PHilMech
Annual Report 2015

Making Waves

In Research, Development and Extension

PHilMech

2015 Report

About the Cover

Year 2015 is a golden year for the center as it received many recognitions from various R&D competitions in the country.

The awards we received are represented by the grains arranged like laurels in the cover. The different crops (rice, cacao, cashew, corn, soybean and coffee) attached to the rice stalk are some of the commodity focus of PHilMech whereby production and postproduction mechanization technologies are being generated and extended to the industry stakeholders.

Moreover, the waves in the cover represent the rise of PHilMech as it makes name in the industry particularly on its RD&E efforts.

Editorial Board

This Annual Report was prepared by the Applied Communication Division from the reports submitted by the different units of PHilMech.

Disclaimer: The appearance of pictures of branded machinery is meant to present available machines in the market. It does not mean endorsement of the product by PHilMech.

Philippine Center For Postharvest Development and Mechanization
Science City of Muñoz, Nueva Ecija,
Philippines
ISBN 0116-7162

Foreword

> ...PHilMech has made great strides in improving the postharvest industry. Now, it is reaping a bountiful HARVEST.

The year 2015 had been a harvest festival of awards for PHilMech. Many researchers and staff have reaped national and regional awards for their outstanding achievements in research, development and extension.

The awards came from different award –giving bodies like the Bureau of Agricultural Research of the Department of Agriculture (DA-BAR), the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development of the Department of Science and Technology (PCAARRD-DOST), Philippine Society of Agricultural Engineers (PSAE), among others.

In spite of these awards, PHilMech does not rest on its laurels. It continues to aggressively pursue its mandate of generating, extending and commercializing appropriate and problem-oriented agriculture and fishery postharvest and mechanization technologies.

In fact, new technologies are emerging as will be seen in this PHilMech Annual Report. PHilMech is developing improved drying technologies for coffee, harvester for medium-scale sugarcane farm, probe meter for moisture detection of selected grains, sensor devices for cacao quality management, green coffee sorter, compact ultra impeller rice mill, rolling corn mill, pilot-scale processing system for pectin from mango peels and so forth.

PHilMech also continues to conduct effective training courses and technology demonstrations, provides technical assistance for postharvest enterprise development, develops IEC materials and promotes technologies and knowledge systems through exhibits, school-on-the air, visitors' bureau, and other communication strategies. Postharvest facility assistance has been provided as well to the grassroots, partners and collaborators.

Meanwhile, in support to its role in the Agricultural and Fishery Mechanization law (RA 10601), PHilMech leads in coming up with an updated framework and coherent RD&E agenda for postharvest and mechanization of various commodities.

All these RD&E activities are meant to achieve our vision of a globally competitive, sustainable agri-fishery sectors.

Although much remains to be done, PHilMech has made great strides in improving the postharvest and mechanization industry. It is making waves in research, development and extension. Now, it is reaping a bountiful harvest.

REX L. BINGABING
Director IV

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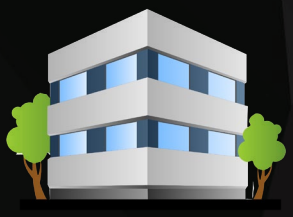


Vision

Become a premier center for postharvest and mechanization development for a globally competitive and sustainable agriculture and fishery sectors.

Mission

To empower the agriculture and fishery sectors by increasing resource-use efficiency and productivity, reducing losses and adding value to the produce through research, development and extension.

Mandate

Generate, extend and commercialize appropriate and problem-oriented agriculture and fishery postharvest and mechanization technologies, practices and systems.

Our History

The Philippine Center for Postharvest Development and Mechanization (PHilMech) was formerly known as the National Postharvest Institute for Research and Extension (NAPHIRE).

NAPHIRE

1978

It was created on May 24, 1978 through Presidential Decree 1380 to spearhead the development of the country's postharvest industry. NAPHIRE was then a subsidiary of the National Grains Authority (NGA), now the National Food Authority.

1986

In 1986, the agency moved to its new home at the Central Luzon State University compound in Muñoz, Nueva Ecija.

BPRE

1992

From a government corporation, NAPHIRE was transformed into a regular agency through Executive Order 494 in 1992. It was renamed as the Bureau of Postharvest Research and Extension (BPRE).

PHilMech

2010

Pursuant to Executive Order 366 or the government's rationalization program, BPRE became the Philippine Center for Postharvest Development and Mechanization (PHilMech) in 2010.

Our Strategic Thrusts

- Efficient drying and dehydration for increased productivity
- Appropriate handling, storage and processing techniques for increased economic value
- Mycotoxin, pests and disease prevention and control for food safety and food quality preservation
- Agricultural waste and by-product utilization for environmental protection
- Appropriate production and postproduction mechanization technologies for increased resource-use efficiency and adoptive capacity to climate change
- Knowledge management and utilization and profitable entrepreneurship for empowered stakeholders

Our Facilities

- Agricultural Mechanization and Demonstration Center
- Bio-Process Engineering Building
- R&D Building
- Administration Building
- Technology Demonstration Center
- Farm Service Provider and Machinery Pool
- Drying Plant
- Training Halls
- Scientific Literature Services/Library
- Information and Communication Technology and Geographic Information Systems Facilities
- Auditorium
- Dormitory and Hostel
- Cafeteria
- Laboratories:
  - Entomology
  - Molecular Biology
  - Plant Pathology
  - Fumigation
  - Thermophysical
  - Microbiology
  - Chemistry
  - Physiology
  - Fungal and Bacterial
  - Food Processing

Our Offices

Head Office
CLSU Compound, Science City of Muñoz, Nueva Ecija
Tel. No. (044) 456-0213, 456-0282
Fax No. (044) 456-0110

Manila Liaison Office
3rd floor, ATI Building, Elliptical Road
Diliman, Quezon City
Tel. No. (02) 927-4019, 927-4029
Fax. No. (02) 926-8159

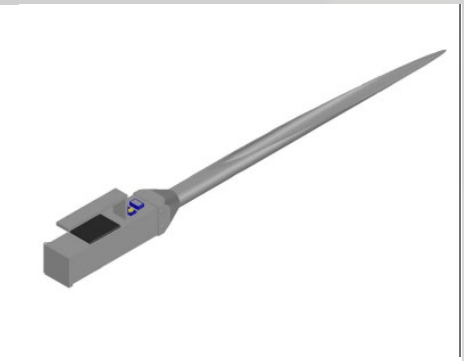
Cagayan de Oro Satellite Office
BPI Compound, Macabalan, Cagayan de Oro City
Tel. No. (088) 880-5825

Davao Satellite Office
3rd floor DA-RFU XI building
F. Bangoy Street, Davao City
Tel. No (082) 226-3625

2015 RD&E HIGHLIGHTS OF ACCOMPLISHMENTS

Efficient drying and dehydration for increased productivity

A grain probe moisture meter which can provide quick and accurate moisture content measurement has been developed at PHilMech. The prototype unit is composed of a commercially available grain probe, a 100-gram capacity test chamber with two-parallel plates, a menu panel for overall control and measurement and a handle for ease of sampling. Among its features is the micro-controller based processor with an LCD display. Actual field testing is being done to establish operational, accuracy and precision characteristics. *p. 13*



Grain probe moisture meter

PHilMech developed an improved drying technology for different coffee varieties. The Greenhouse-Type Solar Dryer (GTSD) with biomass furnace is an improvement of the existing Multi-Commodity Solar Tunnel Dryer (MCSTD). Two units of the GTSD were installed at the coffee growing areas in Lipa City, Batangas and Lupon, Davao Oriental. Drying trials for Robusta coffee showed a reduction of drying time from two weeks in traditional sun drying to six days using the GSTD. *p. 29*

Fluidized bed drying system offers better solution when drying high moisture paddy especially during rainy season. The grains are semi-suspended in air and experience vigorous mixing. This eliminates grain clamping resulting to faster and more uniform drying of grains. A commercial scale fully-automated and complete fluidized drying system for high moisture paddy has been developed by PHilMech. Currently, it is installed at the Nueva Vizcaya Alay-Kapwa Multi-purpose Cooperative in Solano, Nueva Vizcaya. *p. 14*

Improved GTSD for coffee

The improved GTSD retrofitted with biomass furnace is also being field tested as drying technology for fermented cacao beans. This GSTD has a dimension of 13.2m x 7.56m x 3.48m (L x W x H) with a capacity of 702 kg fermented cacao beans. Drying trials showed a reduction of drying time from six days using the greenhouse dryer commonly used by cacao processors to four days using the GTSD. Quality of cacao beans dried in the GTSD produced well dried and a more brown cacao beans. *p. 20*

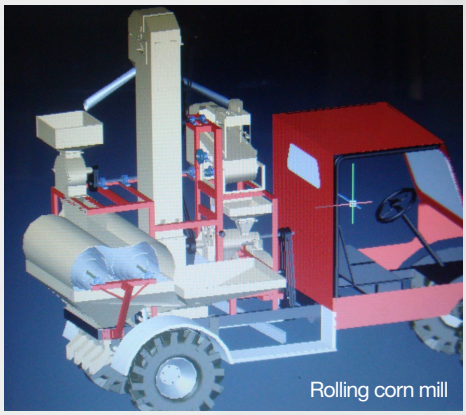
Appropriate handling, storage and processing techniques for increased economic value

Consumers and retailers can now mill their one to four-week requirement of brown rice. Thanks to the PHilMech-developed impact-type centrifugal huller. Field-testing of the technology is being done in Tarlac and Ifugao to determine its technical performance at varying field conditions. Based on field tests, the huller has a milling capacity of 60-75 kg/hr and an operation cost per kilogram output of Php 0.25. *p. 11*

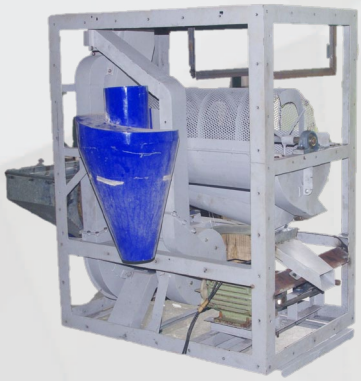
Brown rice mill

An improved and efficient rice mill system capable of producing both brown rice and white rice is also now developed by PHilMech. The technology features an innovative-type hulling mechanism known as “impeller-huller” instead of the traditional rubber roll-type huller. Ideal for village-level operation, the technology is very compact yet equipped with de-stoner and grader, requiring minimal working space of 16 sq meters (4m x 4m). *p. 15*

PHilMech is also developing a rolling corn mill with an input capacity of 1,000 kg/hr. The corn mill is mobile and thus can reach far- flung areas. The corn mill is mounted to a vehicle with the engine of the vehicle as its source of power. The corn mill has a minimum degerminator efficiency of 80% and minimum product recovery of 64%. This satisfies the Philippine Agricultural Engineering Standard (PAES) for corn mill. PHilMech collaborates with the ACT Machinery in Cauayan City, Isabela. *p. 17*



Rolling corn mill



Centrifugal huller machine for adlai

A centrifugal huller for adlai is being field-tested at NOMIARC Malaybalay, Bukidnon. This would verify actual field performance of the machine for other adlai varieties. Based on partial results of laboratory and field trials, the machine has a maximum whole grain recovery of 60% at 120 to 130kg/hr hulling capacity at maximum opening. The average hulling recovery is 60 to 70 % , hence its great potential for hulling adlai grains. *p. 18*

PHilMech in collaboration with the Philippine Nuclear Research Institute and the Central Luzon State University is studying the effect of gamma irradiation on the quality of stored brown rice using different packaging materials. Preliminary results showed that gamma irradiation has no effect on the moisture content, water activity, amylose and free fatty acid contents of brown rice. *p. 12*

Pharmaceutical grade pectin from mango peels was produced using a semi-commercial facility. It met the specifications set by the US Pharmacopeia for the physico-chemical properties and gelling characteristics for pharmaceutical grade pectin. Food products like yogurt and jams formulated with mango pectin are well-liked by the consumers. The produced pectin has a shelf-life of more than one year. It is free from pathogens after one year storage under ambient and cold storage conditions. *p. 34*

Appropriate production and postproduction mechanization technologies for increased resource-use efficiency and adaptation to climate change

