SIDA RESEARCH, DEVELOPMENT & EXTENSION PROGRAM HIGHLIGHTS OF ACCOMPLISHMENTS COMPLETED PROJECTS

A. VARIETY IMPROVEMENT AND CONSERVATION

i. Improvement of the Recommended Sugarcane Varieties using Nuclear Technology and Biotechnology

Implementing Institution: Department of Science and Technology - Philippine Nuclear Research Institute

This project aimed to improve SRA recommended sugarcane varieties grown from Batangas, Negros, and Bukidnon using Nuclear Technology and Biotechnology targeting traits for bioethanol production efficiency. After a series of mutation induction experiments, twenty-two (22) putative mutants with high LKg/TC with erect habits from irradiated accessions of Phil 99-1793, Phil 2000-0791 and Phil 7544 were selected for further observation. Moreover, nine (9) out of the 22 selections with high LKg/TC were also observed to have exhibited reduced lignin contents (-0.7 to -76.37%), indicating that mutation breeding using gamma radiation in sugarcane can potentially decrease the lignin content without significant impact on sugar productivity. Meanwhile, using 2 microsatellites were also observed to have exhibited reduced lignin contents (-0.7 to -76.37%) indicating that mutation breeding using gamma radiation in sugarcane can potentially decrease the lignin content without significant impact on sugar productivity. Meanwhile, using 2 microsatellite markers (performed by SRA-LGAREC), at least 9 irradiated sugarcane accessions were identified as potentially resistant to sugarcane smut, a fungal disease caused by Sporisorium scitamineum. Cane points from these initial selections were sent to SRA-LGAREC for further propagation in preparation for the requirements of Preliminary Yield Trials and National Cooperative Testing (Multi-location Trials) before registering to the National Seed Industry Council.

ii. Utilization of In-vitro Technology for Conservation and Micropropagation for Quality Seed/Planting Material Production for Sugarcane Variety Improvement and Enhanced Farm Productivity

Implementing Institution: University of the Philippines Los Baños

Protocols for successful in vitro culture introduction and establishment, micropropagation, and germplasm conservation for a range of sugarcane varieties and accessions were developed. A total of 444 sugarcane accessions were introduced/reintroduced in vitro and cultured using MS medium + 3 mg/L BAP. Of the total accessions cultured, 364 were successfully regenerated and micropropagated and maintained initially and 80 accessions were repeatedly lost due to initial surface and endogenous contamination. The current active in vitro collections totaling to about 200 accessions maintained in 1932 culture vessels (maximum of 20 vessels per accession, 5-10 shoots per vessel) were regularly subcultured every 1-3 months depending on the accession.

For medium term conservation technique, modification of culture media and vessel closure/cover and the effects of osmotic regulators (mannitol and sorbitol), phenolic

oxidation inhibitor (activated charcoal) and anti-senescing agents (silver nitrate, silver thiosulfate, cobalt chloride) on shoot survival, shoot regeneration and vigor, and shoot growth retardation in vitro were determined. The optimum culture media treatment combinations selected were MS + 1.0 mg/L BAP + 2.0% mannitol and MS + 1.0 mg/L BAP +0.5 mg/L + 3.0% sorbitol. These treatments extended culture storage duration to about 8 months (mannitol) and 6-9 months (sorbitol), exhibited slower shoot proliferation and growth of sugarcane cultures while still exhibiting high vigor with minimum media browning and highest recovery of stored cultures. Addition of 0.5 mg/L activated charcoal significantly reduced the culture media browning and enhanced shoot even for prolonged culture duration. Control of media dehydration through modification of culture vessel closure/cover was achieved through the use of plastic cap cover and sealed with cling wrap.

The genotypic responses and maximum storage duration for a range of sugarcane accessions to combined minimal growth medium (MS + 1 mg/L BAP +2% mannitol + AC and MS + 1 mg/L BAP + 0.5 mg/L kinetin + 3% sorbitol +AC) and MS + activated charcoal (0.5 g/L) were evaluated. Genotypic response of 11 sugarcane accessions to MS+2% mannitol +AC showed 67-100% survival in 90% (10/11) of accessions tested, reduced shoot and root growth, high vigor rating and reduced media and explant browning even after 3 months of continuous culture. Recovery of shoots after 8 months of continuous culture on MS + 3% sorbitol + AC medium ranged from 20-80%. Genotypic response of 54 sugarcane accessions to MS medium + AC showed enhanced shoot growth, high vigor rating for majority of the genotypes, optimum root initiation and proliferation, significant reduction in explant and media browning, and reduced endogenous bacterial contamination in culture.

