinkler irrigation gradient system to screen both sorghum and millet entries for yield under water stress. The sprinkler irrigation gradient system has greatly speeded up the process of identifying drought tolerant sorghums and millets. It can help evaluate thousands of plants each year.

In all, about 3,000 germ plasm sources have been evaluated in the last five years. Breeders from five states and numerous lesser developed countries have sent germ plasm for testing in the gradient irrigation system under the high temperature and low rainfall conditions so characteristic of the desert Southwest. Significant findings include identification of key agronomic and physiological characteristics associated with entries that do "well" under water stress.

Results of studies on photosynthesis, transpiration, leaf temperature, leaf resistance and other features are helping us understand how drought tolerant plants respond to moisture stress. With this information breeders can provide germ plasm with the necessary characteristics for survival in adverse environments. Their work points to water management techniques which permit a crop to develop in a shorter growing season. Among other things, this reduces the amount of water needed for irrigation and the accompanying costs of pumping. (Drs. A.K. Dobrenz, R.L. Voigt and V. Marcarian, Department of Plant Sciences).

Wheat and Barley

Wheat and barley are popular with Arizona growers because they are cool season crops that grow at the time of the year when water loss from the plants is lowest and water use is not in direct competition with other crops having a higher water requirement. The long growing season of the desert areas also permits maturing a second crop following small grains.

Short statured barley lines that mature three or four weeks earlier have been selected. The earlier maturity date eliminates the need of one or more irrigations and makes possible growing a second crop on the same piece of land. This single improvement reduces the cost of seedbed preparation and seasonally adjust the demands for water and other inputs. We are approaching our ultimate goal to produce superior wheat and barley varieties that integrate in a cropping system and are adapted to growing with a lesser amount of water. (Drs. R.T. Ramage and R.K. Thompson, Department of Plant Sciences).

CROPS

Alfalfa

Alfalfa is planted in approximately 20 percent of Arizona's irrigated acres. Sale of this important forage crop amounts to more than 90 million dollars a year.

UA researchers are developing germ plasm of alfalfa which can germinate, grow and establish in brackish water containing high levels of NaCL. After seven years of recurrent selection of salt tolerance, they have identified some plants which will germinate in sea water.

A new generation salt tolerant alfalfa was released as a germ plasm source in 1983. Since then, researchers have developed alfalfa which will also emerge and establish under saline conditions. New alfalfa germ plasm which can withstand the harsh environments of high temperatures, high salt levels and low soil moisture are being developed by the Arizona Agricultural Experiment Station. (A.K. Dobrenz and S.E. Smith, Department of Plant Sciences.)

Fruit and Nuts

The fruit and nut industry in Arizona is everchanging. In the last ten years, the industry has turned more toward deciduous crops than to citrus.

Total acreage of citrus has declined in the last ten years from 68,000 to 43,000 acres. Much of this decline has happened in Maricopa County where citrus groves have given way to urban development in the Salt River Valley. Some groves have also been lost on Yuma Mesa. Nut crops have shown a substantial increase, especially pecans in Pima and Pinal Counties. Pistachio has received a great deal of interest with some planting in Cochise County.

A great deal of interest is being generated in Southern Arizona with wine grapes but actual plantings have been modest. Table grapes, especially the new seedless varieties, have seen increased acreage since 1980.

Stone fruit acreage in the state has stayed relatively constant over the last several years, although location of orchards has varied. Some new low-chill requirement varieties show promise as a possible new crop for the low desert areas.

Apples in southeast Arizona, especially the Granny Smith variety, are being developed by several growers. Apples have the possibility of becoming a valuable new crop for the area.

All of these grapes, deciduous fruit and nut crops have the potential of becoming important new crops for areas in southern and southeastern Arizona but initial investment on a per acre basis is high and excellent management skills are needed.

Total value for all fruit, nut and citrus crops in 1984 for Arizona approached $100 million with citrus furnishing about 67 percent, nut crops 9 percent, grapes 19 percent and deciduous fruits 5 percent.