Frame for the mechanical green coffee sorter

A mechanical green coffee sorter is being developed at PHilMech. This machine would address the need at the trader-level of operation. It would be capable of sorting different varieties of Philippine coffee and would be capable of separating dried coffee beans. *p. 30*

PHilMech aims to develop a sensor-based instrument for determining freshly harvested wet cacao beans. Different sensor devices for design parameters were already prepared. Data gathered from CocoaPhil, partner-cooperator at Talandang, Davao City, are being consolidated. *p. 21*

A harvester for medium-scale sugarcane farm is being designed and developed by PHilMech. The goal is to increase efficiency of sugarcane harvest operation by 30% through mechanization. To date, the design and CAD drawing of the sugarcane harvester has been established. A project collaborator and fabricator had been identified and technical plans have been provided. The fabrication and assembly of sugarcane harvester parts and components being done. *p. 36*

Mycotoxin, pests and disease prevention and control for food safety and food quality preservation

This PHilMech project seek to determine the microbial and mycotoxin contamination in raw cassava and its by-products (e.g. chips and flour). Samples collected in Bicol Region and Central Visayas contain insignificant amount of aflatoxin. Only 6 out of 50 collected raw and dried cassava samples contain aflatoxin ranging from 2 to 44 ppb. *p. 28*

PHilMech is developing a starter culture for enhanced fermentation of cacao beans. Fermentation gives the raw materials of cacao beans a distinct taste and quality that are important in chocolate production. *p. 25*

To increase manageability of the fermentation process of cacao is to isolate, identify and use only the essential microorganisms. PHilMech identifies bacterial, fungal and yeast isolates from cacao beans using molecular biology identification techniques. Fifteen fungal isolates have been identified and needs further optimization. Meanwhile, identification of 44 bacteria and yeast isolates is on-going. *p. 24*

Farmers immediately sell their produce because of difficulty in controlling postharvest diseases of onion. Thus, PHilMech is evaluating alternative treatments to maintain quality of onions. These include the use of organic acids (acetic, malic and citric) and Microbial Control Agents (MCA). *p. 35*

Broccoli is one of the highly perishable vegetable. Postharvest loss from harvest to retail marketing estimated to be 21%. Thus, suitable treatment is necessary to maintain overall quality of broccoli until it reaches the consumer. Broccoli samples were treated with ethanol vapor. Results revealed that ethanol vapor could extend the shelf life of broccoli thus maintaining its quality during storage. *p. 19*

Field application of microbial control agents (MCA) as alternative treatment in the management of anthracnose and stem-end rot of postharvest mango var. Carabao has been done. Microbial formulation combined with Hot Water Treatment (HWT) on export Carabao mango showed 8% disease incidence upon reaching Hongkong, nine days after treatment. The result is superior to that with HWT + synthetic fungicide which showed anthracnose infection at 38 %. Untreated samples under the same handling condition showed 88 % anthracnose infection. *p. 33*

PHilMech is screening and evaluating plant latex extracts in managing

postharvest diseases of tropical fruits such as papaya, banana, mango, star apple, jack fruit and aloe vera. In vitro assay was carried out for their efficacy against mycelia of fungal pathogens. Among the plant materials, latex extracts of jackfruit and banana were found to have high level of activities against the mycelia growth of five fungal species. *p. 32*

Wolbachia is an endosymbiont bacteria. It lives inside its host in a close, long-term relationship. This close relationship of Wolbachia to its host insect or arachnids makes it a potential target or agent of biological control. PHilMech seeks to detect the presence of Wolbachia in psocids and mites and other postharvest insects and arachnids. Based on the study, Wolbachia was detected in the laboratory-reared specimens of mites and psocids. The bacteria is however detected in several laboratory-reared stored product insects like corn weevil, lesser grain borers, cigarette beetle and the saw-toothed beetle and lesser meal worm. *p. 16*

Agricultural waste and by-product utilization for environmental protection

Cacao which is used in chocolate processing generates substantial amount of waste such as drippings. Drippings, however, can be used for the production of wine, vinegar and soft drinks. PHilMech is characterizing the physiochemical properties of cacao drippings and developing commercial products from it. Sensory evaluation and financial analysis of wine, vinegar and soft drinks are on-going. *p. 22*

The Bio-Process Engineering Division of PHilMech is implementing the project, "Utilization of Cashew Nut Shell Liquid (CNSL) for Industrial Applications." Part of this project is to zero-in on the product which can be derived from the spent cashew shell with local industrial application to ensure the workability of the product to be developed. Thus, the Socio-economic and Policy Research Division (SEPRD) is establishing the benchmark information on the potential market of CNSL-derived from the by-products of village-based cashew kernel processors. The feasibility of establishing CNSL processing using locally-fabricated machines is also being studied by SEPRD researchers. *p. 27*

The Central Luzon State University and PHilMech developed a laboratory-scale nano-filtration system for mature coconut water purification using nano-composite derived from coconut byproducts. Produced nano-fibers were blends of Poly lactic acid (PLA), cellulose acetate from coconut husk, chitosan and Amino Lauric Acid Montmorillonite (ALA-MMT). *p. 31*

Engineers of PHilMech are also developing formulation in producing cacao pod husk-based fuel briquettes. Thirteen formulations have been developed by the piston-type briquetting machine. Determination of the investment and production cost of cacao pod husk-based fuel briquettes is on-going. *p. 23*

Fuel briquettes from cacao pod husk

Knowledge management and utilization and profitable entrepreneurship for empowered stakeholders

Benchmark studies on the postharvest handling of major lowland vegetables like tomato, bitter gourd, eggplant, and sweet potato have been conducted. Improvements in the supply chain of these vegetables such as appropriate postharvest technologies and policy recommendations were identified. Actual loss assessments from production areas to major markets were done. One of the research result of the project is the postharvest losses in sweet potato during harvesting operation particularly in the digging and uprooting of sweet potato roots. Identified intervention is a tractor-driven root crop digger. Test results showed a promising reduction of harvesting losses using the technology. *p. 37*

Benchmark information on the postharvest and mechanization of selected commodities like shallot, cassava, Cardaba banana and bulb onion (red and yellow) were also established. Study sites include Ilocos Region for shallots; Regions 2 and 10 for cassava; Regions 2 and 11 for Cardava banana and Region 3 for bulb onions. Initial results showed that postharvest losses incurred by the yellow bulb onion were lower than that of red bulb onion. Postharvest losses for cassava were mainly from physical and moisture loss. Postharvest losses for Cardava banana in Luzon were due to immature hands. In Mindanao, quality losses of banana were due to size. Bigger sizes are required. *p. 39*

To accelerate the development of the local soybean industry in the Philippines, PHilMech is pilot testing the integrated production and processing systems of soybeans. There are several cooperators


Soybean Training

under the project: (1) 3k Enterprise in Mexico, Pampanga and Paco, Manila, (2) Agricultural Rural Alternative Development Options, Inc. in Alang-Alang, Leyte, (3) Golden Beans and Grains Producers Cooperative in Cabanatuan City, Nueva Ecija, (4) Ecological and Agricultural Development Foundation in Bacolod City, Negros Occidental, and (5) Baligi Rural Women's Association in Villa Verde, Nueva Vizcaya. *p. 40*

The Enterprise Development Division of PHilMech provides the needed technical assistance to expand an enterprise that employs mechanization, postharvest and agro-processing technologies and systems. In 2015, some of the assistance given was the preparation of feasibility studies on onion cold storage and pectin processing. PHilMech also assisted recipients of Region VI and Region I Agri-Pinoy Rice Processing Center. They were trained in Business Planning. The Mabunga Cacao Farmers' Association in Dingalan, Aurora was linked to market through DTI-Region 3 and DA-AMAS. *p. 46*

In 2015, a total of 20 technology briefings and five skills training on food processing were conducted at the MCSTD social laboratory. At least 10 entrepreneurs ordered MCSTD units from the PHilMech accredited manufacturer. A project team under the Technology Development and Fabrications Unit of MSC was provided assistance during their visit at the social laboratory and MCSTD fabrication shop at Design 360 in San Jose City, Nueva Ecija. *p. 45*

PHilMech established GIS- based databases as decision-support tool for the development of the Philippine postharvest and mechanization. The GIS-based databases contain barangay –level inventory of postharvest and agricultural machinery. These databases serve as reference material and input to various programs. The databases are now in full service and are being continuously updated. Databases are being enhanced to become a robust web-based platform of updating and accessing the data. *p. 47*

PHilMech through the EDD also generates information for the market potential, technical and operational requirements, socio-economic impact, and financial profitability of a commercial irradiation facility. Thus, a series of consultation meetings with the project Technical Working Group (TWG) was done. Preliminary consultations with private stakeholders on the results of the feasibility study were also completed. *p. 48*

In 2015, four manufacturers' fora were conducted nationwide to introduce PHilMech mature technologies and the the corresponding licensing protocol. Twenty-four manufacturers showed intent to apply for license. To date, 26 License to Manufacture certificates were issued to the manufacturers who have complied with all the requirements under the PHilMech Licensing Protocol. A special forum was also conducted with DA in Quezon City to encourage and increase participation of local manufacturers in the supply and distribution of agricultural machinery. *p. 51*


TMTD training course

The Technology Management and Training Division (TMTD) provides technical support to ensure protection of Intellectual Property Rights (IPR) particularly PHilMech technology outputs. In 2015, three utility models were registered, and six patents were applied for. Also, an in-house Seminar Workshop on Patent Search was conducted to provide project leaders and researchers a comprehensive view on prior art search of their respective technologies. *p. 53*

In 2015, the training section of TMTD organized and implemented 17 batches of training courses, writeshop/faculty meetings and symposia and other related activities. These training courses were anchored on its three major projects, namely: Technical Support to Industry Manpower Development, Technical Capability Enhancement of the Industry Stakeholders on Mechanization & PH Technologies, and Special Project. *p. 49*

The Applied Communication Division of PHIlMech developed and disseminated a total of 62, 301 information, education and communication (IEC) materials in 2015. These materials ranged from popular to technical publications, instructional videos, billboards, exhibit and promotional materials. These materials reached 2,441 visitors and exhibit viewers in 12 agricultural trade fairs, 859 School-


ACD Exhibit

on-the Air graduates, 440 techno fora participants and 702 end-users at the Postharvest and Mechanization sections in six state colleges and universities. *p. 54*

The project, "Establishment of Agricultural Tramlines" has been implemented by PHilMech under the National Tramline Program. A total of 126 ATS are now established in the country. Project implementation efficiency has been assured by PHilMech. Training for the operators and recipients were conducted and Information, Education and Communication (EIC) materials were also given to the recipients. *p. 61*

PHilMech accomplished 100% of its Sustainability Program activities and 95.5% of its Rice Mechanization Program activities. Also, through Agri-Infra Coordinating Unit (AICU), it has been able to conduct national exhibits and consultation meetings, stressing government's campaign in improving the livelihood of farmers through proper agricultural mechanization. *p. 59*

To improve the postharvest operations in the organic agriculture sector, PHilMech implemented the project, "Provision of Postharvest Facility Support to the National Organic Agriculture Program" (NOAP) in collaboration with other department and agencies. In 2015, the project was allocated funds for 10 units Paddy Huller, 10 units of PHilMech-design Corn Mill, and 12 sets of Coffee Processing Facilities. These were distributed in different parts of the country. Likewise, the remaining project activities of 2014 were completed. The first batch of "Training Course on Mechanization and Postharvest Technologies for Organic Coffee was conducted in Benguet. Actual technology demo and facility turnover were also done. *p. 62*


Agricultural Tramline System

R&D
CLUSTER REPORTS

Field Testing of Impact-Type Huller For Milling-on-Demand

Brown rice has been identified as one of the key strategic areas In attaining rice sufficiency as stated under the Food Staple-Sufficiency Roadmap of the Department of Agriculture for 2011 to 2016 (DA-FSSR, 2011). Brown rice has the potential of increasing the availability of rice supply in the market by 10 to 15 % given a 75 to 80 % recovery of brown rice compared to 63 to 67 % of white or polished rice.