For long term conservation through cryopreservation, four cryoprotection and cryopreservation techniques were evaluated for sugarcane tissue explants: Using the modified TPLM-vitrification procedure, successful cryopreservation and recovery of cryopreserved shoot tips of two sugarcane accessions (PHL 2000-0791 and PHL 2000-1419) were obtained. Cryopreserved shoots showed 26.9% recovery after 4 months of culture, produced healthier shoots, and showed minimal browning. The cryopreserved tissues, however, showed very slow growth and limited differentiation into plantlets. The protocols and outputs generated from the project were disseminated to end-users through trainings (3), seminars, farmers forum, technical assistance and farm/field visits, paper presentations (13) in scientific conferences, IEC materials (5), and dissemination of planting materials (~7000).

iii. Sugarcane Varietal Improvement to Develop High-Yielding and Climate Change Resilient Varieties

Implementing Institution: University of the Philippines Los Baños

The project aimed to develop sugarcane varieties with high tonnage yield, high sucrose content with resistance to different pests and diseases and resistance to abiotic stresses. A total of 120 sugarcane accessions were collected from seven regions of the country and are currently being maintained in the University of the Philippines Los Baños. Parentals for breeding were then selected and were hybridized. A total of ~3,500

seedlings were developed during the project. Out of these seedlings, 64 hybrids were selected based on plant vigor, yield and yield-related components, response to drought, and pest and disease incidence. Ten of these hybrids were trialed in three locations namely: 1) UPLB, Laguna 2) La Granja, La Carlota, Negros Occidental and 3) USM, Kabacan, Cotabato. After the multilocation trial, five hybrid lines were found to be promising - UPLBSC 004, UPLBSC 011, UPLBSC 013, UPLBSC 030 and UPLBSC 032 - across Luzon, Visayas, and Mindanao. These promising hybrid selections were also found to be resistant to downy mildew based on field evaluation. From the remaining 54 hybrid selections, 14 have been evaluated in Advanced Yield Trial and 40 in Preliminary Yield Trial in UPLB.

The five (5) promising lines are recommended to be evaluated and trialed in more locations in the Philippines. The other promising selections are also recommended to undergo advance trial and selection to determine performance across the country.

iv. Assessment of Sugarcane Varieties & Germplasm Collection for Drought & Waterlogging Tolerance

Implementing Institution: University of the Philippines Los Baños, Sugar Regulatory Administration

Extreme weather conditions such as extreme dry spells and excessive rains are among the environmental stresses affecting sugarcane production. This project addressed these two extreme conditions in sugarcane production through the evaluation of sugarcane varieties and germplasm collection under drought and waterlogging conditions. The project combined the expertise of plant physiologists, agronomists, and agricultural engineers from UPLB and SRA-LAREC, and SRA-LGAREC in characterizing the drought and waterlogging tolerance of high-yielding sugarcane varieties released by the Sugar Regulatory Administration. The high-yielding varieties were characterized in terms of agronomic, morphological, and physiological traits. Image analyses of captured images during the stress and recovery period were also used to determine canopy temperature and net difference vegetation index (NDVI) which also led to the development of image analysis software. The project also explored the utilization of Visible and Shortwave Near Infrared Spectroscopy (Vis-SWNIR) in the measurement of juice quality. Calibration models using PCA-PLSR to predict Brix level, moisture content, and computed fiber content were developed for each variety at the Vis-SWNIR (300-1000 nm) and NIR (900-1700 nm). Calibration models for predicting Brix level and moisture content that were scanned with the peel intact had the best results in the Vis-SWNIR range. The corresponding models for the NIR range also showed good results. On this basis, the skin scanning method could potentially be used for rapid and nondestructive prediction of cane quality in the field.

The multilocation trials for the drought tolerance study identified the best-performing genotypes across the environment per growth stage of drought imposition. The results of the study indicated that for both growth stages, only 1 - 2 genotypes were identified to be the best performers in terms of cane yield while 3 - 4 genotypes for sugar yield since only these vertex genotypes covered most of the test environments. For cane yield, PHIL 2006-1899 and PHIL 2000- 2155 produced the highest cane yield across the test sites

during tillering stage drought while PHIL 2004-1011 and PHIL 2000-1419 were the best cane yielders during the stalk elongation stage drought. But unlike the former, PHIL 2004-1011 and PHIL 2000-1419 have shown to be more consistent under stalk elongation drought throughout the two cropping seasons in each test environment. PHIL 2004-1011performed best in both Floridablanca, Pampanga, and Los Baños, Laguna while G6 in La Granja, Negros Occidental. Based on the GGE biplot analysis, PHIL 2004-1011 was the most consistent for both the tillering stage and stalk elongation drought experiments in terms of cane yield and sugar yield, PHIL 2004-1011 might have not been the highest performer but it consistently ranked at least 3rd in all the test sites.