—Dr. Michael W. Kilby
Dept. of Plant Sciences
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MICHAEL W. KILBY

Pecans

Vegetables

Vegetables and especially lettuce are important crops in Arizona. Because lettuce quality is so important at the market place and heat and salt stress so difficult to manage in an arid environment, UA researchers are studying mechanisms of tolerance to these stresses during seed germination. UA researchers believe answers to these questions will help improve our ranking as the second largest producer of lettuce in the country.

Still, the major problem for lettuce growers is the increasing costs of water. Drip irrigation experiments show ways to irrigate lettuce more efficiently and thus reduce water costs. Other work with plant growth regulators will show if commercial application of these products will alleviate some of the environmental stresses faced by lettuce growers in arid agriculture.

—Drs. J.M. Kobriger and N.F. Oebker, Department of Plant Sciences

Young guayule plant

Experimental Crops

Guayule

The United States is getting closer to having a domestic source of natural rubber thanks to intensive research at the University of Arizona, University of California, New Mexico State University at Las Cruces, Texas A & M University, and the USDA on the desert shrub called guayule.

This plant which grows wild in portions of Texas and Mexico, produces rubber which is comparable to that obtained from the Hevea rubber trees growing in Southeast Asia.

Dr. David Rubis initiated guayule studies at the University of Arizona in 1976 using seeds, stored since the days of the Emergency Rubber Project of World War II, and from plants growing in the wild.

Research efforts were significantly expanded in 1980 following the funding of special federal legislation to study guayule. Research objectives have included: methods of establishing plants in the greenhouses and field; developing knowledge of water use and irrigation methods; identifying and controlling plant pathogens, including selecting for disease resistance; breeding plants for favorable growth characteristics, rubber, and resin production; understanding the genetics associated with inheritance of desirable plant characteristics; improving procedures for assaying for rubber formation; pinpointing the optional periods for harvesting seeds and also shrub for rubber; perfecting equipment for seed and shrub harvest; and developing economic evaluations for the crop.

Research funding has come from the state of Arizona, and in recent years from the National Science Foundation and the U.S. Department of Agriculture. Research at the University of Arizona has particularly been centered in the Departments of Plant Sciences, Agricultural Engineering, and Plant Pathology and in the Office of Arid Lands Studies.

Particularly promising germ plasm is simultaneously studied in cooperative regional test plantings in Arizona, California, New Mexico, and Texas. Although small quantities of guayule seeds can be provided to U.S. researchers, requests for large quantities by researchers, requests by domestic commercial entities, and all requests from foreign countries must first be approved by USDA.

—Dr. Stan Alcorn Dept. of Plant Pathology

Buffalo gourd

Buffalo Gourd and Coyote Gourd

Two wild relatives of cultivated squashes and gourds, the buffalo gourd and coyote gourd can be found growing during the summer months in disturbed soil along roadsides and as a weedy plant at the edges of cultivated fields in the western United States and northern Mexico.

Buffalo gourd inhabits the semiarid plains and high deserts of the region whereas coyote gourd flourishes in drier lowland desert areas. Although these species produce hard-shelled, baseball to softball-sized inedible fruit which are essentially filled with seed, they also readily reproduce asexually, forming dense colonies of vines. They are perennials by virtue of a large fleshy root, which acts as a storage organ for water and energy in the form of starch.

Scientists became interested in these species (especially buffalo gourd) as potential oilseed crops shortly after World War II. In the following decade, several research groups examined the suitability of the extracted seed oils for edible and industrial purposes. However, agronomic and genetic studies were initiated much later, in the late 1960's and early 1970's. Since 1975, domestication of these gourds and commercialization of their potentially useful products have been the subject of an intensive, interdisciplinary investigation supported in part by both public and private funds.

The useful products of xerophytic gourds include: oil and protein from seed, starch from roots and "specialty materials" extracted from various plant parts. Crude oils extracted from both species are darkly pigmented and highly unsaturated. Buffalo gourd oil can be processed as other crude oils (such as cottonseed and sunflower) to yield a vegetable oil which is essentially odorless and tasteless, light in color and apparently suitable for use in foods or as a frying medium. However, coyote gourd oil (crude and refined) displays an unusual chemical profile, containing specific unsaturated constituents which predispose the material to rancidity. As its use in foods would be hampered by instability, the oil extracted from this species may be more suited for industrial use.

