

Sugarcane research facilities and breeding programs of the Philippines, Indonesia, Bangladesh, Thailand and Malaysia

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Research is indispensable to any endeavor. More so during these times when the world enters globalization and the free-market economy. The sugar industry specifically must move forward and be competitive. In this regard, the need for regional cooperation becomes essential.

The ISO/CFC project includes the exchange of sugarcane varieties and technology in the Asia-Pacific member countries – Thailand, Indonesia, Malaysia, Bangladesh and Philippines. This report is a description of the breeding programs of the participating countries during a two-week trip from February 25-March 11, 2001 with Mr. Leon Arceo, Director-General of PHILSURIN. All the grounds have been laid for a successful cooperation on exchanges – both on sugarcane variety and technology. Even Malaysia, which has relegated the 'marginal' areas for sugarcane in favor of palm oil, has expertise to share on the aspect of technology transfer and licensing. The immediate impact of having a diverse genetic base and the ability to evaluate varietal performance across different regions would be significant and lasting.

The following are the brief description of the working Sugarcane Varietal Development Program of 4 countries.

PHILIPPINES

Location and Facilities

PHILSURIN's breeding station is located at Victorias City, in the province of Negros Occidental which is considered the sugar bowl of the country since almost 80% of the agricultural land is planted to sugarcane. The province has 10 operating mills.

The breeding station is composed of 16 staff with the senior plant breeder managing the station's activities. It has 4 sections – Breeding, Pathology, Agronomy and Micropropagation laboratory. Each section is under a head with 1-2 field assistants. The breeding section handles the first 2 years of the breeding activities – from hybridization to field selection. Testing for the different ecological test areas is the responsibility of the agronomy section while disease screening and observation is under the pathology section. The micropropagation laboratory enables the rapid dissemination of disease-free new releases. It takes 7-10 years for a release to be made. The station is under the deputy director for operations, Dr. Ramon Cu.

The station has a 1,000 germplasm collection which has been accumulated since 1967 when the center had Active exchange programs with USDA, France, South Africa, Formosa, and China. Foreign varieties account for half of the collection. A duplicate germplasm collection is planted at the Institute of Plant Breeding (IPB), University of the Philippines at Los Banos as part of PHILSURIN's germplasm preservation project.

The station is equipped with two bi-parental sheds, two polycross sheds, a greenhouse, two big tanks as rainwater reservoir, a photoperiod chamber, a fumigation chamber (for methyl bromide), a micropropagation laboratory, and a 15-hectare experimental field. The station also houses the MDDC

facilities like the small-capacity Hot Water Treatment (HWT) tank for the production of RSD-free cane setts.

The Bureau of Plant Industry (BPI) is handling the quarantine activities for PHILSURIN. The quarantine facilities are located at the Los Banos Economic Garden, Laguna.

Breeding Program

The hybridization activity starts in the second week of October and lasts for a month. About two hectares are planted to the parental varieties with the proven parents planted in greater plot sizes (based on the percent selection from the prior selection records). The problem of flowering synchronization for early and late flowering is partially addressed by utilizing an area with a higher elevation and cooler temperature as tassel source. Flowering in this site normally occurs a week earlier than at the station. As such those varieties that would otherwise not flower together can be crossed. A normal breeding season utilizes about 270-350 parent varieties for 700-900 crosses.

Two types of crosses are made – bi-parentals and polycrosses. Bi-parentals make up 60% of the total crosses and the rest are polycrosses. Bi-parental crosses are set-up with 4 stalks for both the male and the female parents. They are enclosed using rectangular 6 footer cheesecloth inside a shed with a capacity of 120 set-ups. A modification for bi-parental called an area cross is done by using a single male parent against several pollen sterile parents. Another is the outside polycross, a modification of the melting pot technique. In a normal polycross there is a melting pot of all the flowering varieties, yet control is achieved by focusing on a single trait like sweetness or resistance to smut. The task of pairing for the bi-parental crosses and polycrosses, which must be done daily during the season, is sped up by utilizing a computer program that generates the optimum pairs based on the desired criteria. The criteria include parental performance of the parental varieties, disease records, and other parameters like stalk size, trashiness and sweetness. This serves as a guide for the breeder to consider.

After the list of pairs is finalized, the flowering stalks of the cane are finalized, the flowering stalks of the cane are cut in the field and brought to the station. No emasculation is done. The crosses are preserved until full bloom by using the acid solution technique (this is a concoction of strong acids like sulfuric, citric, and nitric acid). The acid solution is changed every three days to maintain its concentration until complete shattering of the male parent is achieved after two weeks. The fertilized flower, called fuzz, is harvested from the females.

After two weeks the crosses are harvested and kept in a cool room until sowing is done on the 2nd week of December. A sample of 15 grams from the harvested fuzz from each cross is sown in sterilized soil (using methyl bromide) in plastic trays. The remaining fuzz are placed in paper bags and stored in a freezer. To enhance germination, the sown fuzz are kept in a warm room (28°C) for three days after which they are brought to the nursery. The germinated fuzz are then separated and individually dibbled in plastic trays on the projected population and available area. Normally, the seedling population is 100-150 thousand.