Mass screening of germplasm accessions was conducted either under field or greenhouse conditions with the confirmatory trials conducted under field conditions. Field evaluations of 198 sugarcane varieties and accessions for drought tolerance were conducted from 2018-2020 under field conditions at UPLB. The confirmatory trials in UPLB and SRA-LAREC showed that the UPLB selections were better than the check varieties in terms of plant height during early establishment, stress, recovery, and harvest. Moreover, they were comparable with Phil 2004-1011 in terms of tillering ability and SPAD values. However, the selections were not at par with the checks in terms of stalk diameter, juice quality, sugar recovery, and total sugar yield.

The benefits derived from drought stress priming were observed in ratoon canes grown under rainfed conditions in terms of cane yield, number of millable stalks, and plant stand. The ratoon harvest data showed the significantly higher cane yield of canes that had twice the exposure to drought compared to the canes with single drought exposure. This was a result of the higher number of millable canes and higher plant stand of canes with twice the exposure to drought.

A greenhouse protocol for rapid screening of sugarcane for drought tolerance was developed with the aid of different multispectral parameters to ensure accuracy and efficiency of selection. Under greenhouse conditions, the protocol involved growing sugarcane seedlings in SNAP hydroponic solution for 2-3 months (tillering stage) before treating them with PEG 6000 to simulate drought conditions. PEG-induced drought can last up to 30 days, or up to visible drought-related responses can be observed. The protocol was able to identify at least 3 (out of 10) potential genotypes that xxviii maintained their photosynthetic capacity at the peak of stress while the other genotypes exhibited significant reductions. The presented protocol identified variation in sugarcane in a shorter amount of time with the aid of different multispectral parameters during its tillering stage.

The field evaluation of 10 SRA varieties under waterlogging conditions imposed during the early stalk elongation stage on sugarcane grown in contrasting soil types identified 2 promising varieties, Phil 2000-1419 and Phil 2000-2569 in terms of their high GMP and STI for the IPB trial and UP La Granja trial, respectively. A collection of 162 sugarcane germplasms were screened for waterlogging tolerance at the germination stage together with five (5) high-yielding varieties (HYV) as reference. The best-performing germplasms compared against the HYVs are propagated to confirm tolerance to waterlogging. Confirmation is split into a greenhouse trial and a field trial. The field trial was conducted in the rice paddies of UP La Granja Research and Training Station (UP LGRTS). The 2 months of flooding showed that the check varieties tend to invest in shorter, thicker stalks

and lower tillering and 74.2% higher recoverable sugar. Whereas the selected germplasms have 80.5% more mean tillers. Cane yield for the check varieties lost 27% with waterlogging, while the selected germplasm lost only 0.08% on average. However, the check varieties were noted to have higher sugar recovery than the selected accessions for waterlogging conditions such that the sugar yield per hectare of the selected accessions was significantly lower than the check varieties. Sett viability of the germplasms under waterlogging has shown tolerance to cane yield loss when flooded. The selected accessions might not be directly used for commercial plantings due to low sugar recovery, but they can be used for varietal improvement for waterlogging conditions. The confirmatory trial showed the promising agronomic characteristics of selected accessions under waterlogging conditions resulting in low reductions in the agronomic traits measured.

Like the results obtained from drought stress priming, the beneficial effect of flooding stress priming was observed in the ratoons. Ratoons that were derived from previously waterlogged plots showed a 13% advantage over ratoons with no previous history of flooding when subjected to 14 days of waterlogging. Ratoons from plots that have not been previously flooded had 43% yield reductions whereas canes with a flooding history had only 30% yield reductions.

v. Marker-Assisted Selection (MAS) of Sugarcane

Implementing Institution: Sugar Regulatory Administration

This study was performed in the experimental field and Biotech Laboratory of the Sugar Regulatory Administration – La Granja Agricultural Research and Extension Center (SRA-LGAREC) from January 2018 to December 2019. This study intended to evaluate 60 promising sugarcane clones for their resistance to fungal diseases specifically downy mildew and smut, and detect molecular markers associated with fungal resistance to downy mildew and smut using Simple Sequence Repeat (SSR) technique to assist selection of disease resistant promising lines at an early stage of the SRA Sugarcane Variety Improvement Program (SVIP). The results of the study revealed that SSR markers are useful in identifying fungal resistance in sugarcane clones. The study produced 12 positive and 1 negative markers that could be used for marker-assisted selection for disease resistance in sugarcane.

