

# Rice Breeding Past and Present

The varieties bred and rice produced by NARO: left: Eminokizuna; center, Koshihikari; right, Itadaki



The objectives of rice breeding in Japan have changed over time, reflecting the social conditions that prevail. An initial focus on yield gave way to a focus on eating quality, shifting in more recent times to high-yield and good eating quality rice produced at low cost for home markets as well as for export. Today, the accomplishments of technology over more than a century are expected to help improve the world's food situation.

## KATO KYOKO

THE cultivation of rice in paddies in Japan is said to have started about 3,000 years ago. Until the Meiji period (1868-1912), people bred rice varieties by selecting those that were best suited to their region from among the mutants that had arisen by a rare natural mutation. Since this was not based on genetics, rice breeding progressed slowly, and farmers often had to deal with poor harvests when crops were damaged by cold weather or pests, often resulting in deaths due to famine. All people could do was pray for a successful rice harvest.

At the end of the nineteenth century, the Japanese government established agricultural experiment stations and the full-scale breeding of rice began with the aim of improving its yield, disease resistance, cold resistance, and so on. The first superior variety produced by artificial crossing in Japan, Rikuu 132, was developed in 1921. Rikuu 132 is a hybrid that is resistant to cold-weather damage and has good eating quality. Koshihikari, Japan's top-ranking rice bred in 1956, is the descendant of Rikuu 132.

Ishii Takuro, Director of the Division of Rice Research, Institute of Crop Science, at the National Agriculture and Food Research Organization

All photos: Courtesy of NARO

(NARO), says, “Currently, there are more than 300 varieties of rice grown in Japan. Koshihikari accounts for the largest percentage (33.9%) of the area planted in 2019. The most widely grown cultivars after Koshihikari are Hitomebore followed by Hinohikari, then Akita Komachi and Nanatsuboshi. These are all descendants of Koshihikari and are the most popular rice varieties with consumers.”

Until the period of high economic growth, the purpose of breeding was yield to achieve self-sufficiency of rice. However, the emergence of rice overproduction in around 1970 brought a shift toward prioritizing eating quality. Despite the drawbacks of Koshihikari, namely lodging<sup>i</sup> during cultivation and susceptibility to disease, it has become popular for its plump cooked rice, sticky texture, and its rich umami taste that suits the Japanese palate. Ishii says it has become important to breed varieties that have good eating quality while also being high-yield and disease resistant, reducing production costs.

“Restaurants and take-out food establishments demand rice that is reasonably priced and tastes good. One technique that has been introduced to lower production costs is direct seeding, which means sowing seeds directly into the rice paddies rather than using the conventional method of growing seedlings first and then planting them in the fields. Chihominori, developed by NARO, is a high-yield and tasty variety with short plant height and resistance to lodging, making it suitable for direct seeding. More and more growers in Japan are now introducing the direct seeding technique, especially those with large-scale operations.

With Japanese food such as sushi spreading around the world, rice breeding is also being carried out with an eye to export. Eminokizuna, one of the varieties bred by NARO, is suitable for sushi rice because when cooked it is less sticky so sushi vinegar can penetrate the cooked rice well and the grains separate easily, imparting a light texture. Eminokizuna is now being exported, mainly to Singapore and other Asian countries.

There is a demand too for varieties that cope with global warming. If the temperature is too high in the



Rice immediately before and after harvesting

summer when the grains are developing and growing, the grains become chalky and the quality drops significantly. At the same time, there is still a risk of cold damage, so NARO is researching varieties that can cope with both high and low temperatures.

“From 1998 to 2004, the rice genome<sup>ii</sup> was sequenced by an international consortium led by Japan. Based on this information, it is now possible to determine characteristics such as the disease resistance of a rice plant simply by extracting DNA from its leaves. Selection techniques that use rice genome information could make a significant contribution to the world’s food situation, by enabling efficient breeding of varieties with the purpose of improving disease resistance and yield,” says Ishii.

The rice breeding techniques developed in Japan over many years are expected to offer major benefits for the world at large. **7**

<sup>i</sup> The weakening of plant stems under the weight of grain.

<sup>ii</sup> Sequence of the four types of bases inside a nucleic acid molecule: adenine (A), thymine (T), guanine (G), and cytosine (C).