Brown rice huller at the Ventinilla Farmers Marketing Cooperative

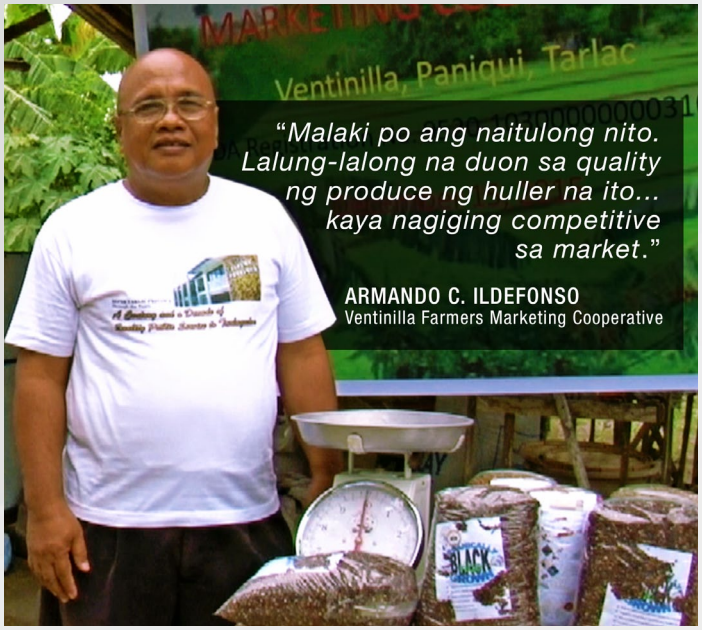
PHilMech developed an impact-type centrifugal huller for milling on-demand brown rice. The technology addresses short shelf-life of brown rice of around four weeks under normal condition by "milling-on-demand" hulling approach. Brown rice consumers or retailers shall be given the capability to mill their requirement of one to four weeks avoiding quality deterioration.

The PHilMech designed and developed brown rice huller is easy to operate, easy to move, has low maintenance and power requirement, and has a hulling efficiency of 75 to 80 % as tested for different rice grain varieties. Based on the test performance result of the on-going field testing activity, the huller has a milling capacity of 60 to 75 kg/h and an operation cost per kilogram output of Php 0.25.

The sites of the project are Tarlac and Ifugao. Generally the project aims to develop an improved impeller-type huller and determine the technical performance at varying field conditions.

PHilMech regularly monitors and evaluates performance of the impeller huller. At the Ventinilla Farmers Marketing Cooperative, Paniqui, Tarlac and Lamut Organic Farmers Association, Lamut, Ifugao. These associations serve as cooperators in the development and eventual commercialization of the impact-type huller. The government will aggressively promote said huller for the wider adoption of brown rice in the country.

Red and black pigmented rice locally produced in Paniqui, Tarlac using the Brown Rice Huller



Technology adopter of the village-level brown rice huller

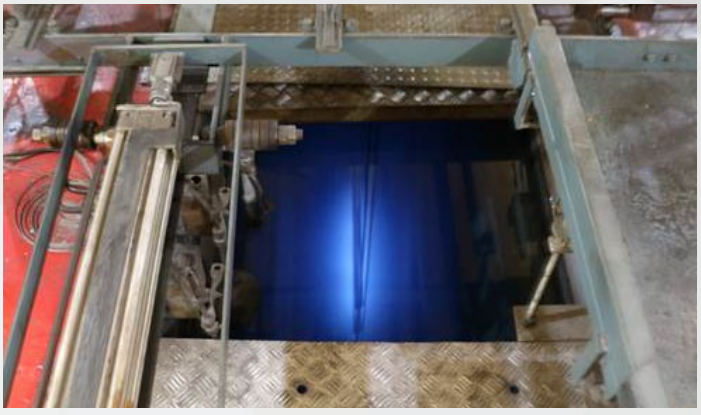
Effect of Gamma Irradiation on the Quality of Stored Brown Rice Using Different Packaging Materials

Brown rice contains high oil content that shortens its shelf-life causing the grains to be rancid at a fast rate. Also, it is very susceptible to microbial and insect damage setting drawback on its shorter shelf life too.

Gamma irradiation is an effective treatment to control microbial activities and insect infestation. Philippine Nuclear Research Institute (PNRI) reported a significant reduction in microbial contamination and shelf-life extension of irradiated foods. However, no local studies have been conducted on the effect of irradiation in maintaining the quality while extending the shelf-life of brown rice. Thus, this project aims to investigate the efficacy of irradiation technology on the physical, chemical, nutritional and sensory qualities of brown rice.

Two rice varieties, two ages of rice, two packaging types and two radiation doses comprised the experimental design. Radiation treatment was conducted at the irradiation facility of PNRI. Sampling was done every month for eight months at the PHilMech laboratory.

Preliminary results showed that gamma radiation has no observed effect on the moisture content, water activity, amylose and free fatty acid contents. Analyses on the effect of gamma radiation on the physico-chemical and sensorial qualities of stored brown rice is on-going.



Cobalt -60 as radiation source submerged in water as shield

PNRI Commercial Irradiation Facility

Irradiated brown rice samples

Development of Probe Meter for Moisture Detection of Selected Grains

For both field and laboratory grading of grains, moisture content (MC) and purity are primary quality factors which must be properly determined because they serve as bases for payment before the grain trade and marketing. Accuracy of moisture content level in a product is very critical when transactions are based on weight. Small errors in measurement can have significant consequences (Sampang, R.L.1992).

Several methods are used to determine the moisture content of grains, the most common of which is the the empirical evaluation. The method involves nibbling of grains and crushing between fingers. Others rely on the smell of dull or sharp rattle produced by shaking a few grains in a box. These methods, based on individual experience, do not give a true objective measurement, but estimate the degree of moisture by subjective sensory perception (touch, sight and smell) of the grains. (Semple, R.L. et.al, 1988). Besides being subjective, this entails repetitive moisture estimation per sample thereby prolonging trade transactions. Farmers and traders do their inspection by means of a grain probe. Gathered samples are observed for moisture content, purity, damaged and discolored kernels by ocular inspection.

CAD plates of the probe moisture meter

In 2015, PHilmech explored the development of a grain probe with moisture sensing mechanism which aimed at providing a quick and accurate moisture content assessment while doing actual grain sampling. A frequency-based capacitance laboratory set-up was designed and developed to measure electrical properties of different paddy varieties at different MC levels. The protoype unit is composed of a commercially available grain probe, a 100-gram capacity MC test chamber with two-parallel plates, a micro-controller based processor and an LCD display, a menu panel for overall control and setting. It has a handle for ease of sampling.

Results of calibration tests between frequency readings and standard oven moisture content measurements yielded an exponential pattern. Using non-linear regression technique, a calibration model was established with a relatively high correlation coefficient (R2) of 0.938 and a relatively low standard error of estimate (SEE) at 0.0538 which indicates fitness of the design principle.

Actual laboratory testing of probe moisture content meter

Operational requirement was initially evaluated in Alay Kapwa Multi-purpose Cooperative in Nueva Vizcaya , results of which have been incorporated in the final design. Actual field testing of this prototype grain probe moisture meter is being done to establish the operating characteristics and test its accuracy and precision under actual field condition.

Functional field testing of prototype unit grain probe moisture meter

Development of Commercial-Scale Fully-Automated and Complete Fluidized Drying System for High Moisture Paddy

Drying of high moisture paddy remains a major problem especially during the wet season when sundrying is not possible. Wet paddy deteriorates rapidly if not immediately dried. Among the more popular heated-air dryers such as flatbed dryers and recirculating batch dryers have been introduced to alleviate the problem.

The flatbed dryer is simple to operate and maintain. It works well at farmer or small farmer-organizations' level and in areas where electricity is not accessible and labor is readily available. It is labor-intensive and the drying capacity per day is limited.

On the other hand, multiple units of recirculating batch dryers can provide larger drying volume. It requires significantly less labor. However, recirculating batch dryer is not ideal for handling very high moisture paddy. Wet paddy tends to clump together and clog the dryer. This is a common problem especially when grains contain large amount of impurities.

Fluidized bed drying system offers better solution when drying high moisture paddy. Paddy is subjected for short duration very high air flow resulting to fluidization of the grain bed. The grains are semi-suspended in air and experience vigorous mixing. This eliminates the problem of grain clumping and result to faster and more uniform drying. The grain bed acquires fluid-like character and thus flows more easily.

The commercial-scale model of fluidized bed dryer is currently installed at the Nueva Vizcaya Alay-Kapwa Multi-Purpose Cooperative in Solano, Nueva Vizcaya.

Its features are as follows: (1) Uses biomass furnace, (2) Quick drying at 82% reduction of normal drying time, (3) Fully automated, (4) High Head Rice Yield Recovery, (5) Low energy requirement with substantial drying time reduction, (6) Locally fabricated.

Its specifications include:

- Output Capacity : 1,000 kg per hour
- Drying Time : 2.07 hours
- Drying Temperature : 70ºC
- Fluidization Time : 2 minutes
- Drying Cost : Php 8/bag
- Labor Requirement : 2 persons

The following are the technical drying parameters generated using the commercial-scale model fluidized bed dryer:

Particulars	Parameters
Drying temperature (ºC)	70
Superficial air velocity (m/s)	3.21
Airflow rate (cfm)	10,943
Static pressure (in H_20)	4.5
Grain depth (cm)	10.16
Fluidization time (minute)	2
Ambient tempering (minute)	30
Forced air tempering (minute)	30

Development of Compact Ultra Impeller Rice Mill

The prevalence of inefficient single-pass steel huller rice mills in the country has limited the supply of rice. This is because of their low milling recovery of 52 to 57% as compared to a single pass rubber-roll-type compact rice mill with an average milling recovery of 63 to 65%.

While the rubber-roll type rice mill is considered as the most efficient type of rice mills in the Philippines, it requires higher investment and operating cost, higher power requirement and requires regular replacement of the rubber rolls (IRRI). Likewise, existing rice mill is specifically designed for the production of white rice and this requires retrofitting of some vital components of the rice mill system in order to efficiently produce brown rice. Furthermore, the high investment cost in establishing a rice mill system has also limited ordinary farmers to invest on such important postharvest technology. It is thus imperative to develop an efficient compact rice mill for village-level operation.

The invention features an innovative type hulling mechanism which is called an "impeller huller" instead of adopting the traditional rubber roll type huller. It features an improved and efficient rice mill system that is capable of producing both brown rice and white rice with high hulling efficiency and milling recovery. The developed technology has a milling capacity of 250 kg/hr with milling recovery of 63 to 66%. The design is highly ideal for village-level operation. It is very compact yet equipped with de-stoner and grader. It requires minimal working space of 16 sq. meter (4m x 4m) thereby reducing the investment cost for the establishment of shed of the rice mill facility. The developed technology is highly viable. Estimated cost of milling per kilogram output is only Php0.96 output, way below the prevailing milling fee of Php1.75/kg.

Identification of Wolbachia Bacterial Endosymbionts in Storage Populations of the Philippine Psocids and Mites

Insects and arachnids are linked with microorganisms that influence their survival and growth. These microorganisms have variety of effects ranging from immune protection, reproductive alternations, to lethal consequences.

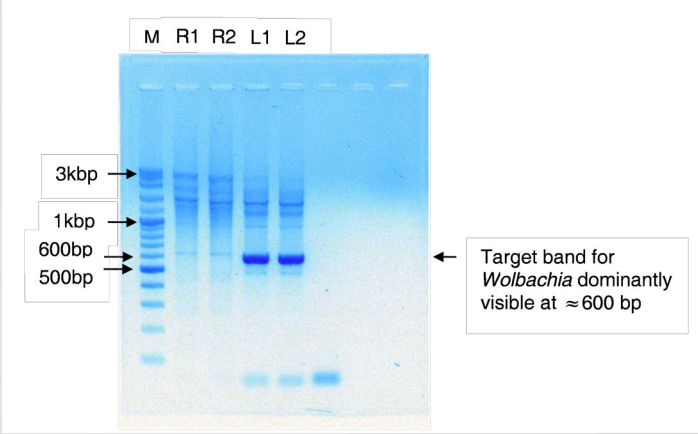
One group of these microorganisms is the bacteria called Wolbachia. These bacteria are endosymbionts, that is, they live inside their hosts in a close and long-term relationship. Long term relationship is made possible by non-detrimental effects to host. Some type of Wolbachia for example improves the immune response of their hosts to diseases, while others only shorten their hosts' lifespan and turn lethal only in limited conditions.