vi. Post-entry Quarantine and Disease Indexing of Newly Introduced Varieties of Sugarcane

Implementing Institution: University of the Philippines Los Baños - Institute of Plant Breeding

*The activities have been temporarily suspended mainly due to the absence of foreign varieties; however, the SRA has signified its full intention to revive the post-entry quarantine activities once there are foreign varieties available for indexing.

A number of sugarcane diseases were documented and recorded during the nationwide survey of various mill districts and sugarcane plantations in the Philippines. These diseases include red rot, Pokkah boeng, smut, downy mildew, brown rust, leaf scorch, red spot, ring spot, yellow spot, sugarcane mosaic, yellow leaf syndrome, and leaf scald. Additionally, several insect pests belonging to the orders Hemiptera, Isoptera, Coleoptera, and Lepidoptera were noted. This information served as a baseline for the post-entry screening of introduced sugarcane varieties. A total of 11 noble sugarcane varieties and one unknown variety from Thailand, acquired from the Sugar Regulatory Administration (SRA), were subjected to pathogen testing and insect pest monitoring inside the post-entry quarantine glasshouse for two years at the Institute of Plant Breeding – College of Agriculture and Food Science, University of the Philippines, Los Baños, followed by another year under open-field conditions at Barangay Mainit, Bay, Laguna.

Based on visual inspection and initial diagnostic procedures, leaf scald and sugarcane mosaic were among the most common diseases detected in the noble sugarcane varieties. In addition, the unknown variety from Thailand was observed to be susceptible to red rot disease. A cold soak and hot water treatment (HWT), coupled with fungicide treatment, were found effective in eradicating the pathogens and insect pests associated with the seed pieces received from the SRA. Furthermore, the use of an optimized and standardized scheme of quarantine testing through antibody- and nucleic acid-based assays proved to be a reliable practice for checking the introduction of new pathogens in new and promising sugarcane varieties received from other countries. These quarantine practices have been found effective in protecting the Philippine sugarcane industry from unwanted quarantine pathogens.

B. HYV PROPAGATION

vii. Establishment of Sugarcane Flower Induction Nursery in Negros Occidental

Implementing Institution: Sugar Regulatory Administration

The project aimed to induce flowering of potential varieties for parental purposes. It was planted in May 2018 and cutbacked in January 2019 to synchronize with the pollination activity in November 2019. Selected 44 potential varieties from the germplasm were planted in a humid and elevated place in Canla-on City. These varieties are Ecologic Test entries selected from thousands of varieties that passed several breeding stages; planted in several locations in Negros and Panay with different agro-climatic conditions; selection criteria at least at par or surpassed the performance of the national check variety Phil 8013 and local check variety VMC 86550. They are maintained as noble varieties for experimental purposes. The only problem is they do not flower so they cannot be utilized as parent materials. Thirteen varieties flowered out of the 44 selections, namely; Phil 92-0051, Phil 93-3727, Phil 96-2691, Phil 97-3501, Phil 06-1899, Phil 07-0563, Phil 07-0359, Phil 07-2081, Phil 08-0827, Phil 08-0909, Phil 08-1009 and Phil 08-0161. These were marcotted and utilized during the cross-pollination activity last November 2019. Plants were ratooned and six additional varieties were also planted.

viii. Upgrading of Micropropagation Laboratory

Implementing Institution: Sugar Regulatory Administration

The objective of the project is to optimize, enhance efficiency and safety of the laboratory to sufficiently provide the sugarcane industry stakeholders of the newly released varieties of SRA as planting materials. Thus, utilizing the micropropagation technique for rapid multiplication of new high yielding varieties (HYVs) to produce micro propagated plantlets at SRA laboratory and released to sugarcane planters. After renovation in 2018, an additional 677,170 plantlets were distributed and released to interested stakeholders from different areas of the country.

