2. Plant breeding

Successes and limitations

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Since its beginning, the University of California has been actively involved, directly or indirectly, in traditional plant breeding programs, including germplasm collection and evaluation, development of genetic stocks for use in plant breeding programs, development of finished varieties, new crop development, and training of plant breeders. Such plant breeding is actually a form of genetic engineering. It involves management of genes and their carriers, the chromosomes.

Germplasm collection

University personnel have been plant explorers, searching areas where crop plants originated or where their wild relatives exist to bring back to the United States stocks that very often provided characteristics to improve our plants (see *California Agriculture*, September 1977). Germplasm collections have been made for established crops, such as grapes, strawberries, and safflower; crops established elsewhere but not yet grown in California, such as rapeseed and amaranths; and wild species not yet domesticated, including wild sunflower, guayule, and jojoba.

Development of genetic stocks and finished cultivars

University researchers have provided genetic stocks, which in turn have been used to improve cultivars being developed by both public and private agencies. Often these have involved transfers of characteristics from related wild species. Examples of genetic stocks are:

☐Tomatoes with disease resistance

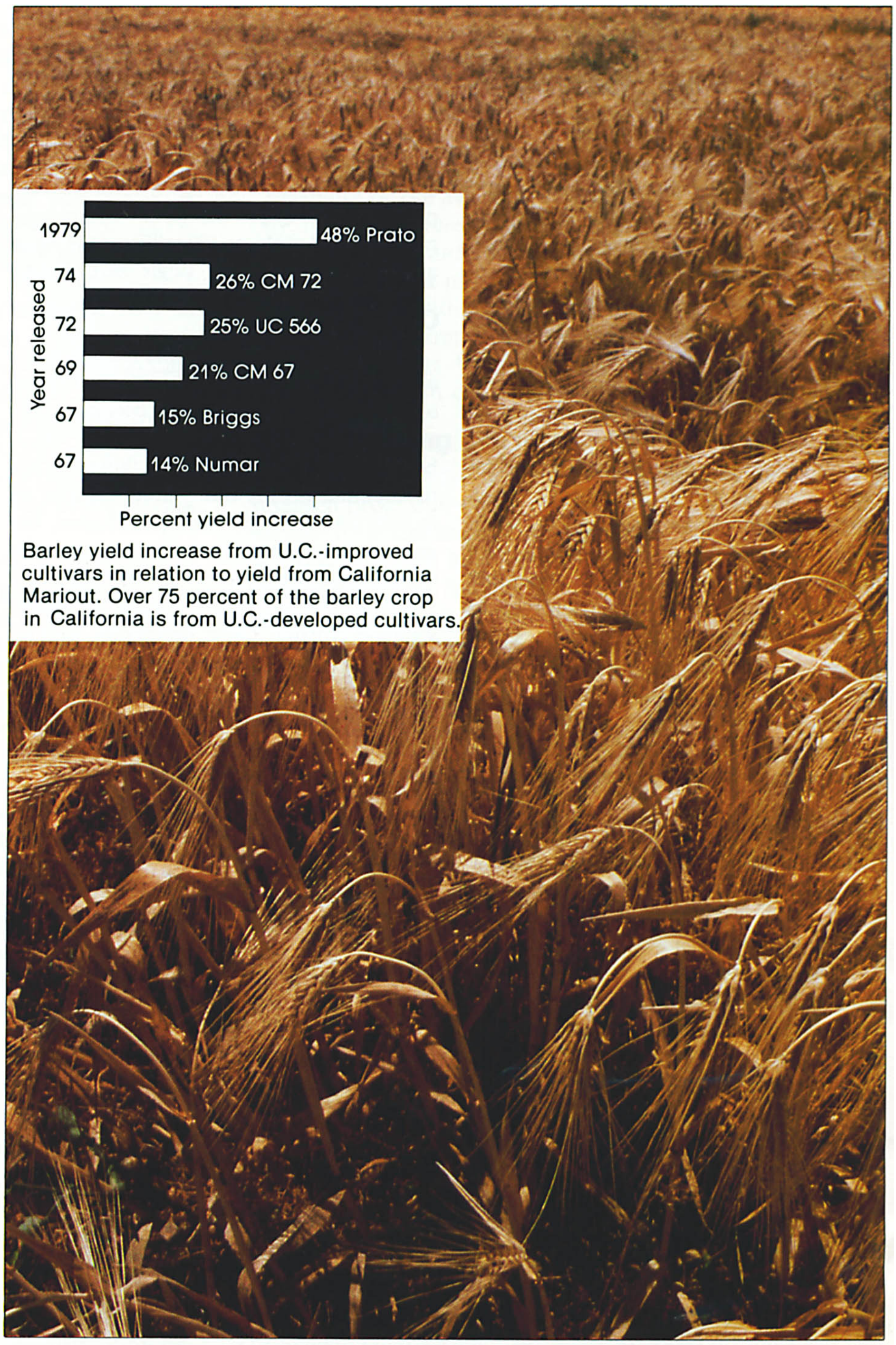
☐Safflower (from the wild *Carthamus oxyacantha* of the Middle East) resistant to rust

☐Yellow-dwarf-resistant barley obtained from introductions from Ethiopia

☐Short-stemmed high-yielding types of rice obtained by using mutagens.

