Mini-Documentary: *Salt of the Earth*

**A History of Collaboration Breeds Modern Solutions**

Vietnam is the second largest rice exporter in the world, and the Mekong Delta lies at the heart of the country’s rice-producing region. But the Delta is not static. In an effort to feed themselves year-round and maximize opportunities produced by the river’s ebb and flow, farmers in the Mekong Delta flood rice fields with saline water in the dry season to raise shrimp. In the wet season, they use rain and fresh river water to flush the salt out of the soil to prepare for rice planting. This practice poses severe challenges: namely, rice crops do not adapt well to the high salinity caused by the shrimp farming, and crop failures are a frustrating legacy for a people steeped in the agrarian traditions of generations.

One such farming couple, the Thucs, who were featured in the mini-documentary “Salt of the Earth,” can now dream of sending their children to university after planting Pioneer® brand rice hybrid PHB71, a seed that prospers in salty soils and low water levels, producing predictably higher yields in the short four- to five-month planting season that choreographs the rhythm of the Thucs’ lives.

Addressing world hunger requires a global effort to hone in on local solutions. Over a period of several years, DuPont Pioneer worked with research institutes and local partners throughout Asia testing PHB71 to address the very challenges that have kept generations famers like the Thucs in poverty.

PHB71 is the commercial hybrid developed from crossing a female parent line developed in the Philippines by the **International Rice Research Institute** (IRRI) with a male parent line developed by Pioneer. Bringing together positive attributes from both parent plants resulted in a hybrid with improved roots, vigorous growth and increased yield over local varieties. Very adaptable to different environments, PHB71 has proven to be a top-performing hybrid across the board, standing up in rigorous tests in Vietnam, India, the Philippines, Indonesia
An Intricate Hybrid Breeding System

Cytoplasmic male sterility (CMS) is an intricate breeding system designed to combine good genetic traits from “parent” seeds that is used in the development of many hybrid crops, including rice, maize, sunflower, canola and numerous vegetable crops.

A female inbred (“male sterile”) line that does not produce pollen is cross-pollinated with a male inbred line that produces fertile pollen, resulting in the production of a hybrid seed strengthened by attributes from both parents. A critical first step is the production of the male-sterile female inbreds: they are first developed from germplasm with normal cytoplasm that produce viable pollen. This “maintainer” version of the female line, which can self-propagate since it has normal pollen, is then converted to a male sterile version—the cytoplasmic genetic male-sterile (CMS) line—that does not produce pollen by crossing the maintainer version to a rice line that has a sterility factor in the cytoplasm of its cells. Through a series of backcrossing, an identical male sterile version of the female line can be developed.

To propagate the male-sterile inbred, a parent seed production step must be undertaken: the original fertile maintainer line is cross-pollinated with the genetically identical, yet sterile, female version to produce seed on the sterile version. The resulting parent seed is used as the sterile female line in seed production fields. There, the sterile female inbred is grown adjacent to a fertile male inbred line (i.e., an inbred with different genetics that complements the female inbred) and allowed to cross-pollinate, resulting in the production of hybrid seed. In the case of rice, farmers grow hybrid seeds to produce high-yielding crops with improved stress-tolerance.

and Cambodia. For the Thucs and their neighboring farmers, PHB71 demonstrated strong tolerance for the high salinity of the Mekong Delta soil, producing a 30-40% higher yield. It has also proven to be more resistant to Bacterial Leaf Blight and Leaf Blast than local seed varieties. With its extensive root system and enhanced vegetative vigor, the hybrid is also more drought tolerant than the open pollinated varietals (OPVs), which are seeds that pollinate openly in uncontended fields.

Although the hybrid has been used in Vietnam since 2008, the science behind developing hybrid rice and commercializing it for use by farmers in the region has a much longer history. Governments, multinational research organizations and private companies have contributed key links in the chain. The first generation of hybrid rice technology was developed in China some 40 years ago.

Up until the last 40 years, rice was strictly a varietal crop. A breakthrough came in the 1970s when Chinese scientists created the cytoplasmic genetic male-sterile (CMS) line, which allowed the establishment of the female lines necessary for hybrid production.