C. PEST & DISEASES MANAGEMENT

ix. Emerging & Re-emerging Diseases of Sugarcane

Implementing Institution: University of the Philippines Los Baños – Institute of Plant Breeding

In this project, survey of sugarcane diseases and collection of the diseased samples in various mill districts and plantations in the country were done. A total of 194 collection areas of sugarcane were surveyed from seventeen (17) provinces namely llocos Norte, Isabela, Cagayan, Tarlac, Pampanga, Batangas, Cavite, Camarines Sur, Iloilo, Capiz, Negros Occidental, Negros Oriental, Cebu, Leyte, Bukidnon, Davao del Sur, and North Cotabato. Among the sugarcane varieties observed include VMC 86-550, VMC 84-524, VMC 84-947, PHIL 99-1793, PHIL 98-0255, PHIL 2003-1389, PSR 02-247, PSR 01-136, PSR 15-187, PSR 04-172, PSR 80-013, PSR 00-034, PSR 01-105, and PSR 02-272. From the survey of the different sugarcane growing provinces in the country, 500 fungal isolates were obtained. Of these, 350 isolates came from samples with Leaf spots, while 90 and 60, were obtained from samples showing Pokkah boeng and red rot, respectively. A total of 90 isolates were obtained from sugarcane suspected to be harboring leaf scald.

For biotrophic pathogens, such as in the case of downy mildew, rust, and smut, no cultures were stored and were maintained instead, spores were collected and were stored in sterile distilled water under 4°C. On the other hand, propagative stalk samples were collected from sugarcane plants exhibiting characteristic symptoms of viral infection. These stalks were planted and were maintained in a secure screenhouse in the Institute of Plant Breeding, UPLB.

Morphological and biological characterization of the isolated pathogens were done. At the same time, genetic diversity and phylogenetic analyses were conducted. Results of the phylogenetic analyses revealed that three species of Fusarium can cause Pokkah boeng in the country, these include F. sacchari, F. proliferatum, and F. verticillioides. On the other hand, F. sacchari, F. proliferatum, F. verticillioides and F. subglutinans can initiate Red rot. Phylogeny of the Leaf scald isolates from Negros Occidental also revealed that their identity is Xanthomonas albilineans, similar to earlier reports on the causal organism of the disease. The pathogen of Yellow leaf syndrome, Sugarcane yellow leaf virus, has also been detected in the provinces of Batangas and Cebu. Phylogenetic analysis of ScYLV showed clustering between the Philippine (Batangas and Cebu) and other country isolates. Results of the survey were used to come up with a book and a field guide on different sugarcane diseases in the country. Both publications provide information, practical knowledge, and technology that agencies, stakeholders, and sugarcane growers in the country can consult to identify and mitigate sugarcane

diseases in the Philippines. At the same time, various journal articles were written, and a number of oral papers and poster papers were presented, in order to augment existing knowledge on sugarcane pathology in the country.

x. Establishment of Demo-plots to Monitor Leaf Scald Disease of Sugarcane

Implementing Institution: University of the Philippines Los Baños

Sugarcane is an important crop in the Philippines. Production of this crop, however, is threatened due to the presence of agricultural pests. Leaf Scald Disease is considered an emerging disease of sugarcane, which could potentially reduce yield. The project team from UPLB investigated the presence and development of this disease. Demo plots were established in La Castellana and La Carlota to monitor disease progression in sugarcane variety VMC 84-524. Another field experiment was conducted to assess disease susceptibility of 10 sugarcane varieties. Detections through ELISA and PCR were also done to confirm the presence of the bacterium, Xanthomonas albilineans, particularly for asymptomatic plants (leaf and juice). Presence of other diseases was also noted. Meteorological parameters were gathered during the conduct of the field experiments. In both studies, there is an inconsistent relationship with yield and the disease. It is expected that leaf scald occurrence will potentially decrease yield. However, since severity is not high, plant death may be necessary to observe significant effects in yield.

xi. Rehabilitation of Trichogramma Laboratory

Implementing Institution: Sugar Regulatory Administration

In 1960, PHILSUGIN (now SRA) recognized the importance of Trichogramma and established a laboratory at La Granja Agricultural Research and Extension Center (LGAREC) for its mass production and distribution to farmers. Since then, the laboratory has become the primary source of Trichogramma in Negros and Panay, serving not only sugarcane farmers but also those growing rice, corn, and vegetables. It is the longest-running Trichogramma laboratory in Visayas.

After more than 40 years of use, the building was old and dilapidated, and it had not been prioritized for rehabilitation. Therefore, this project was undertaken in 2019 to renovate the facility and upgrade its laboratory equipment, making it more useful for workers and clients. The laboratory is a significant part of SRA-LGAREC, showcasing the biological control of important pests attacking sugarcane. Thousands of visitors, including students, planters, and farmers, visit the laboratory for educational field trips and research.