—Dr. Joe Scheerens
Dept. of Nutrition and Food Science

Jojoba

The potential for the jojoba plant to provide a renewable source of liquid wax continues to stir much interest in both the academic community and private industry. This drought-adapted Sonoran desert native is the only plant in the world known to produce such a wax; a wax very similar to that obtained from the endangered sperm whale. Potential uses for jojoba wax are very diverse, ranging from lubricants to cosmetics to medicinals.

The University of Arizona began its program to domesticate this evergreen, woody shrub in 1972. Help was provided to the San Carlos Apache Indians in southeastern Arizona to establish a jojoba oil industry based on harvesting wild plants. Sale of this wild seed has provided much-needed income to the unemployed of southern Arizona in recent years; however, the market for wild harvested seed will likely disappear when less expensive plantation-grown seed becomes available.

Large scale commercial growing of jojoba began in 1978. By 1984 about 41,000 acres had been planted in the southwestern United States and Mexico.

The University of Arizona is involved in several ways to help this fledgling industry. To identify higher yield-

ing varieties, a germ plasm collection was made from throughout the naturally occurring population of jojoba, and plants were established in research plots where detailed records could be made. In conjunction with this research, asexual methods of propagating jojoba have been developed to allow rapid multiplication of superior clones once they are identified.

Additional studies are being conducted on irrigation, fertilization, pruning, and fruit development. Pathologists and entomologists at the University of Arizona have identified diseases and insects found to attack jojoba and are working on control strategies for them.

Researchers have continued to refine the economic evaluation of the potential of jojoba as a new crop. New data on yields and production costs are fit into the model as they become available.

The jojoba meal which remains after the oil is express has been evaluated as a livestock feed and studies have been conducted on a suspected toxin in the meal. Another by-product, the jojoba hulls, have been evaluated as an organic soil amendment.

The program at the University of Arizona has involved the work of researchers from several different departments and has attracted monetary support from both private industry and governmental agencies.

—Dr. David Palzkill
Dept. of Plant Sciences

DAVE PALZKILL

Jojoba Harvesting

Halophytes

An alternative to increasing salt tolerance of our present, conventional crops through selection and breeding is to domesticate wild plants that already possess high salt tolerance. There are well over 1000 species of such plants, called halophytes (literally, salt-plants), widely distributed throughout the world.

The Environmental Research Laboratory (ERL) has amassed a large collection of many of these plants and has been intensively screening them for potential use as saltwater-irrigated crops. Some of the potential forage crops, such as saltbush, have produced yields when irrigated with seawater that equal, and in a few cases even exceed, the yields of alfalfa irrigated with fresh water. In addition to the seawater irrigation work that has been conducted at ERL's experimental plot in Puerto Penasco, Mexico for the past six years, some of the more promising species were grown last year near Safford, Arizona and irrigated with brackish water (about 10,000 ppm salt). Yields from those plants were superior to the high yields from the seawater-irrigated plants.

Nutritional value of the halophyte forage compares favorably with conventional crops such as alfalfa. Cooperative work with the Departments of Animal Science and Nutrition and Food Science indicates that the digestibility and feed value of these plants looks promising too. Animal feeding trials are continuing. The high salt content of the halophyte forage poses some problems of palatability and acceptability for some animals, and these issues are being investigated now.

Also, because of the high salt content in the forage, increasing attention is being directed toward developing potential seed crops since halophyte seeds contain no more salt than seeds of conventional crops. Seeds of some halophytes, such as saltgrass, are as large as, and nutritionally equal to, wheat seeds.

There are thousands of miles of barren desert seacoasts that could be made productive through cultivation of halophytic crops. Of more immediate concern, in an agricultural context, however, are the millions of acres of cropland that have been lost to salinization. Halophytic crops could not only significantly reduce continued loss of cropland in this way but also bring back into production much of that land already lost.

—Dr. James O'Leary
Environmental Research Laboratory