Rice introduction and germplasm development

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Rice, a crop native to the Orient, was introduced to the eastern United States as early as 1609. The earliest recorded experimental plantings in California were near Butte Creek in the Sacramento Valley in 1909. By 1912, rice was established here as a commercial crop. The most successful early introductions generally were from similar high-latitude areas of the Far East. For example, the variety Caloro was first selected in 1913 from the Japanese variety Early Wataribune, and Colusa was selected in 1911 from the variety Chinese (from China via Italy).

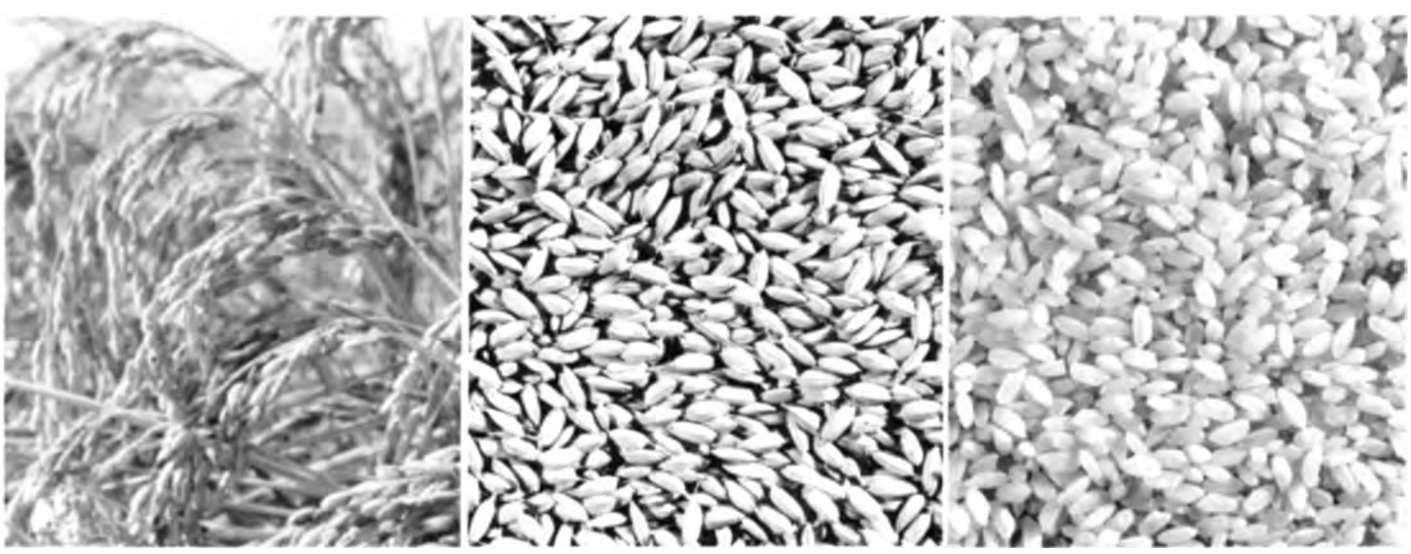
Colusa and Caloro, both highly successful, were released to the public in 1917 and 1921, respectively, and are still grown on limited acreages. They, along with Calrose, released in 1948, persisted for many years as the principal varieties in California until more recent breeding efforts provided improved lines.

Plant introductions

All rice introductions from foreign countries must first be grown for one generation in a plant quarantine nursery isolated from commercial rice growing areas to insure against accidental release of new diseases and insect pests. Quarantined greenhouse plantings of rice for many years were made only by the U.S. Department of Agriculture at Beltsville, Maryland. By the 1960s this operation had gradually accumulated a collection of about 5,000 rice lines.

But by this time many rice lines (especially short straw selections) had been accumulated by the International Rice Research Institute (IRRI) in the Philippines. It was no longer possible to grow the desired volume of U.S. introductions in the Maryland greenhouse. Therefore, in 1969, when an accelerated rice research program was funded by the California rice industry, the U.S.D.A. approved the growing of large numbers of rice introductions at the University of California's Imperial Valley Field Station near El Centro. At this desert station 400 miles south of the nearest rice field, over 11,000 lines have been grown during the last eight years through cooperative efforts of the university, the U.S.D.A., and the California rice industry.