Two years after the rehabilitation, the number of Trichogramma strips produced increased by 20.17%.

D. SOIL FERTILITY IMPROVEMENT

xii. Upgrading the Soils Laboratory of Davao MDDC

Implementing Institution: Davao Mill District Development Council Foundation, Inc.

The project involved the acquisition of additional laboratory equipment which will benefit the block farms, researchers, and sugar farmers for the complete analysis of soil for fertilizer recommendations. Various equipment was delivered to the proponent which include mechanical/reciprocating shaker, pH meter with soil electrode, top loading balance, emergency shower with eyewash, spill kit, fume hood, analytical balance, moisture balance analyzer, and bottle top dispenser.

xiii. Upgrading of the Environmental Research and Services Laboratory of Isabela State University (ISU) – CABAGAN, CAMPUS

Implementing Institution: Isabela State University

This project aimed to improve the operations of ERSL through repair, upgrading of equipment, and capacity building of personnel through the use of the new equipment and standards on soil quality analysis. Through the funding from CHED, the repair/rehabilitation of the soil laboratory was conducted after the pandemic. A total of sixteen (16) brand new equipment was donated to the ISU which includes atomic absorption spectrophotometer, water distiller, shaker, moisture balance analyzer, top loading balance, pH meter, fume hood, hot plate with magnetic stirrer, bottle top dispenser/dispensette, analytical balance, vortex mixer, water bath, and emergency shower/eyewash.

E. IRRIGATION

xiv. Rehabilitation of the Irrigation Water System & Greenhouse of LAREC-Pampanga in Support to RDE

Implementing Institution: Sugar Regulatory Administration

The construction of a greenhouse with climate control and irrigation was completed in the first semester of 2022 and it was immediately used for establishment of research purposes afterwards. Additionally, the renovation of the pump house and procurement of a diesel type engine compatible with the existing water pump was completed in the third quarter of 2022. All of the rehabilitated facility was essential as support on the on-going research activities in SRA-LAREC.

xv. Rehabilitation of the Irrigation Water System of LGAREC in Support to RDE

Implementing Institution: Sugar Regulatory Administration

From the first semester of 2022, construction for the rehabilitation of water impounding of SRA-LGAREC Station was proceeded. These include the excavation of three ponds, construction of a pump house, installation of a filtration system, polishing of riprap walls of ponds and pipe trenching. The project is 100% completed by the last quarter of 2022.

xvi.Nutrient & Water Management for SRA Block Farms Towards Technical & Economic Viability

Implementing Institution: Central Luzon State University

Sugarcane farmers grow sugarcane in limited areas because of shortage of irrigation water. Water management in sugarcane production is the key in increasing sugarcane productivity level. With the introduction of improved irrigation methods and water control and management tools, this project optimized water resources utilization to meet the growing demand from agriculture as a whole through the aid of drip irrigation systems. The experiment was conducted in three (3) different sites—Brgy. Lumbangan, Nasugbu, Batangas; Brgy. Dampe, Floridablanca, Pampanga; and Brgy. Tinang, Concepcion, Tarlac. With an area of 10,000 square meters, an area of 5,000 square meters was used to install drip irrigation systems, and 5,000 square meters was devoted to farmer's practice. A 50-millimeter PE pipe was used as the main line for the drip irrigation system. 16-millimeter drip lines with 30-centimeter emitter spacing with rated discharge of 1.22 liter per hour were laid along the sugarcane plant. Drip Irrigation System and Farmer's Practice Irrigation methods were significantly different on yield, number of bags of sugar produced, millable stalk length, plant height and tiller count. Study revealed that Using Drip-irrigation for sugarcane can save 49.34% - 62.42% of water with an average yield of 201.20 – 241.23 tc/ha and 384.30 – 431.06 bags/ha of sugar produces as compared to Farmer's Practice with a value of 128.80 - 201.18 tc/ha and 264.93 - 353.85 bags/ha.

F. CAPACITY BUILDING

xvii. Participation in the 30th Session of ICUMSA

Implementing Institution: Sugar Regulatory Administration, Philippine Sugar Millers Association, Philippine Association of Sugar Refiners

Attendance of representatives from SRA, PSMAI and PASRI to the 30th Session of ICUMSA in Warsaw, Poland in 2016. The savings was utilized for the procurement of ICUMSA Methods Book distributed to the different sugar mills and refineries.