India has also played a leading role, dating back to the launch of its government’s hybrid rice program in the early 1990s. Pioneer started its hybrid rice program in 1988.

“Hybrid rice is an important solution to solving the problem of global food security.”

Pham Trung Nghia, PhD, vice director,
Cuu Long Delta Rice Research Institute, Can Tho, Vietnam

Hybrid testing for response to regional environmental and climatic challenges is rigorous, collaborative and wide-reaching. Before being used by farmer Thuc for “rice after shrimp farming” in the Mekong Delta, numerous organizations put PHB71 through its paces, including the Food Crop Research Institute and the South Center for Plant and Fertilizer Testing of the Ministry of Agriculture and Rural Development in Vietnam, the All India Co-ordinate Rice Improvement Project of the India Council of Agricultural Research, India’s Directorate of Rice Research, the Indonesia Center for Rice Research, IRRI, the National Seed Industry Council in the Philippines, and the Cambodian Agricultural Research and Development Institute.

The Pioneer testing team also used large areas for demonstrations under certain soil conditions. This process can take 2-3 years, and agronomists work closely with local farmers to ascertain the costs and benefits of introducing new seeds. Pioneer also sampled PHB71 with growers to allow them to grow the hybrid side by side with their local varieties under their own management practices. In most cases growers realized a significant yield advantage with PHB71.
Plant Breeding Glossary

Doubled Haploids – Genetically pure plants that are developed through a special cross-breeding and chemical process. This process takes a fraction of the time of traditional inbreeding and provides improved parents for higher performing hybrids.

Genomics – The study of the genetic material in a chromosome set. The information gathered through genomic tools, when used in conjunction with other technologies, helps researchers better understand which genes determine important characteristics and how genes work together.

Germplasm – A collection of genetic resources for an organism. The Pioneer collection of maize genes used to develop hybrids, which is one of the most genetically diverse in the industry, is one example. These collections are critical resources for researchers who are committed to finding genes that improve specific characteristics.

Grey Leaf Spot (GLS) – A fungal disease that affects maize, or corn, and is often manifested as brown lesions on the leaves. This disease is most prevalent in hot and humid climates.

Heterosis – A term used in cross-breeding to define when an organism has qualities that are superior to those of either parent.

Hybrids – The offspring of a cross between two different parent plants.

Inbreds – The parents of hybrids, which exhibit desirable characteristics and genetic purity.

Male Sterile Line – Seed that has sterility factor in the cytoplasm of its cells and, thus, does not produce pollen. These lines are crossed with those that do produce fertile pollen, resulting in production of a hybrid seed that has attributes from both parents.

Northern Leaf Blight – A disease caused by the fungus exserohilum turricum, which affects maize, or corn. The lesions are long and narrow.

Open Pollinated Varieties (OPV) – Types of plants (for corn, rice, etc...) that develop when the pollination of seeds in a field is not controlled. This process results in more genetic diversity and crops may not be uniform. However, the costs of OPV seeds are not as high as those of hybrids.

Molecular Marker – A piece of DNA that is closely associated with a gene (or genes) responsible for a certain characteristic, like height. By using molecular markers, researchers can better predict which plants will have beneficial characteristics. It also saves time because plant breeders can begin field trials with an improved pool of candidate hybrids that are more likely to succeed.

Stress Tolerance – Strains of seeds that can withstand stresses such as drought, high salinity, floods, cold, or soils that are deficient in nutrients.

Transformation – A process whereby the genetic characteristics of an organism is changed via the insertion of a new gene. The new gene generally comes from the DNA of a different organism. It gives scientists the ability to improve products in ways that may not be possible through conventional breeding, such as improving a plant’s resistance to insects.
Additional Resources

Cambodia
Cambodian Agricultural Research and Development Institute

India
Directorate of Rice Research
Indian Council of Agricultural Research

Indonesia
Indonesian Center for Rice Research

Philippines
International Rice Research Institute
National Seed Industry Council

Vietnam
Ministry of Agriculture and Rural Development

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