Most of the recent material tested has been from the IRRI collection. Included is seed of elite germplasm; all IRRI



California rice (left), after harvest (center) must be hulled and polished (right) for use.

Rice plants 10 to 14 inches shorter and with promise of greater grain production have been bred in California through seed irradiation. The research team at the University of California was led by J. Neil Rutger (above), U.S. Department of Agriculture geneticist with the Agricultural Research Service.

short stature varieties from IR8 through IR42; and much of the Institute's cold-tolerant, saline-resistant, and wild species collections. However, small groups of rice lines introduced through the Imperial Valley station have also come directly from Brazil, Taiwan, Korea, Mainland China, and India.

The El Centro-grown introductions have been used in (1) breeding programs; (2) tests for resistance to stem rot, rice water weevil, and grain moth; (3) inheritance studies on height, leaf angle, and shattering; (4) special studies on mechanical harvesting, plant height, seedling vigor, cold tolerance, and salinity; and (5) analyses for protein and other quality factors.

A portion of all introduced germplasm is stored in the U.S.D.A. world collection of rice maintained at Beltsville, Maryland. This conserves germplasm which might otherwise be lost, and ensures immediate availability of rice seed with important characteristics, for future research work in the U.S.

Germplasm development

In California new rice varieties and other improved germplasm lines are being actively developed through the combined research efforts of the California Cooperative Rice Research Foundation, the U.S. Department of Agriculture, and the University of California, as well as through private breeding programs. In the last decade the following public varieties have been released: CS-S4 and S6 (short grain); CS-M3 and M5 (medium grain); and Calrose 76, M7, and M9 (short straw, medium grain).

Germplasm development has included a long grain line, several short stature lines with varying combinations of genes for shortness, early maturing lines, and lines resistant to cold-induced sterility. Basic genetic stocks including male sterile lines, primary trisomics, and tetraploid lines, have also been developed in the last few years. Most of these materials have been developed by conventional breeding methods: i.e., crossing a standard variety with another variety or a newly introduced line, then selecting offspring adapted to California.

However, considerable use has been made lately of "mutation breeding," a long-known but rather unconventional approach to developing new varieties. For example, the variety M5 originated from spontaneous early-maturing mutants from CS-M3, while Calrose 76 was developed as a purposely induced short stature mutant from Calrose. Calrose 76, being a short stature variety adapted to California, is being used extensively as a parent in crosses. Thus it was the short stature parent of the new variety M7, and will undoubtedly be in the lineage of many future varieties.

Since the initial work (1969 to 1975) leading to Calrose 76, several other induced short stature mutants have been produced. Included are at least two lines with short stature genes different from the one in Calrose 76. These have enabled creation of "double dwarf" lines by recombination of two independent short stature genes. Now, with availability of three different single dwarf genes, it should be possible to create "triple dwarf" plants. Short plant height is extremely valuable because it prevents "lodging" or falling over, especially with greater fertilization aimed at higher grain production.

Induced mutants for short stature have also been recombined with induced mutants for early maturity, so now we have numerous short stature, early maturing breeding lines, some of which may be our varieties of the future. Earliness contributes to higher yielding, more efficient harvests ahead of fall rains.

Induced mutation breeding has been somewhat more successful with rice in California than with other crops, or with rice in other parts of the U.S. and the world. Two reasons for this are:

- The objectives were limited to obtaining adapted short stature and early maturity sources. It was possible to ignore the numerous deleterious mutants commonly produced by radiation and concentrate on the useful ones desired.
- Work concentrated on lines already adapted to California.

Except for some Japanese and Chinese varieties, most introduced lines are not well adapted to California's environment. Hence, it has been easier to make single gene changes in adapted lines—those successfully grown here for 25 to 50 years—by using induced mutation rather than by conventional hybridization with introduced lines.

However, induced mutation breeding using an adapted germplasm base may only be a stop-gap procedure, because it works best for changing only a few characters. The greater germplasm diversity resulting from hybridization with introduced lines may show greater, longer-term advantages.

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