G. FARM MECHANIZATION

xviii. Design/Fabrication of Farm Mechanization Machineries, Equipment and Implements & Acquisition of Prototypes for Testing

Implementing Institution: Sugar Regulatory Administration, Philippine Center for Postharvest Development & Mechanization, CREA-ING

Funds for the procurement of farm machinery was transferred to PITC in December 2018. A total of 5 brand new units of Sugarcane Grabber Loader and 26 brand new units of Tractor Driven Whole Stalk Sugarcane Harvester were completely delivered in December 2021 to various beneficiaries (SRA and MDDCs). Afterwards a test protocol for the prototype of equipment shall be prepared as a basis for data gathering and studying the performance of the equipment per sugar mill district.

xix. Performance Trials & Evaluation of Various Sugarcane Harvesting Machineries in the Various Sugarcane Mill Districts

Implementing Institution: Sugar Regulatory Administration

The project aims to address the problem of the shortage of labor in the sugarcane industry especially in the harvesting and loading operations which are strenuous & hazardous. It also aims to establish through research & development, the design & specifications of harvesting & loading equipment that would best fit in each mill district. Due to many procurement constraints, SRA decided to transfer the funds to Philippine International Trading Corporation (PITC) to do the procurement. The funds were transferred to the agency on December 28, 2018. However, in 2020, due to the travel restrictions and constraints brought by the COVID19 pandemic, procurements of machinery were delayed. The delivery of machinery was completed only in December 2021. A total of 29 brand new units of Sugarcane Grabber Loader and 30 brand new units of Tractor Driven Whole stalk Sugarcane Harvester were distributed to various beneficiaries (SRA, and MDDC).

H. OTHERS

xx. Analysis of Sugarcane Supply/Value Chain in some Major Sugarcane Producing Provinces in the Philippines

Implementing Institution: University of the Philippines Los Baños

The research study used both secondary and primary data. Secondary data were obtained from the Philippine Statistical Authority (PSA), Sugar Regulatory Administration (SRA), reports, and web-based information networks while primary data were gathered through surveys and key informant interviews. Survey respondents included 685 sugarcane planters (with small, medium and large sized farms) with production and marketing operations for CY 2016-17 or CY 2017-18 depending on the province with available data, mills, market intermediaries and business development service providers (BDS). The study covered the following provinces: Negros Occidental, Negros Oriental, Batangas, Tarlac, and Bukidnon. Data were analyzed using the following approaches: (1) descriptive analysis; (2) benchmarking; (3) stochastic frontier analysis; (4) profitability analysis and, (5) value chain analysis. The study focused only on the sugar value chain stream.

More than half (58%) of the 685 planter-respondents' farms are small in size, 5.01 to 10 has, 22% are medium sized. 10.01 to 50 has and 20% have large sized farms (.50.01 has). Most of these small sized farms come mostly from Batangas (83%) while the large sized farms are distributed almost equally in Negros Occidental, Bukidnon, Negros Oriental and Tarlac. Only 6% of farms in Batangas are large in size. The result of the study shows that as farm size increases, the higher the efficiency of the farm. Those that are efficient are the benchmark farms. However only 23% of the farms are benchmark farms and the rest are typical farms: 58% are typical-high farms and 19% are typical-low farms. Benchmark farms, with technical efficiency of 89% and more, come largely from Negros Occidental (31%) and least from Negros Oriental (11%). Typical-high farms are almost equally distributed among the five provinces except in Batangas where typical-low farms abound (56%). Negros Occidental has the lowest number of technically inefficient farms (3%). On the average, benchmarks have a score of 94.11%, the highest

coming from Negros Occidental followed closely by Tarlac and Negros Oriental farms. Typical-high farms across provinces have a score of 78.59% while typical-low farms, 44.59%. A Batangas farm has this lowest score. Benchmark farms are large in size while typical-low or typical high farms have small sized farms.

Benchmark farms have more access to capital, production inputs and machineries. Across provinces, benchmark planters employed more man-machine days than the typical-high or typical-low planters. Again, benchmark planters had applied the highest quantity of fertilizers per hectare of area tilled vis-à-vis the typical planters. These farms also have greater access to irrigation facilities and extension service.

Thus, in terms of yield, benchmark farms on the average have a yield of 75.76 TC/ha, meeting SRA's long term target of 70 TC/ha while typical-high and typical-low farms lagged behind with yield of 57.11 TC/ha and 41.29 TC/ha, respectively.