Wolbachia are more commonly known as reproductive parasites, because most of them manipulate the reproductive system of their hosts to ensure the survival of their kind or type. Among these reproductive effects include zygote mortality of hosts due to incompatibility of germ cells infected by different types of the bacteria, development into female adults without fertilization (parthenogenesis), transformation of males to females (also called feminization), and arrested development of male embryos (male killing).

These close relationships of Wolbachia to their host insects or arachnids make them potential target or agent of biological control. By strategically influencing their presence and activities in their host, control can be potentially implemented on their host's population. Such strategies have been tried in mosquitoes to control spread and proliferation of dengue virus.

The presence of Wolbachia in the Philippine stored product insects and arachnids has not been known yet. The study seeks to detect the presence of Wolbachia in psocids and mites and later in other postharvest insects and arachnids.

Wolbachia is not detected in the collected as well as in the laboratory-reared specimens of mites and psocids. The bacteria is however detected in several laboratory-reared stored product insects such the primary insect pests corn weevil (*Sitophilus zeamais*), lesser grain borer (*Rhyzopertha domnica*), and cigarette beetle (*Lasioderma serricorne*), and the secondary insect pests saw-toothed beetle (*Oryzaephilus surinamensis*) and lesser meal worm (*Alphitobius sp.*)



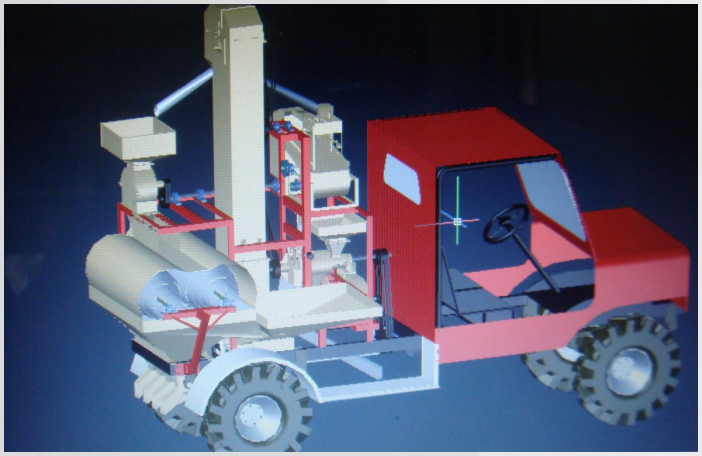
Optimization of Wolbachia PCR protocols for R. dominica and L. serricorne. (M – 1kb (kilobase) plus marker, R1- Rhizopertha dominica fragments replicate 1, R2 – R. dominica replicate 2, L1 – Lasioderma serricorne fragments replicate 1, L2 – L. serricorne fragments replicate 2.

Development of Rolling Corn Mill

Corn is a perfect substitute of rice among Filipinos. It is estimated that about 15% of the country's population has utilized corn as their staple food (DA-BAS, 2012). The National Corn Program (2014) estimated that the total requirement of corn mill in the country is about 4,560 units of 300 kg per hr capacity with a total capacity deficit of 2,790 units.

There were initial efforts on the part of the local manufacturers to satisfy the milling requirements in the countryside with the fabrication of village-type corn mills. Based on the report of Agricultural Machinery Testing and Evaluation Center (AMTEC) in 2011, however, these newly developed and commercially available corn mills have not fully satisfied the minimum technical specification set by the Philippine Agricultural Engineering Standard for main product recovery of 64% and the degerminator efficiency of 80%.

Unknown to many, the farmers have shouldered the cost of the technical inefficiency of existing corn mills which is highly evident on the milling fee being charged by corn mill operators They charged milling fee based on the total weight of input (corn grain) and not on the total weight of the output of cornmill. Moreover, most of the corn eating Filipinos are living in the remote areas with no existing corn mill in their area since majority of the corn mills are located in the commercial centers of the municipalities.



In line with this, the Philippine Center for Postharvest Development and Mechanization (PHilMech) is developing a rolling corn mill with input capacity of 1,000 kg/hr. Mounted on a vehicle, the corn mill is designed to move from one place to another and can reach far-flung areas. The source of power of the cornmill is the engine of the vehicle itself. The corn mill is capable of producing minimum degerminator efficiency of 80% and minimum product recovery of 64% to satisfy the Philippine Agricultural Engineering Standard (PAES). The corn mill machine is equipped with a pre-cleaner and de-stoner for the removal of cobs, stones and other impurities in the corn kernels.

The fabrication of the prototype unit is collaborated with ACT Machinery in Cauayan City, Isabela. Field testing and evaluation of the prototype unit is scheduled in 2016 to establish the technical feasibility of the technology.

Development of Centrifugal Huller for Adlai

Adlai, along with rubber, coffee, cacao, abaca, vegetable spices, fruits, saba banana, root crops and soybeans is one of the priority crops of the Department of Agriculture (DA), under its High Value Crops Development Program (HVCDP). The DA through the Bureau of Agricultural Research (BAR) is intensifying its research and development activities to promote adlai.

In anticipation of the intensified commercial production of adlai, appropriate postharvest equipment, facilities and technologies are being developed.

Mix varieties of adlai had been tested at four different shutter openings of the developed adlai centrifugal huller for the determination of its optimum setting and technical performance. Based on the initial results of laboratory and field trials, the developed machine has a maximum whole grain recovery of 60% at 120 to 130 kg/hr hulling capacity at maximum opening. The results also give an average hulling recovery of 60 to 70%.

The developed centrifugal huller has a great potential for hulling adlai grains. For glutinous variety, pulot showed to exhibit promising results.

Hulled adlai grains using the developed centrifugal huller machine

Currently, the machine is being field tested at NOMIARC, Malaybalay, Bukidnon to verify further its actual field performance and for other varieties found in the area.

Field testing of centrifugal huller machine at NOMIARC, Malaybalay, Bukidnon.

Developed centrifugal huller machine for adlai

Effect of Ethanol Vapour on the Quality of Broccoli

Broccoli (*Brassica olaracea*) is one of the most popular but highly perishable vegetable. It is an important source of vitamins, minerals and antioxidants which are essential components of human diet. It ranks fifth among fresh fruit and vegetable with substantial amount of vitamin C content. However, It senesces rapidly after harvest. The florets turn yellow in three to four days at storage without postharvest treatment. Development of off-odor and incidence of decay are expected at storage in room temperature after harvest. Postharvest losses from harvesting to retail market is 21% Thus, suitable treatment is necessary to maintain the overall quality of broccoli until it reaches the consumers.

Silica gel packed in permeable paper (6.5 x 15.5cm) and sealed with second layer of non-permeable plastic film (oriented polypropylene/cast).

Storage of broccoli was conducted at PHilMech to ascertain the efficacy of ethanol vapor in extending the shelf-life and in maintaining the overall quality of broccoli in storage for 10 days. A factorial experiment involving 2 kg of broccoli heads was treated with 5 % ethanol and packed in oriented polypropylene bag (1040x1080mm, thickness 30 µm) with two holes (5mm diam) on both sides. Broccoli samples were treated with ethanol vapor thru placing together inside the package a pack of 100 ml food grade ethanol encapsulated into 200 of silica gel. Treated and untreated broccoli heads were stored at laboratory condition with two different storage conditions (17±0.3 and 22±0.2 ^{0}C). Destructive sampling was carried out at 0, 3, 5, 7 and 10 days after storage. Samples from each storage conditions were analysed for biochemical changes like chlorophyll degradation, total soluble solid content, nutritional quality, weight loss and organoleptic quality.

Results revealed that broccoli treated with 5% ethanol vapor and stored for 10 days at 17±0.3 ^{0}C has lower total chlorophyll content loss of only 60% than that of untreated samples with 90% loss. Weight loss was within the minimum acceptable level of 4%, the treatment also retained high level of ß-carotene, total phenolic and ascorbic acid content and delayed the development of decay until seven days in storage. Ethanol vapor could extend the shelf-life of broccoli thus maintaining its overall quality during storage.

Sachet of silica gel placed inside the package of polypropylene with 60 um thickness

Field Testing of Improved Drying Technology for Fermented Cacao Beans

An improved Greenhouse-Type Solar Dryer (GTSD) retrofitted with biomass furnace was developed as an improvement of the Multi-Commodity Solar Tunnel Dryer (MCSTD). This technology will to facilitate convenient regular mixing of the fermented cacao beans during periods of continuous rainfall. It uses UV stabilized polyethylene sheets which protect the beans from rain, absorb solar radiation and retain heat resulting to higher temperature inside the dryer. The ambient air is drawn inside by axial fans installed at the lower part at one end of the dryer and heated air is exhausted by another set of axial fans at the upper part at the other end. During night time and periods of continuous rainfall, the biomass furnace is operated to supplement heating. The heat generated by the furnace is transferred to the dryer through the heat exchanger ducts installed along its length.

The GTSD has a dimension of 13.2m x 7.56m x 3.48m (L x W x H) with a capacity of 702 kg fermented cacao beans. Results of the drying trials showed that drying time was four days in the GTSD as compared to that of the six days drying time in the greenhouse dryer commonly used by the cacao processors. The temperature inside the dryer ranged from 30°C to 60°C during daytime compared to the ambient temperature range of 25°C to 34°C. With supplemental heating at night, the temperature ranged from 28°C to 44°C. The quality analysis of the samples showed that the greenhouse solar dryer produced well dried and more brown cacao beans compared to the traditional greenhouse dryer.

Improved Greenhouse-Type Solar Dryer (GTSD) for cacao beans

Field testing of improved GTSD at CocoaPhil

Development of Sensor Devices for Cacao Quality Measurement

The cocoa bean is one of the priority products in Mindanao. It is an important cash crop. In Davao region, most of the cacao processors buy wet cacao beans from farmers . After harvesting and collecting the cacao pods from the farm, the farmers break the pods , cut the pods into half, carefully running the shaft cutting blade around the pod in order not to cut the beans inside and scoop to remove the beans out of the pods. The scooped wet beans are then put inside woven polypropylene sacks lined with polyethylene bag to keep the seed pulp juice from dripping out.

To avoid a low-quality product and to reduce defects during the production process, it is desirable to detect defects at an early stage of cocoa processing. As soon as possible, initiate remedial action.

This research explores the applicability of electronic nose as potential objective tool for assessing the condition of the cocoa beans. The availability of an instrument to determine the initial condition of wet cacao bean is an initial step towards improving the supply of good quality and Grade 1 cacao bean.

Different sensor devices for different design parameters were prepared. Sensor for volatile alcohol, for sugar content (refractometer), salinity meter and pH sensor were readily purchased.

Collection of standards and quality evaluation of newly harvested cacao were done.

Software, electrical testing and sensitivity testing are on-going activities.

Data gathered from Cocoaphil, Talandang, Davao City (partner cooperator) are being consolidated to establish range of changes in all the parameters to be used in developing the prototype sensor and its sensitivity to measure the quality of cacao wet beans.

Instrument set-up for analyzing quality of newly harvested cacao beans.

Color determination of cacao wet beans

Cacao samples in pod

Samples of newly harvested fresh cacao beans

Development of Commercial Products from Cacao Drippings

Cacao beans are primarily used in chocolate processing. However, this generates substantial quantity of waste such as drippings, which are good materials for the production of alcoholic beverages, vinegar, and soft drinks.

This project aimed to characterize the physico-chemical properties of cacao drippings and formulate products for commercial application.

Fully mature cacao pods of mixed varieties were harvested. The pods were cracked hygienically. During fermentation, the collected drippings were processed into four different products, namely: wine, vinegar, cordial and soft-drinks.

Results showed that the physicochemical properties of the four products were the following: For wine, it contained Total Soluble solids (16.2 brix depending on the ripeness of the cacao fruit and adjusted to 25 brix) alcohol (10-12%), pH (3.0-4.0), and total titratable acidity (≤1.0). For vinegar, it has a total soluble solids of (10 Brix), alcohol of (3-5%), pH (2.95-3.02), and total titratable acidity (4-5%) that pass Philippine legal standard. Lastly, for the soft-drinks: pH (3.95- 4.5), total soluble solids (15 Brix) and total titratable acidity (≤ 1.0%).