This important activity of the University will be advanced by genetic engineering.

The University's role in development of finished cultivars has yielded economic benefits to agriculture far in excess of all the costs



Barley yield increase from U.C.-improved cultivars in relation to yield from California Mariout. Over 75 percent of the barley crop in California is from U.C.-developed cultivars.

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Plant breeding trials with guayule, a potential source of rubber, by P. F. Knowles may yield economic benefits well above research costs.

of U.C. agricultural research.

Today, 75 to 80 percent of the barley crop in California is grown to U.C.-developed cultivars, which have resulted in yield increases of up to 48 percent during the last 15 years.

About 80 percent of the strawberry acreage in California is planted to cultivars developed by the University of California. The new cultivars with high yields and excellent quality have expanded the area of production and permit year-round production of fruit.

Virtually all the California asparagus acreage has been planted to University cultivars for 40 years. The latest in a series of seven cultivars is F_1 hybrid UC 157, renowned for its high yields of uniform, superior spears and tolerance to fusarium wilt.

The University has been deeply involved in melon breeding since the 1920s. The most recent developments are short-internode bush cultivars of honeydew and crenshaw types, which are easier to harvest and better adapted to the home garden.

The male-sterile variant in the onion cultivar Italian Red was discovered in the 1920s, and the first studies on its inheritance were made by the University. This discovery led to development of the hybrid onion industry and served as a model for the use of cytosteriles in other crops.

U.C. cultivars have had a profound effect on the tomato industry for six decades. Some steps in cultivar development were: improved selections of cultivar Santa Clara; cultivar Pearson with bush habit and high yields; VF 6 and VF 9 with resistance to fusarium and verticillium wilts; VF 36 with improved fruit setting; VFN 8 and VFN 14 with resistance to nematodes; and VF 145 and 13L in 1954, and more recently UC 134 and UC 82, which are adapted to completely mechanical harvest because of their compact plant type, concentrated fruit ripening, and fruit characteristics. Because of their superiority, the latter four varieties occupy most of the California acreage and have increased production to 5 to 7 million tons per year, accounting for 75 to 85 percent of U.S. production. Over the last 40 years, in large measure because of the University breeding program, production of processed tomatoes has quadrupled.

A U.C. grape breeding program began yielding new cultivars in 1946. Since then a steady flow of cultivars has been released for all facets of the grape industry including raisin varieties, red and white wine varieties, and an array of table varieties. Improvements in table grapes include seedlessness, earliness, storage ability, and bright red color. Disease, nematode, and insect resistance has been incorporated into new varieties, in some cases through interspecific hybridization.

UC-1 was the first commercial variety of safflower with high levels of oleic acid, instead of linoleic acid, in the seed oil. Chemically, the oil is like olive oil. It is an example of using a single gene to provide a new oil crop.

A new area of research where the University has provided leadership is the development of dwarf cultivars of peaches and nectarines. Such dwarf varieties have short internodes, which reduces woody growth, yet have the same number of leaves, flowers, and fruits as normal trees. The result is precocious bearing of many fruits per unit length of stem: if 1,000 trees are planted per acre instead of the usual 100, yield is doubled. The dwarfing gene is being transferred to almonds, where it is expected that the increased yield, compared with that of normal trees, will be greater than in peaches.

New crop development

The University's research program on safflower, initiated in 1947, was the necessary first step to commercial development of safflower beginning in California in 1950. Tests were conducted both at Davis and in the counties under the supervision of farm advisors.

In large part because of the University's research, jojoba, a shrub of the Sonoran Desert, is now grown on nearly 16,000 acres in the United States. Jojoba performs well with low amounts of irrigation water, low soil fertility, high salinity, and a broad range of temperatures. Its seed oil, chemically similar to that of the endangered sperm whale, has many uses (see *California Agriculture*, August 1979).

Other potential new crops being investigated by the University are sesame and mustards as a source of oil and protein, amaranths and triticale as a source of carbohydrate and protein, and guayule as a source of rubber.

Not the least of the University's contributions to plant breeding has been the training of plant breeders through formal courses, textbooks on plant breeding, and research or apprentice-type experience under the guidance of a plant breeder. The training has focused on both basic and applied aspects of plant breeding, and graduates serve agriculture throughout the world.

Trends

At one time much of the plant breeding was supported financially from state and federal sources. This support was justified, because society as a whole benefited from the programs. In recent years, with declining support from public agencies, breeding programs have derived much of their financial support from commodity groups.

Where private companies have assumed a major role in breeding improved varieties, the University has often shifted its emphasis from development of finished varieties to development of germplasm and to the study of breeding systems. It has sought to have its breeding programs complementary to, and not competitive with, those in the private sector. In some cases the University has assumed very long-range, high-risk objectives in plant breeding.

Training will continue to be an important role of the University. As in the past, the trend will be towards a better understanding of fundamentals rather than the practice of plant breeding. It will deal with the behavior and management of genes and chromosomes, with basic physiological processes, and with the interactions of crop plants with pathogens and insect pests.