Negros benchmark farms have the highest yield of 79 TC/has whereas Bukidnon, the lowest at 26.9 TC/ha. On a per Lkg basis, benchmark farms generated the highest revenue (PhP2,004 per Lkg) and highest profit of PhP1,351 per Lkg vis-à-vis the typical-high and typical-low planters with profits of PhP 635 and PhP444 per Lkg, respectively. Across provinces, Negros Occidental and Bukidnon sugar cane planters obtained the highest revenue and profit from their sugarcane business.

With the increasing demand for sugar from industrial users (F&B manufacturers), SMEs in food business and even the underground economy, sugar is here to stay. But there is always the threat of cheap imported sugar that can displace local producers. Thus, there is a need for sugarcane planters to be competitive and cost efficient. The result of the study showed that there are challenges that the planters have to hurdle. Fragmented sugarcane farmland under the agrarian reform program resulted in inefficient and unproductive lands. Sugarcane farming is also dominated by small planters. Productivity is affected by lack of irrigation, shortage of labor especially during the harvest season, delayed mechanization, and lack of financing and credit facilities at low interest rates to fund farm operations and buy machineries. Although the planters' association/cooperatives negotiated for the sale of the planters' raw sugar, the existence of a buyer's market did not work well for them. This is further aggravated with the independent planters' credit marketing arrangement with the traders leaving them with weak bargaining power. While SRA provides extension services, very few of the planters (36%) had access to this service. Planters have limited knowledge on new cane varieties available, pest control, the disadvantages of cane burning or market information. There is also mismatch in the professional competency and training of their personnel in their research center.

xxi. Characterization of HFCS & Comparative Effects of Cane Sugar & HFCS in Blood Glucose & Lipid profile of Sprague-Dawley Rats

Implementing Institution: Department of Science & Technology – Food & Nutrition Research Institute

Research studies show increased preference and consumption of sugar-rich products sweetened with HFCS. Epidemiological and clinical studies revealed that sugary beverages increase the risk of obesity, leading to various lifestyle diseases such as elevated blood pressure, insulin resistance, fatty liver, and dyslipidemia. The fructose component of sugar and HFCS appears to have metabolic effects independent of weight gain, including the ability to induce fatty liver, insulin resistance, and elevated blood pressure. The study was a randomized controlled trial divided into short-term and long-term exposures. The SD rats were grouped into five (5) solutions, namely, 8% HFCS, 12% HFCS, 8% Sucrose, 12% Sucrose, and Control. The effects of the exposure solutions were determined by measuring daily food and liquid intake, weekly anthropometric measurements, and baseline and endline blood collection for the analysis of lipid profiles such as total cholesterol, High-Density Lipoprotein (HDL), Low-Density Lipoprotein (LDL), Very-low Density Lipoprotein (VLDL) and Triglycerides. The data were evaluated using MANOVA analysis. The results of the short-term and long-term experiments showed significant differences in the total cholesterol for both female and male groups (p = 0.045 and p = 0.005), VLDL, and triglycerides (p ≤ 0.001) across the different treatment groups. The total cholesterol, VLDL, and triglycerides level of the Control group was lower than those given with HFCS and Sucrose solutions.

xxii. Establishment of Bio-Organic Fertilizer Facility in Cotabato Mill District

Implementing Institution: Cotabato Mill District Development Council Foundation, Inc.

The project on Establishment of Organic Fertilizer Facility in Cotabato mill district was finally established last October, 2019. One month after the establishment, the MDDC started producing bio-organic fertilizers with a total production of 8,266.20 bags from November 2019 up to date. With the cooperation of COSUCECO mill, the MDDC had a sure market for its produce where the mill's loan program for the planters utilized bio-organic fertilizer from the MDDC. The bio-organic fertilizer was sold at a subsidized price of PhP 135.00 per bag. This amount was pegged to cover the cost of production to sustain its operation.

xxiii. Alternative Method of Conducting Physical Sugar Inventories

Implementing Institution: Sugar Regulatory Administration

3D Laser Scan Equipment was procured in 2018.

Phase 1 (2018)

- Creation of Official Team for the Project
- Attended Trainings to enhance knowledge on the 3D Laser Scan
- Conducted Profiling of warehouses (12) and determination of on-site problems that may

impede the activity inventory activities using 3D Laser Scanner

Phase 2 (2019)

- Conducted Laser Scan activities for gathering of research data for the 1st trial (CASA, BISCOM, HPCO, URSUMCO)
- 2020: Scheduled trials and other activities were temporarily suspended due to COVID-

19

pandemic