On the other hand, the microbial load (e.g. aerobic plate count, yeast and molds, total viable count, E. coli) of cacao sweating, its byproduct wine, vinegar and softdrinks obtained a value of 1 cfu/ml which is a very safe level according to USDA.

Sensory evaluation and financial analysis of wine, vinegar and softdrinks are on-going.

Products from cacao drippings : vinegar, wine, softdrinks

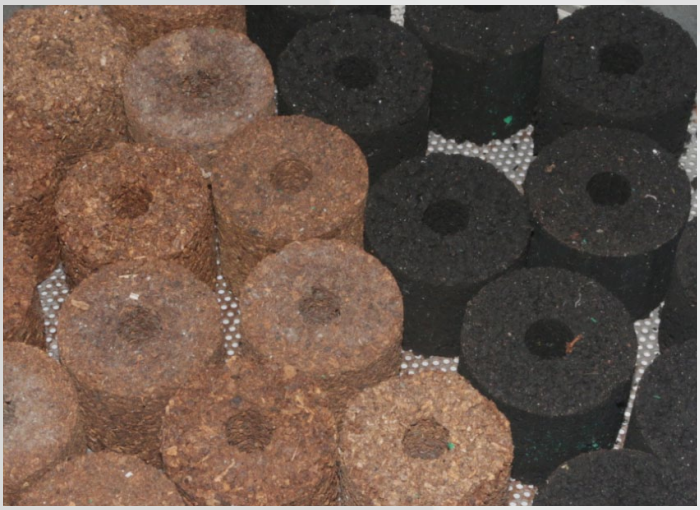
Utilization of Cacao Pod Husk as Fuel Briquettes

Cocoa beans are primarily used in chocolate processing. However, the entire processing operation generates substantial quantity of pod husks approximately between 70 to 75% of the whole weight of cacao pods. Traditionally in practice, the cacao processors prefer to collect the cacao beans leaving the cacao pods in the field unutilized. With the current cacao production in the country, around 3,382 million metric tons of pods turn into wastes per year. Converting cacao pod husks into usable products (e.g briquettes) will address the problem of waste disposal.

The general objective of the study is to develop an environment-friendly fuel briquette sufficient to resist impact during handling and transport. It also aims to produce the required heat in briquette for domestic cooking and other industrial applications.

Thirteen formulations in producing cacao pod husk-based fuel briquettes were developed using piston type briquetting machine. Results showed that as the percent binding agent increases and particle size of pulverized cacao pod husk decreases, the bulk density, shatter resistance and break strength of fuel briquettes increases.

Determination of the investment and production cost of cacao pod husk-based fuel briquettes is on-going.



Fuel briquettes from cacao pod husks

Molecular Identification of Bacterial, Fungal and Yeast Isolates from Cacao Beans

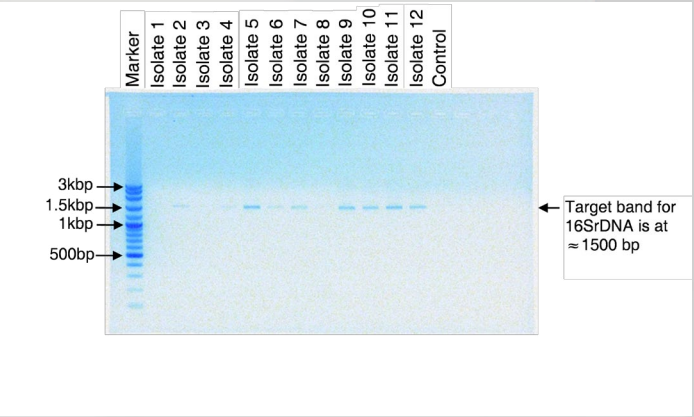
Farmers use fermentation to turn cacao beans into cocoa products. Cocoa beans are allowed to ferment in a traditional fermentation box, and microorganisms naturally present in the box grow and carry out the fermentation process. These microorganisms primarily include yeasts, lactic acid bacteria and acetic acid bacteria. Contaminating microorganisms are present too, such as fungi which leave their effect on the quality of the resulting fermented product. All of these microorganisms grow naturally in succession during fermentation with limited control from the farmers to deliberately produce high quality cocoa products.

One way to increase manageability of the fermentation process is to isolate, identify and use only the essential microorganisms. Establishing starter cultures of identified microorganisms provide farmers option to apply only the necessary microorganisms for fermentation, and to add more speed to the process. Isolation and identification of contaminating microorganisms enables research to find relevant information and create solutions that prevent their growth in the fermentation process. With these, properly identifying microorganisms facilitates control in producing intended product quality.

Molecular identification of microorganisms can now be done at PHilmech with its newly completed instruments for basic laboratory work in molecular biology. The instruments and the protocols to be used however will require optimization. Once optimized, this capability will provide a more accurate and faster identification of microorganisms.

The project then aims to identify bacterial, fungal and yeast isolates from cacao beans using molecular biology identification techniques.

Optimization of reagents and instruments is on-going for molecular identification. 16SrDNA primers, for bacteria, and the internal transcribed spacer primers, for fungi and yeast, are being used, but other important housekeeping genes will also be tried. Fifteen fungal isolates have been identified and needs further optimization. Identification of 44 bacteria and yeast isolates is on-going.



Optimization of molecular identification protocol for bacterial isolates using 16SrDNA primers 27F (forward) and 1492R (reverse).

Development of Starter Culture for Enhanced Fermentation of Cacao Beans

Cacao fermentation gives the raw materials of cacao beans a distinct taste and quality which is important in chocolate production. Addition of starter cultures during fermentation has the possibility of decreasing the days of fermentation as well as provide a microbial inoculum that might be helpful in improving the quality after fermentation.

Three trials were done for this project with two types of fermentation boxes used. These include the wooden box which is the traditional way of fermentation and a stainless box which is used to decrease the possibility of contamination from the other box.

The microorganism that were used as starter culture were isolated from the back-slopes and were identified using BiOLOG. These were *Lactobacillus sp., Acinetobacter gerneri, Bacillus pumilus, Bacillus subtilis, Enterococcus casseliflavus, Kurthia sp., Ochrabactrum sp., Candida tropicalis, Hypopichia burtonii, Kluyveromyces lodderae, Kluyveromyces wickerhamii, Pichia anomala, Pichia membranaefaciens, Pichia subpelliculosa, Saccharomyces cerevisiae* and *Zygosaccharomyces fermanti*.

All treatments from the experiments reached the 45° to 50°C which are essential for the microorganism to work and process the beans for fermentation. Using the cut test parameters to evaluate the quality of fermentation and cacao beans, the fermentation with mix starter cultures and back-slopes revealed a higher number of fermented beans in just four to five days of fermentation while the spontaneous fermentation took six to seven days until the fermentation of beans are complete.

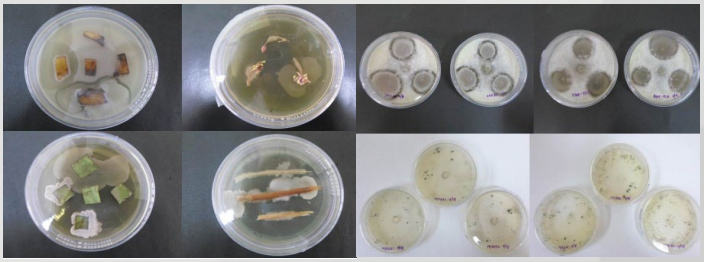
Epiphytic and Endophytic Microorganism as Biocontrol Agents of Black Pod Rot (*Phytophthora spp.)* of Cacao (*Theobroma cacao*)

Cacao is one of the emerging cash crops in the Philippines as cacao beans are used to manufacture chocolate. Black pod (BP) of cocoa are caused by several Phytophthora spp., predominantly *Phytophthora palmivora* (Butl.) Butl., which are devastating to cocoa production, which combined pod losses generally exceed 80% under traditional management.

Most of the area's production in the Philippines is certified organic, so that only cultural and biological approaches are viable disease management options. In this context and from the perspective of Integrated Pest Management (IPM), biological control is an additional method that can help in reducing the disease to economically viable levels, with a concomitant decrease in the use of chemicals (Krauss and Soberanis 2001). Biocontrol of FPR and BP has shown great promise.

The close association of microbial epiphytes and endophytes with plants offers a unique opportunity for their potential application in plant protection and biological control. Microorganisms living inside the plant tissues (endophytes) and on surfaces (epiphytes) form associations ranging from pathogenic to symbiotic.

The objective of the study is to isolate epiphytic and endophytic microorganisms as biocontrol agents of black pod rot of cacao. Epiphytic and endophytic microorganisms were isolated from pods, stems, leaves and flower cushions of cacao. These isolates were tested against *Phytophthora palmivora* by dual incubation method for candidate bacteria and precolonized plate method and detached pod assay for candidate fungi. Candidate microorganisms which showed potential antagonistic property were *Bacillus licheformis, Bacillus amyloliquefaciens, Bacillus pumilus, Enterobacter hormschei, Paanibacillus pabuli, Bacillus subtilis* and *Klebsialla amytoca* for bacteria and *Trichoderma spp.* for fungi. These candidate epiphytic and endophytic microorganisms which showed potential antagonistic property will be subjected to in vivo trials.



Establishment of Benchmark Information on the Potential Market of CNSL Derived from the By-products of Village-based Cashew Kernel Processors

The study is under the project, "Utilization of Cashew Nut Shell Liquid (CNSL) for Industrial Application" which is led by the Bio-Processing Engineering Division. This study was conducted to zero-in on the product which can be derived from the spent cashew shell with local industrial application to ensure the marketability of the product to be developed.

Presently, the industrial application of CNSL in the country is as raw material for friction dusts of local brake linings and as fuel for industrial furnaces. Cashew friction dusts (CFD) are used as additives in manufacturing friction materials for automotives such as brake linings, disc brake pads and clutch facings to stabilize the friction level. It controls wear and offers a protective device by prohibiting excessive temperature from being developed. It also helps control brake noise.

In 1988-1998, a company operating public utility buses, manufactured CFD using technologies from India and Brazil. After 10 years of operation, the company ceased its CFD production due to economic and environmental concerns. Currently, brake lining manufacturers in the country rely on importation of CFD from other countries particularly India. The Philippine imports an average of 100,000 kg of CFD yearly which is valued at around PhP3M. With the increasing number of motor vehicles specifically the trucks and buses which are the common users of locally produced brake linings, there will be greater demand of these products in the future.

Researchers at the Bio-process Engineering Division gear toward the development of a process in producing CFD. The feasibility of establishing CNSL processing using locally-fabricated machines is at the same time undertaken by the researchers at the Socio-economics and Policy Research Division.

Cashew shells generated by local processors from the extraction of cashew kernels that are dumped in open spaces; Roxas, Palawan, 2015

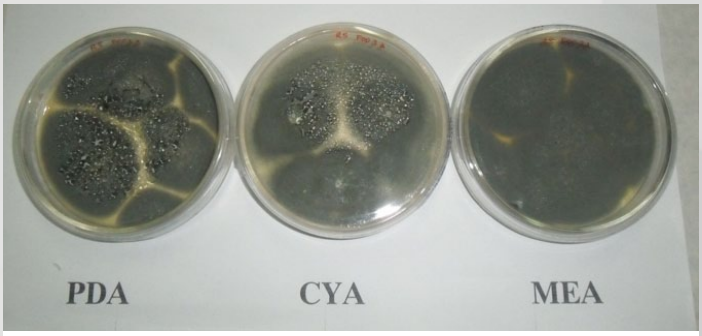
Microbiota and Mycotoxin of Cassava

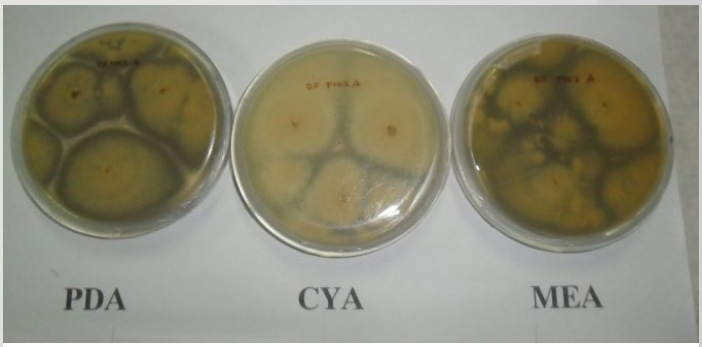
Conservation of cassava is hindered by its highly perishable nature. This requires immediate processing to ensure stability during storage and to minimize postharvest losses. The field observation shows that dried cassava were contaminated with molds which could be mycotoxin producers.