The first multi-location test is called the preliminary yield trial (PYT) that starts on the 6th year. The entries are planted in RCB design of 6x9 m plot size, 4 replication experiment set-up. Emphasis at this stage is on the yield performance for three geographical divisions of the country – Luzon, Visayas and Mindanao. This is followed by the advance yield trial (AYT) where the emphasis is yield (palnt and

ratoon) performance for each of the mill districts across the country. Right now, there are 15 AYT test sites. The AYT tests are conducted with the participation of the MDDC coordinators of PHILSURIN such that release or consideration for releases of the clones at this stage is based largely on the evaluation and recommendation of the local MDDC coordinators.

Varieties released by the station beginning from 1997 series have a prefix of PSR (PHILSURIN); while previous releases have a prefix of VMC (Victorias Milling Co.)

Diseases

The most important diseases are smut, downy mildew, leaf scorch and rust. Screening for smut, downy mildew, leaf scorch are done by artificial inoculation while rust screening is done in pots at the greenhouse. The program includes RSD diagnosis for entries at the advance tests. There is no reported case for white leaf disease, leaf scald and mosaic.

Varieties

The station has also the capacity to produce 40,000 seedlings of micropropagated seedlings per month and is the main tool, aside from the conventional cane setts, for the rapid dissemination of the new high yielding varieties across the country.

Varieties for exchange are VMC 67-611, VMC 71-238, VMC 71-39, VMC 73-229, VMC 76-16, VMC 87-599, VMC 86-550, VMC 87-95, VMC 84-524, and VMC 84-947.

INDONESIA

Location and Facilities

Breeding for higher yielding varieties is still the main task of the Indonesian Sugar Research Institute (ISRI). Other projects include research and services on production equipment, agricultural technology, processing technology, waste-treatment technology, etc. Among its frontier researches are biotechnology research on sugarcane, production of dextranase enzyme, production of Maillaerd-Reaction Products (MRP) to inhibit microbial activities, desugarization of molasses, serodiagnosis for early detection of smut disease, research on sucrose esterase surfactant in the cosmetic industry and as additive in food industry. ISRI is located at Pasuruan. It has 70 ha. Of land where the germplasm collection is planted and where experiments and selections are conducted. It has a plant breeding laboratory with facilities for sugarcane seed storage, biotechnology and tissue culture laboratories that can produce more than 200,000 plantlets per year. Cane juice and sugar analysis laboratory is available.

The institute has a total of 403 staff broken down to 9 PhD, 23 Ms, 53 Ir/BSc, 56 support staff and 262 technical laborers. ISRI is a government agency under the Ministry of Agriculture.

ISRI has total germplasm collection of 6,000 hybrid clones, 767 of which are wild native canes. These collections have been accumulated through an active germplasm exchange program with other breeding stations such as Australia, India, Barbados, Hawaii, Japan, and Mainland US. Other collections were from expedition conducted throughout the Indonesian archipelago.

The quarantine station at Puteran Island, Madura, east Java is located more than 100 km from the closest sugar plantation.

Cane crossing is conducted at Sempalwadak, Malang station, which is about 70 km away from Pasuruan with an elevation of 400 m above sea level.

Breeding Program

The crossing season begins on the month of November. Six to ten technical staff stay at the station for the duration of the crossing season. It has seven crossing houses, a laboratory, a seed dehumidifying room, structures for light interruption of spontaneum varieties, and a large shed for the crossing and emasculation activities. A two-hectare field for tassel source is at the back of the station.

The acid-solution technique also known as the Hawaiian method and marcotting are employed to prolong the life span of the cut stalk until full bloom. The marcotting method is used in approximately 40-60% of the total crossings made by ISRI. Since the 1988 crossing season, a computer was used to make a parent matching priority. This computer program generated pairing matches. Two types of crosses are made: proven crosses (good combination made with yield data) and trial crosses (pairing between parents before yield trial data is available).

Bi-parental crosses are made with 2 male x 1 female stalk enclosed with circular cheesecloth to prevent pollen contamination. In-field pairing is also done wherein the cut male stalk is placed in an acid solution-filled bamboo tube, then brought to the standing female clone and enclosed by a suspended cheese cloth to prevent contamination. For the polycrosses, a set-up of several good female clones against 1 male clone is made and is referred to as area cross. The station is capable of making up to 10,000 crosses in one season.

Emasculation with ethanol was applied to avoid selfing. The intended female flowers are soaked in 63% alcohol for 9 minutes and then washed with running water. The resulting fuzz from the crosses were then germinated and sown in sterilized soil (10 ml of formaldehyde to kg soil for 2 days) in plastic trays. The normal seedling population is 200-300 thousand seedlings.

On the sixth year of screening the entries goes to the different substation for multilocation ecological test. Seedling selections are carried out on representative locations such as Pasuruan, Comal, Jengkol, Solo, Cirebon, Medan, Pelaihari, Jatiroto, Bungamayang, Gunungmadu, and Takalar. The substations provide seeds to farmers and the millers (which own majority of the sugarcane-planted areas) at the cost of 1,000 Rupiah per kilo of cuttings. It also provides technical advice.

