Soil Salinity: Breeders Try Something New

IRRI scientists have begun a ground-breaking experiment in plant breeding that they hope will overcome the seemingly intractable problems of providing rice plants capable of thriving in saline soils.

For the first time, a breeding program that begins with the latest biotechnology will end only after several seasons in farmers' fields, when the farmers themselves become the final arbiters and select plants for their own conditions.

Soil salinity, in its many forms, is a growing problem throughout Asia. Often, flooded paddies raise local groundwater levels, bringing salts to the surface. Elsewhere, chemical processes within the soil itself result in both acidity and toxic levels of various minerals. And rising sea levels because of global warming are expected to transport saltwater inland, thus polluting coastal wetlands.

The new approach represents a challenge to plant breeders, who are used to developing new plants according to known parameters and delivering the finished articles for release to farmers. In the case of saline-tolerant plants, this procedure has rarely been successful.

According to IRRI plant breeder Dr. Glenn Gregorio, there has been scant recognition of the variety of soil conditions described broadly as "saline." He says that saline soils can be acid, acid sulfate, peat, or alkaline. Most are lacking in phosphorus and zinc, and some have toxic levels of iron or aluminum. This variety extends across the normal range of rice-growing environments, pest and disease problems, and grain qualities.

"In the past, national agricultural research and extension systems (NARES) have tended to select salinity-tolerant varieties for release by averaging their performance over a range of saline soils," Dr. Gregorio says. "This has worked for a few farmers where the plants were able to adapt to the soil conditions, but it's failed for the rest. A lot of people out there don't recognize the difference between salinity and alkalinity, much less the other differences.

"So we realized the need for a large range of plants capable of adapting to diverse soil conditions. What we've come up with is almost site-specific breeding."

IRRI's plant breeders began by developing a large number of plants whose genetic salinity tolerance has been proven by molecular-assisted selection. They are the raw material for the new approach, and the coastal wetlands of Bangladesh are the trial ground.

The project involves two procedures: farmer participatory variety selection and farmer participatory plant breeding.

In the first, a collection of salinity-tolerant varieties will be grown under different soil conditions by local farmers themselves and they will be asked to select varieties according to their performance on soils similar to their own. The chosen varieties will then be grown in national trials prior to release.

The second procedure is more radical. About 15 farmers, each with one hectare of land or less, have been chosen as the first farmer-breeders. Because they're poor and the experiment will use a large plot of their land, deals have been made to guarantee their normal domestic rice supplies.

In the first season, each farmer will receive seeds for as many as 20,000 different plants, to cover the widest possible range of adaptability. These plants will be traditionally bred crosses between salinity-tolerant varieties and popular high-yielding varieties. They will have undergone screening for salinity tolerance using molecular markers and advanced through six generations to ensure their genetic stability.

The farmers will be asked to watch carefully how the plants compete with weeds, how they develop and yield under their normal management practices, and how the grain suits their tastes. They'll be asked to identify the best plants in the crop, perhaps as many as 100 plants.

Researchers will then help the farmers gather seed from their selected plants and, in the following season, one row of seed from each selected plant will be grown in the same field. Once more, the farmers will watch carefully and select only the best rows, cutting the short-listed varieties down to about ten.

Seed will once more be collected from the chosen rows and, finally, the farmers themselves will plant these seeds in plots, using their own procedures and systems. At the end of the third season, they will select the best plot and that variety will thereafter be theirs to grow. The farmers will choose the variety that most successfully adapts to the specific conditions of their individual farms.

"We expect the technology to spread rapidly because the farmers themselves will be involved; they will regard their chosen varieties as their own," Dr. Gregorio says. "But I don't expect it to be easy. We will have to teach them to be brutal in their assessment of the plants. They must learn to discard the good ones and keep only the best.

"It's also going to be difficult for us, as plant breeders, to accept a different way of doing things," he adds. "It's not all science any more. We've got to learn to work with the farmers, to spend time with them, to use their language, and to listen to what they say."

Watching the procedure with great interest will be scientists from NARES in India, Thailand, Indonesia, and Sri Lanka. These are the countries most in need of successful salinity-tolerant rice varieties.