The objective of the project is to determine the extent of microbial and mycotoxin contamination in raw cassava and its by-products such as chips and flour. Most of the samples collected in Bicol region and Central Visayas contain insignificant amount of aflatoxin. Only six out of 50 collected raw and dried cassava samples contain aflatoxin ranging from 2 to 44 ppb.

Microbial analysis shows that the dominant fungi isolated are *Penicillium islandicum, Aspergillus flavus, Aspergillus niveus, Aspergillus ochraceous, Aspergillus fumigatus, Aspergillus japonicas, Rhizomucor pusillus, and Lasiodiplodia theobromae.*

Cassava samples





Microbial Analysis

Development of Improved Drying Technologies for Coffee

Coffee is the second most consumed beverage in the world. It is second to oil as the most traded commodity. The Philippines produces all commercial varieties of coffee. Robusta accounted for 70% of the country's total production, followed by Liberica (15-20%) and Arabica (5-10%).

However, the total coffee production continues to decline. Among the postharvest constraints in the industry are poor quality of coffee beans, lack or inappropriate postharvest facilities thus resulting to low income of farmers. Analysis shows that drying is a major cause to this situation.

To address this problems, PHilMech developed an improved drying technology for different coffee varieties.

Improved Greenhouse-Type Solar Dryer for Coffee

Field testing of improved Greenhouse-Type Solar Dryer for coffee

The Greenhouse-Type Solar Dryer (GTSD) with biomass furnace was developed as an improvement of the existing Multi-Commodity Solar Tunnel Dryer (MCSTD). Its major components include furnace, fan, drying tray and heat exchanger duct. The dryer has a dimension of 8.4m x 5.1m x 2.7m (L x W x H) with a capacity of 180 kg coffee berries. Two units of GTSD were fabricated at PHilMech and installed at the coffee growing areas of Lipa City, Batangas and Lupon, Davao Oriental.

Results of the drying trials for Robusta showed that drying time was reduced to six days as compared to two weeks drying time in the traditional sun drying. The maximum temperature inside the dryer reached 60°C during day time.

Development of Improved Postharvest Technologies for Coffee: Green Coffee Sorter

Coffee quality is the key in maintaining the Philippine foothold in the world market (Philippine Coffee Board, 2009). Unsorted coffee bean is identified as one reason in the lowering of roasted coffee. Coffee beans are graded according to the Philippine Standards for Green Bean Coffee. The different grades also command different pricing schemes.

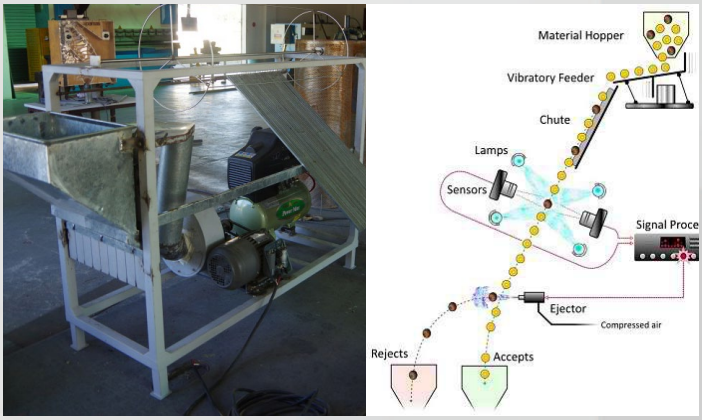
The quality and color sorter should address the need at the trader-level of operation, where maximum impact for maintaining coffee bean quality could be established. The envisioned color sorter should be comparable with existing imported machines. The localization of the design that will be made available at the farm-level should address the volume requirement of the local trading capacity.

The sorter when developed will have an ideal capacity of 300 to 500 kg per hour and capable of sorting different varieties of Philippine coffee. It would also be capable of separating dried beans from green beans.

The project developed a mechanical and sensor-based machine capable of measuring the size and color quality differences of coffee, separating them according to desired quality. This will contribute in the upgrading of the coffee industry in terms of high quality, graded coffee available in the market. It will also raise consciousness for high quality production of coffee.

Coffee cherry and bean quality assessment were already undertaken, comparative assessment of different coffee quality in major growing areas, assessment of quality classifications, collections of samples as standard reference and development of parameters for sorting standards.

Mechanical sorter components by means of aspiration, density and dimension are being developed and fabricated at the PHilMech fabrication shop.



(Left) Fabricated base frame of the coffee sorter-hopper, suction blower, seed (GC) slider; (Right) Design concept in color determination and ejection of low quality beans.

Development of arduino set – up for the determination of RGB value of each bean and with a comparative study based on the reading of the purchased color meter to arrive in much conclusive result; on-going activity is the conversion of RGB value to wavelength (Nm).

Synthesis and Characterization of Nano-composites from Coconut Waste (Coconut Husk): A New Potential Materials for Nano-Filtration System

Coconut (*Cocos nucifera L.*) is the most important and extensively grown palm tree in the country with a total cultivation area of 3.3 million hectares and annual production of 15,667,600 tons. However, utilization of the by-product was given less attention. With the development of nanotechnology with high specific surface area and highly porous with highly pore interconnectivity composites can be used for further applications such as nano-filtration system.

The study used nano-composite from novel clay reinforced to cellulose acetate derived from coconut husk to develop and fabricate a nano-filtration system. Produced nano-fibers were blends of Poly Lactic Acid (PLA), cellulose acetate from coconut husk, chitosan and Amino Lauric Acid Montmorillonite (ALA-MMT).

Fourier Transform Infrared Spectroscopy (FTIR) analyses revealed carbonyl group, alkene bending (CH2), asymmetric ester group that is a band characteristic of PLA and cellulose acetate (CA), asymmetric stretching of pyranose and CH2 bending bands revealing the polymer blend of the treatments used. Scanning Electron Microscopy (SEM) analyses showed no significant difference among treatments. Hence, increasing voltage from 25kv to 30kv showed no effect the diameter size of the fibers. Also, the results confirmed non-toxicity and antibacterial property of the nano-fibers in terms of growth inhibition as per higher content of cellulose acetate and chitosan. Prior to water analysis, results showed significant difference ($P \leq 0.05$) among all the water samples depicting that stage of filtration affects the quality of water decreasing the colony forming of microorganisms, hence prolonging the shelf life and quality of water comparable to water filtration system pasteurization.

Screening and Evaluation of Plant Latex Extracts in Managing Postharvest Diseases of Tropical Fruits

The application of fungicides is the common practice to reduce postharvest losses caused by fungal pathogens. However, excessive use of commercially available fungicides may result to contamination in crops and fungicidal residues in the environment and the development of resistance in fungal pathogens. Public and scientific concerns about the presence of synthetic chemicals in our food supply and the environment has been increasing for the past decades (Wisniewski and Wilson, 1992). Despite the risk, the advancement of fungicides for postharvest use is persistent.

Alternative control measures were developed to control postharvest diseases which include the use of bacterial and fungal antagonists as biological control agents and the use of natural products particularly of plant origin. Bioactive products of plants are less persistent in the environment and are safe to humans, other non-target organisms (Sharma and Trivedi, 2002; Fokialakis et al., 2006) for the control of postharvest diseases than synthetics (Barrera-Necha et al., 2008). Bioactive compounds from plant latex are potential source of antifungicides against postharvest pathogens. Unripe fruits are observed to be free from fungal diseases. This could be attributed to the presence of latex during immature stage of the fruit. Latex producing plants secretes endogenous milk like fluid in a network of laticifer cells in which subcellular organelles intensively synthesize proteins and secondary metabolites (Ramos et al., 2007). Plant latex contains great varieties of defense chemicals and defense proteins (Konno, 2011). The study will provide wide-range of options in managing postharvest diseases by evaluating latex extracts against fungal pathogens of selected tropical fruits.

In-vitro assay of papaya, banana, mango, star apple, jackfruit and aloe vera latex extracts was carried out for their efficacy against mycelia of fungal pathogens namely Colletotrichum gloeosporioides, Colletotrichum musae, Fusarium verticillioides, Lasiodiplodia theobromae and Thielavipsis paradoxa.

Results showed that among the plant materials evaluated, latex extracts of jackfruit and banana were found to have high level of activities against the mycelial growth of the five fungal pathogens. Latex extracts of these two plant materials were evaluated further at lower concentrations 75, 50 and 25%. At a lower concentration of 75%, jackfruit latex extract was able to completely inhibit the growth *C. musae* followed by *L. theobromae* with an average of 96.98% inhibition. Likewise, it was also found to be effective in controlling the mycelial growth of *Colletotrichum gloeosporioides, Fusarium verticillioides* and *Lasiodiplodia theobromae* with average of 90.20, 74.20 and 57.16%, respectively. On the other hand, using the same concentration of 75%, banana latex extract was able to inhibit the mycelial growth of Colletotrichum musae, Colletotrichum gloeosporioides and Lasiodiplodia theobromae with average growth inhibition of 82.05, 80.19 and 74.37%, respectively. To further evaluate their efficacy on fruit samples, in-vivo assay will be conducted.

Collection and extraction of latex

Field Application of DGA14 and DG02 as Alternative Treatment in the Management of Anthracnose and Stem-end Rot of Postharvest Mango var. "Carabao"

The use of microbials provides alternative to the narrowing options of HVCC farmer-exporters regarding crop protection management relative to the stringent MRL requirements of importing countries. Hence, this novel technology contributes to the national development program in terms of safe export commodity as a means of maintaining dollar reserve.

The objective of the project is to determine the efficacy of formulated microbial control agents (MCA) as postharvest treatment against anthracnose and stem-end rot of mango in commercial scale. Microbial formulation combined with HWT on export 'Carabao' mango showed 8% disease incidence upon reaching Hongkong, nine days after treatment. The result is superior to that with HWT+synthetic fungicide (azoxystrobin) which showed anthracnose infection at 38 % and 88 % on untreated samples under the same handling condition and period. Adoption of MCA is consistent with the principles of IPM, food safety, good agricultural practices and organic farming system.

HWT+microbial (DGA 02), nine days after treatment

HWT+fungicide (Amistar), nine days after treatment
untreated control, nine days after treatment

Development of a Pilot-scale Processing System for the Production of Pectin from Mango Peels

A study was conducted to establish the potential of semi-commercial pectin production from mango peels. A previous study found that it was technically feasible to produce pharmaceutical grade pectin at a laboratory scale. The outcome of the project served as basis for further up-scaling and eventual commercialization of the technology nationwide.

Two kilogram output pectin processing plant was put up in partnership with Profoods International Corp. and Suki Trading Corp. The pilot-scale pectin production from mango peels was established at the Profoods Facility in Mandaue which provided the laboratory space, manpower, and some supplies. The Suki Trading Corp. provided the equipment and logistics. PHilMech provided the technical expertise, manpower and supplies and materials.

Pharmaceutical grade pectin from mango peels was produced using this semi-commercial facility. It met the specifications set by the US Pharmacopeia for the physico-chemical properties and gelling characteristics for pharmaceutical grade pectin. Food products like yogurt and jams formulated with mango pectin are well-liked by the consumers. The produced pectin has a shelf-life of more than one year. It is free from pathogens after one year of storage under ambient and cold storage conditions.

Financial indicators showed that pectin production with a 2kg output per day is a promising, profitable venture with payback period of 3.7 years and a total investment of P1.4 M.

Semi-commercial processing plant for the production of pectin from mango peels

Evaluation of Organic Acids and Microbial Control Agents Against Postharvest Diseases of Onions

Lack of available practical options to halt postharvest diseases of onion is one reason why farmers immediately sell their produce. It is the objective of the study to evaluate organic acids and MCA as alternative treatment to maintain quality of onions.