It takes about 9-10 years before a release can be made. Since the 80s, the releases by the station were location-specific releases. In 1965, all POJ numbers codified since 1945 were renumbered into Ps (for Pasuruan). Moreover, the release of PS number had to be approved and declared by the minister of agriculture.

To overcome the limitation of planting materials required by cane growers, a rapid multiplication method of new varieties by tissue culture is used.

A number of studies in searching for sugarcane mutants by using gamma rays irradiation have been reported. Specifically, gamma radiation was found to produce mutant clones that reduces flowering. Another area of research conducted by the breeders is cell fusion as an alternative in cane crossing.

Breeding for drought tolerance and biotechnology, specifically the transfer of the cry gene of *Bacillus thuringiensis* to sugarcane callus is also undertaken.

Diseases

The most important diseases are smut, RSD, rust scorch, mosaic, leaf scald, top rot, root rot, CSD.

Varieties

Varieties for exchange are PSGM 88-5052, PSBM 90-44, PSCO 90-2411, PS 86-10029, PS 80-1424 and PS 81-362.

BANGLADESH

Location and Facilities

The Bangladesh Sugar Research Institute (BSRI) is located at Ishurdi and has been in existence since 1945. It became a full-pledged research institute in 1951. In 1989, it was transferred from the ministry of Industry to the Ministry of Agriculture.

In Bangladesh, 60% of the growers have an average land area of 10 acres and almost half of the sugarcane grown is intended for "gur" or muscovado sugar. Aside from the breeding for higher yielding and drought/flood-tolerant cane, the institute embarks on technology transfer (SAEC) of basic sugarcane cultural practices, intercropping, small machines development and improvement in gur processing. The institute is composed of five departments: Research and Development, Plant Genetics and Breeding, Training and Extension, Soil Fertility and Pathology.

BSRI has a total of 368 scientist/technical staff, 3 regional stations, 4 service stations and 8 pre-evaluation sites. BSRI has a total of 1000 germplasm collection with 30 wild species. These are mostly exchanges from India though most of the commercial varieties have local varieties as parents.

The quarantine station takes place in November-December at the Ishurdi experimental complex. The institute has a bi-parental shed with panels of fiberglass that serve as separator for each pair of cross and a canal with flowing water to maintain the marcotted crosses. It also has eight (8) photoperiod chambers which are not currently used, as light interruption to delay flowering was more practical.

Most if not all pairings are bi-parentals. Pairing of the flowering clones are based on the previous performance of the cross, the disease rating of the parents and the yield potential. The acid-solution was discarded because of the limited availability of sulfuric acid. Marcotting is instead being practiced. The station normally makes 600 crosses from 140 parents.

The sex rating of the clones is based on the iodine test conducted regularly. The fuzz from the crosses are sown in July in permanent cemented flats with sterilized soil. Excess fuzz are stored in a freezer to be utilized the following year. The seedling population would be 50-60 thousand.

Diseases

The most important diseases are red rot, mosaic, smut, white leaf, RSD, top rot, leaf spot, leaf scald. There is no incidence of downy mildew.

THAILAND

Sugar is one of Thailand's major industries and as such the government has created a committee that oversees all activities in all spheres of the industry – research, extension and policy making. This committee, which is under the Ministry of Industry, is the Office of Cane and Sugar Board (OCSB). Under this umbrella is the Sugarcane Research station located at Kanchanaburi, about 100 km southwest of Bangkok. The station is composed of Pests and Diseases, Soil and Fertilizer, Cultural Practices and Sugarcane Variety Improvement departments.

The organizational structure of the station is lean. It has 12 staff, 4 are agriculture technicians and 8 are technical assistants.

The station has a total of 500 collections which it has accumulated through exchanges with the neighboring sugarcane breeding countries such as Indonesia, Philippines, and China.

Cane crossing starts from the month of November to December. The station relies on natural flowering. The breeder utilizes the records of yield, characterization and pathology data to decide the pairs to be made.

The acid-solution technique is employed in preserving the crosses, which are all bi-parentals. The flowering clones are collected early in the morning from the field and are paired according to the prior match made. The female clones are emasculated by using water vapor (50oC) for 7-10 minutes. The crosses, consisting of 3 stalks of male for every stalk of female, are then enclosed in bi-parental lantern.

The resulting fuzz from the crosses are then sown in cemented flats approximately 0.5m x 0.5m with sterilized soil (using methyl bromide). The germinated seedlings will stay at the nursery for 2 months until June where it will be transplanted to the field. The excess fuzz are stored in paper bags with fungicide (IBA) and then stored at 8oC. The station normally makes 20,000 seedlings from 100 crosses.

Diseases

The most important diseases are white leaf, smut, and red rot. There is no incidence of downy mildew.

Varieties

The varieties listed for exchanges are K76-4, K84-69, K84-200, K88-65, K88-87, K88-92, and UT1.