In-vitro trials were conducted to establish antagonistic effect of DGA02 and DGA14 against pathogens isolated from infected bulbs such as *Aspergillus niger, Erwinia carotovora, Fusarium sp.* and *Sclerotium rolfsii.* Antagonistic test in-vivo comprising of artificially- inoculated and naturally-infected bulb samples showed that candidate MCA had suppressive effect against all test pathogens at 12.5 percent dosage (diluted to 1L), seven days after treatment compared with untreated samples. To identify MCA candidate, onion phyllosphere and rhizosphere were tested.

Results showed that the most common organisms were *Rhizopus oryzae, Aspergillus niger, Penicillium citrinum* and *Trichoderma harzianum*. *T. harzianum* was included along with DGA02 and DGA14 long term storage trial. Screening of organic acids (acetic, malic, citric and lactic) is on-going.

Bulb samples (top) artificially-treated with MCA showing curative effect while untreated onion bulbs (below) showed decline of quality

Design and Development of Harvester for Medium-Scale Sugarcane Farm

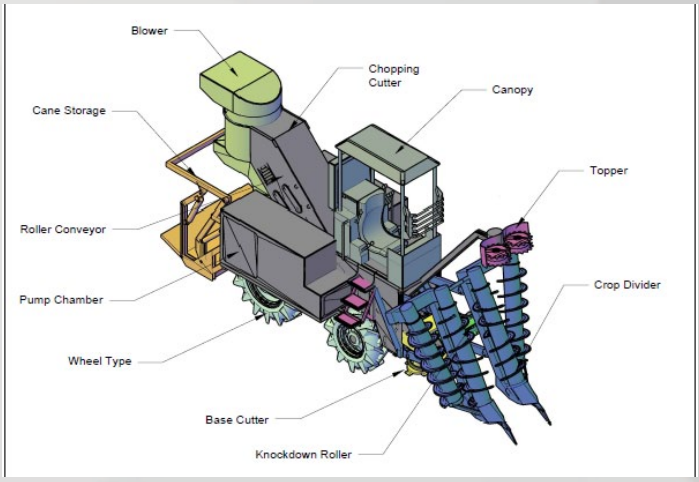
The sugarcane industry contributes around P70 billion in the Philippine economy every year . The contribution to the gross national product is around 1.2% per annum (SRA, 2012). The Philippine government envisions a sugarcane production area of 465,704 ha with an annual production of 33 million TC by 2016.

Harvesting of sugarcane is the tedious part in sugarcane production (Li et al., 2002) This consists of cutting, trimming, bundling, and loading. Today, small- and medium-scale farms still rely on manual harvesting of sugarcane. Scarcity of laborers during harvesting is attributed to the heavy work and harsh working conditions in the field. During harvesting, laborers are required to carry heavy bunches of canes and perform other back breaking activities. Available imported mechanical harvesters with drive row-spacing of 1.2m are still expensive (approximately around P5-10 M). Also, the unavailability of parts imposes problems during repair and maintenance (Maglanlan, 2013).Most of these imported harvesters are not suitable to hilly areas which is very common in the Philippines.

Hence, mechanization for sugarcane production is important to improve efficiency, productivity, and competitiveness in the country. It implies the use of various power sources and improved farm tools and equipment, in order to reduce the drudgery of manual labor, enhance the cropping intensity, allow precise and timely sugarcane production and reduce the losses, especially during harvesting. Therefore, the development of a locally made, medium-scale sugarcane mechanical harvester to address these problems is timely and necessary.

PHilMech aims to increase efficiency of sugar cane harvesting in medium-scale farms by 30% through mechanization.

In 2015, PHilMech has established the criteria for the design and CAD drawing of the sugarcane harvester. It has gathered benchmark technical information necessary for the conceptualization of the design of the harvester. It has completed the details of the technical plans of the major components and the key features of the sugarcane harvester. A project collaborator and fabricator has been identified thru bidding protocols. A MOA has been signed and the technical plans have been awarded to the fabricator. The technical specifications of the major parts of the harvester (e.g. hydraulics system assembly) for the bidding process were finalized. Pre-procurement of some of the major parts (e.g. engine) by the winning fabricator was done. Already, fabrication and assembly of sugarcane harvester parts and components have been done.



CAD design of the sugarcane harvester

MOA signing with the Metalworking Indrustries Association of the Philippines (MIAP)

Benchmark Studies on the Postharvest Handling of Major Lowland Vegetables

Lowland vegetables such as tomato, bitter gourd, sweet potato and eggplant are among the important crops that are being promoted by the Department of Agriculture (DA). However, several factors such as high production and postproduction losses due to improper handling practices impede the growth of this vegetable industry.

This project aimed to identify the improvements in the supply chain in terms of appropriate postharvest technologies and policy recommendations conducive to the development of lowland vegetables. In order to establish baseline information on the postproduction systems and come up with data on quantitative and qualitative postharvest losses of these crops, key informant interviews (KII), focus group discussions (FGD), actual loss assessment and supply chain analyses were undertaken. The study areas include: Pangasinan, Nueva Ecija, Nueva Vizcaya, Laguna, Bukidnon (for tomato); Quezon, Nueva Ecija and Batangas (for bitter gourd); Quezon, Batangas, Pangasinan and Nueva Ecija (for eggplant) ; and Tarlac, Albay and Bataan (for sweet potato).

Tomato

Tomato (*Lycopersicum esculentum*) which is locally known as "kamatis" is an important fruit vegetable planted in many parts of the country. It is grown both for home consumption and trade. Majority of the farmers interviewed in Luzon and Visayas prefer Diamante Max. In Bukidnon, the famous varieties planted are Dwarf Puti and Dwarf Green.

Diamante Max is preferred by farmers because it is a high-yielding variety, thick skin, juicy flesh, longer shelf-life and high transportability. In Bukidnon, Dwarf Puti and Dwarf Green are planted by farmers because it is adaptable in their soil type, resistant to pest and diseases, it has thick skin and low breakage during transport. Tomatoes are classified according to size following informal grading systems that are adapted by traders. Most of the farmers are dependent on traders with regard to price. They rely on private persons who provide loan with high interest.

The off–season planting contributes to significant income because the price of tomato is high compared to the regular planting season. The regular season usually results to oversupply depressing farm gate prices substantially. This produces high losses due to extended marketing periods and absence of postharvest technologies to prolong shelf-life. Most of the tomatoes from the major growing areas in the Philippines are transported to the major markets in Metro Manila (e.g. Divisoria, Balintawak and Munoz market).

Actual loss assessments from production to major markets were done following the major routes of tomato from the major producing areas to the market. The conduct of loss assessment was conducted in Nueva Ecija, Nueva Vizcaya, Iloilo and Bukidnon.

Bitter gourd

Bitter gourd, scientifically named as *Momordica charantia* L., is one of the most popular and widely grown vegetables in the Philippines and is considered to be one of the biggest income generating crops. It is either grown commercially or in backyard scale. Most of the farmers' plant the long varieties of bitter gourd like Galaxy and Galactica. Bonito and Makiling varieties, the small size variety, have gained popularity because it can be best processed for medical purposes.

Most of the long varieties of bitter gourd are transported in Divisoria. The Bonito and Makiling varieties are mostly traded to ampalaya processors. Government grading system for amplaya are not followed instead traders have their own trading system. Farmers harvest schedules are dependent on the availability of buyers. There are cases when bitter gourd is harvested in the ripening stage thus leading to shorter shell life. It was observed that some farmers lack awareness or knowledge on food safety and hygiene

Actual loss assessments were done from selected farms in Nueva Ecija, Quezon and Bulacan to major markets.

Eggplant

Eggplant (*Solanum melongena L.*) is one of the most important vegetables in the world. It is one of the banner crops and most popular lowland vegetables in the Philippines because of its inclusion as one of the basic ingredients of the most popular vegetable food viand in the country called "pinakbet"

Based on the results of FGD, Morena is the top variety planted by the farmers followed by Fortuner because of their resistance to pests and diseases, heavier and fleshier fruits, high yielding variety, longer in shelf life than other varieties. Other varieties planted are Native, Casino, and Guapito. Some farmers most especially in Pangasinan preferred Native variety because of its demand for pinakbet, higher productivity and for production of their own seeds.

Actual loss assessments were done from selected farms in the provinces of Quezon and Pangasinan to major markets in Metro Manila. Weight reduction due to moisture loss/ evaporation and quality deterioration caused by fruit borers that only manifested during the postharvest operation were the most observed contributors to losses in eggplant production.

Sweet potato

Sweet potato (*Ipomoea batatas L.*) is one of the main crops grown in sub-tropical and tropical countries. It is one of the most important cash crops in the Philippines because of its low input requirements. Most of the preferred variety planted by the famers is "Super Bureau" because of its fast maturity days and highest yield among the common varieties.

Actual loss assessments were done from selected farms in Tarlac and Bataan to major markets. It has been observed that high postharvest losses occurred in harvesting during the digging and uprooting of sweet potato roots. Thus, an intervention using a tractor-drawn root crop digger was tested and this showed a promising reduction of harvesting loss.

Establishment of Benchmark Information on Postharvest and Mechanization of Selected Commodities: Shallot, Cassava, Cardava Banana and Bulb Onion (Red and Yellow)

The project established baseline information on priority high value crops as bases of providing appropriate postharvest and mechanization research and development interventions.

Study sites include Ilocos Region for shallots; Regions 2 and 10 for cassava; Regions 2 and 11 for Cardava banana and Region 3 for bulb onions. Value chain analysis framework was used. Focus group discussions, key informant interviews, actual loss assessments trials were conducted to collect the information and data needed.

Shallots and Bulb Onions (Red and Yellow)

Three chains were observed for marketing cured and bundled onion shallots in Ilocos Region. These include farmer to the local market, farmer to the export market and traders to processors. In the local market chain, retailer earned more than the others while exporter and processor gain more in the chains of export and minimal processing. The farmer earned the least in all identified chains.

Postharvest losses for local and export market were determined. Feasibility studies on the profitability of engaging on processing shallots into pickles, flakes, chips and powder were prepared to serve as guide for those interested to venture on the business. Available imported machines were considered in the FS.

Meanwhile, two chains were observed for marketing red and yellow bulb onions produced from Nueva Ecija. These were the fresh yellow and red bulb onions sold to local market and red bulb onions from the cold storage to the local market. From the different actors involved retailers received the highest income followed by the farmers while traders got the lowest income.

Initial results showed that postharvest losses incurred by the yellow bulb onion chain were lower than that of red bulb onion. Feasibility studies on the profitability of engaging on custom servicing business of tractor for land preparation, onion seeder, uprooter, sorter and sorter-conveyor were prepared. Some machines considered on the FS are imported because no local ones are available.

Cassava

Two chains were observed in marketing fresh cassava tubers from the farmer to the feed and industrial/food processors in Mindanao. In Luzon, only the feed processing chain was observed. From the chain actors involved, farmers and the traders/cooperatives in Mindanao and Luzon, respectively earned the highest.

Postharvest losses determined were mainly on physical and moisture loss. Feasibility studies were prepared to have an idea on the profitability of custom servicing for planter, peeler, granulator, digger, chipper and belt dryer, Moreover, viability of investing on different cassava processing such as cassava chips, grates and flour were also analyzed.

Cardava Banana

Observed Cardava banana chains in Luzon were selling fresh Cardava banana from the farmer to the market and farmer to the banana chips processor. In Mindanao, export chains were observed: the microwavable banana to United States and Canada, fresh Cardava banana to Japan and Dubai, and banana chips to U.S., Europe, Australia and China.

In Luzon chains, farmers got the least income from among the chain actors while the retailers received the highest followed by the wholesaler/consolidators. Meanwhile, all the processors/exporters received the highest income. Postharvest losses incurred by Luzon were due to immature hands. In Mindanao, quality losses by the farmers were due to rejects in terms of size especially for microwavable and fresh banana export which requires bigger sizes. Losses incurred by the different processors vary depending on the requirement and recoveries.

For investors, feasibility studies were prepared as handbook on the profitability of engaging on the different Cardava banana processing. Among them were the kitchen or village type banana chips processing, village type microwavable saba processing, different modules on flour and fiber processing, and washing/packaging business of fresh Cardava banana.

Pilot Testing of Integrated Soybean Production-Processing Technologies Towards Accelerating the Development of the Local Soybean Industry in the Philippines

The Department of Agriculture through the High Value Crops Development Program implemented the National Soybean Development Program. The program aims to build a strong soybean production industry that is community-based. It also seeks to establish viable products through public and private partnership.

In line with this, PHilMech implemented this project to evaluate the financial viability and social acceptability of integrated soybean production –processing modules in selected areas of the country.

It has pilot tested integrated production – processing systems with the following coooperators: (1) 3 K enterprise in Sta. Ana, Mexico, Pampanga and Paco, Manila ; (2) Agricultural Rural Alternative Development Options, Incorporated in Alang-Alang, Leyte ; (3) Golden Beans and Grains Producers Cooperative in Cabanatuan City, Nueva Ecija; (3) Ecological and Agricultural Development Foundation in Bacolod City, Negros Occidental; and (4) Baligi Rural Women Association, Villa Verde, Nueva Vizcaya.

Visitation/monitoring of KKK Ent. farm in Mexico, Pampanga

The 3K Enterprise is an example of a close production processing system where the processor produces his own soybean raw materials. Mr Gadmer “Mer” Layson has been PHilMech cooperator in processing soymilk and other products since 2014. His soybean farm is located in Sta. Ana, Mexico and his soybean processing center is based in Paco, Manila. The 3 K enterprise produces 600 bottles (330 ml) of soymilk and 100 bottles daily of soyfee (i.e. prepared from roasted soybean) to satisfy the demand of his markets. Six to eight persons are now employed daily at 3 K enterprise. PHilMech supports the enterprise by providing GMP compliant grinder, continuous technical assistance in the production and processing of soybean and providing linkages to different government institutions (e.g., DOST and DTI) for product improvement and/or quality monitoring.

Training on Soybean Production and Postharvest held in Alang-Alang, Leyte

PHilMech provides assistance to the typhoon Yolanda victims through the Agricultural Rural Alternative Development Options, Incorporated (ARADO) based in Alang-Alang, Leyte. ARADO is a farmer-based organization that trains farmers and the landless on sustainable farming and other means of livehood (e.g., piggery project and vermi composting). The organization serves as PHilMech cooperator since October 2014. PHilMech provided seminars and trainings on soybean production, postharvest and processing technologies last year. Facilities like multi-tilling machine, pedal type thresher, multi-grain thresher, cleaner/sorter and other processing equipments were also provided to the organization.

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Continuation...

ARADO is now producing soymilk and tokwa. Sister Eloisa David, the Chief Executive Officer of ARADO wanted to help reduce the incidence of malnutrition by nourishing kids with soymilk. To ensure the supply of raw materials, ARADO is maintaining a three hectare soybean farm.

Aside from maintaining a processing center and providing employment to regular processors, ARADO helps associations of women to have additional sources of income and to provide nutritious food for the household. A group of rural women is producing soybeans from their own farms and process soymilk and roasted ground soybeans for home consumption and for sale within the neighborhood. Other farmers are also selling soybeans to processors of roasted ground soybeans for brewing.

The Golden Beans and Grains Producers Cooperative (GBGPC) is actively promoting the production of soybeans in Region III. For 2016, around 20 hectares are targeted for soybean production. At present, the cooperative is producing soymilk, tokwa, taho and other soybean-based products. The cooperative employed two laborers daily on their processing operation. PHilMech gives technical (i.e., provision of training and mentoring) and facility assistance.

The Ecological and Agricultural Development Foundation and Baligi Rural Women Association are the new cooperators of the project. In October 2015, training on soybean production and postharvest was provided to the foundation. Both organizations will be provided with training on soybean processing.

Actual demonstration of planting soybeans in Bacolod City, Negros Occidental

ESETS

CLUSTER REPORTS

Development of Multi-Commodity Solar Tunnel Dryer-Based Micro-Enterprises

The project aims to establish viable micro-enterprises using the MCSTD. It has three components: (1) Sustained partnership with the KMNE in implementing the social laboratory; (2) Establishment of new social laboratory at the Marinduque State College (MSC); and (3) Setting-up of a viable MCSTD-Based Enterprises for fish products and dried gabi leaves.

In 2015, a total of 20 technology briefings and five skills training on food processing were conducted at the MCSTD Social Laboratory. Clients were representatives from government agencies like PCW, DTI, DAR, DA, DSWD and DOLE, local government units, student interns from CLSU and SLSU, foreign nationals, NGOs, group of women and food processors, etc. Of these clients, 10 participants decided to invest. They ordered MCSTD units from the PHilMech accredited manufacturer.

Meanwhile, the MCSTD Social Laboratory based at the MSC, suffered a lot of setbacks in 2015. These include: (1) the difficulty of the newly assigned project team in adjusting between teaching and project involvement and (2) the limited operating capital. Despite these limitations, the project team prepared training modules and conducted information campaign through posters to invite prospective trainees to attend technology orientation and demonstration at the MSC campus. Promotional MSC-MCSTD tarpaulins were also printed and posted for each of the six municipalities in the province to create awareness about the project. PHilMech assisted the project team under the Technology Development and Fabrication of MSC during their visit at the KMNE social laboratory and MCSTD fabrication shop at the Design 360 in San Jose City, Nueva Ecija.

The MCSTD-based fish processing project of the Rural Improvement Club (RIC) of Minanga in Gonzaga, Cagayan continued to process dried fish, shrimp and seaweeds, seaweed chips, shrimp paste, and fish bagoong. In May 2015, however, the MCSTD of the RIC Minanga was destroyed because of typhoon Dodong. This forced the club to temporarily stop their processing operations.

The farmer processors in the three barangays of Nabua, Camarines Sur produced quality dried gabi leaves through MCSTD. Since the farmers cannot meet the demand of traders due to low capacity, (5 kg dried gabi leaves/batch/dryer at 4-6 hour drying duration), they were encouraged to practice grading of dried leaves and adopt price segmentation and value adding.

Through the project, the gabi growers became more aware of the importance of producing good quality dried gabi leaves and the necessity to unite as a federation for a consolidated marketing. At present, the group regularly receives purchase orders from a food processing company based in Metro Manila with a minimum order of 450 kg quality dried gabi leaves/week sold at P150/kg.

Production and commercialization of fish-based products of the Rural Improvement Club of Minanga, Gonzaga, Cagayan

Production and marketing of quality dried gabi leaves by the Nabua Gabi Producers Association in Camarines Sur

Provision of Technical Assistance for Postharvest Enterprise Development

This project provides the needed assistance to clients who seek to start or expand an enterprise that employs mechanization, postharvest and agro-processing technologies and systems.

During the year, the project prepared the feasibility study on onion cold storage as requested by Anak Bukid Producers Cooperative in Sto. Domingo, Nueva Ecija. Said FS will be presented to private investors abroad.

Similarly, the project team prepared a feasibility study on pectin processing as requested by the Bio-Process Engineering Division (BPED) of PHilMech.

Also, the project team assisted in the preparation and presentation of the feasibility study on the Agri-Pinoy Rice Processing Center to Mr. Ricardo Provido Jr., the Region VI chairman of the Regional Agricultural and Fishery Council (RAFC), Mr. Manuel Olanday, RTD of DA-Region VI and Mr. Remi Tianson of NFA Region VI.

Two Regions (Region VI and Region I) were assisted in the Business Planning training/workshop for Agri-Pinoy Rice Processing Center recipients. Furthermore, Mabunga Cacao Farmers Association of Umiray, Dingalan, Aurora was linked to markets through DTI Region III, DA-AMAS Central office, and financial support from private group. The project also assisted and linked the said association to DOST to improve their packaging of materials.

The project team facilitated the visit of entrepreneurs from the Fernando Rice Mill in Talavera, Nueva Ecija to the RPC in Pangasinan. The visit is expected to enhance their knowledge on rice milling.

Project monitoring of all assisted groups like the Mabunga Cacao Farmers Association, Anak Bukid Producers Cooperative, and those involved in the Pilot Testing of Pectin and Benguet Cold Storage was done. Business advice was given to a private individual from Nueva Vizcaya.

The project team also reviewed and edited the cost analysis of two equipment (two-row corn planter and biomass-fed furnace dryer) for future use and reference.

Presentation of feasibility study on Agri-Pinoy Rice Processing Center to RAFC Chairman, representative from NFA and RTD of Region VI

Establishment of GIS-based Decision-Support System for Postharvest Development and Mechanization

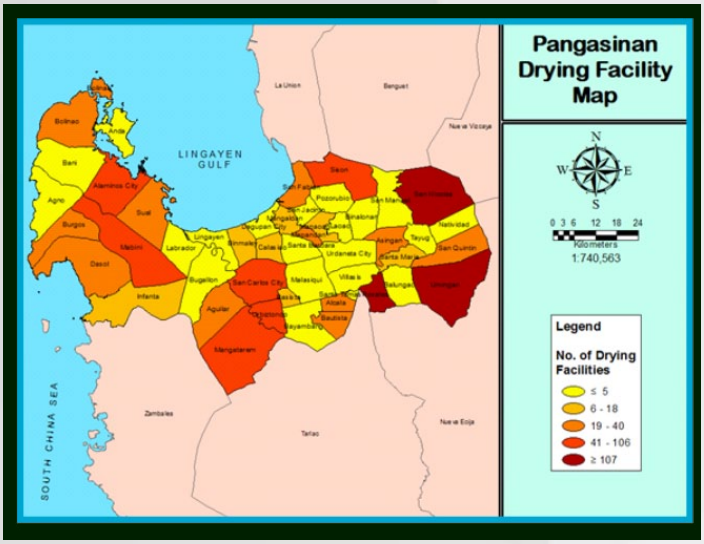
For over 10 years, PHilMech has gathered, processed, stored and encoded voluminous data on postharvest machinery, facilities and equipment. In 2011, PHilMech completed its collaborative project on crafting the postharvest development masterplans of the 81 provinces of the country's 15 regions (excluding the National Capital Region and the Autonomous Region of Muslim Mindanao).

In addition, a masterplan for seven cities and one municipality were crafted. The masterplans contained a comprehensive inventory of postharvest facilities, machinery and equipment, which placed the agency as the major repository of database on postharvest-related machines and equipment. This project enhanced the database to include other agricultural machines and equipment, especially with the expansion of PHilMech's mandate to include mechanization of the country's agriculture landscape.

The GIS-based databases contain barangay-level inventory of postharvest and agricultural machinery, facilities and equipment for rice, corn and high value commercial crops. These databases serve as reference materials and inputs to various programs like the Rice Mechanization Program, provincial and regional development road maps, other government development projects and private business groups that cater to the agriculture industry (e.g manufacturers of agriculture and postharvest machineries and equipment).

Data were gathered in collaboration with Municipal and Provincial Agricultural Offices, Provincial Agricultural, Department of Agriculture Regional Field Offices and various government agencies like the National Food Authority, Philippine Rice Research Institute, Bureau of Fisheries and Aquatic Resources, Bureau of Soils and Water Management, and the Department of Agriculture Information and Communications Technology Service, among others.

The databases, now in full service, are being continuously updated. The software that manages these databases is being enhanced to become a robust web-based platform for updating and accessing the data.



Drying facility map of Pangasinan

Feasibility Study on the Establishment of a Commercial Irradiation Facility for Agricultural Products and Other Purposes

This project is implemented in collaboration with the following agencies: Department of Science and Technology (DOST) – Philippine Nuclear Research Institute (PNRI), Department of Trade and Industry (DTI)-Export Management Bureau (EMB), National Food Authority (NFA)-Food Development Center (FDC), University of the Philippines at Los Baños (UPLB), Department of Agriculture: Bureau of Plant Industry (BPI)- Plant Quarantine Services (PQS), Bureau of Agriculture and Fisheries Standards (BAFS), High Value Crops Development Program (HVCDP), Agribusiness and Marketing Assistance Services (AMAS) and Philippine Council for Agriculture and Fisheries (PCAF). Its implementation is in line with Department of Agriculture Special Order No. 552 Series of 2013 dated 6 August 2013.

The project intends to determine the viability of a commercial irradiation facility for the treatment of agricultural products and for other purposes. Specifically, it aims to generate information for the market potential, technical and operational requirements, socio-economic impact, and financial profitability of a commercial irradiation facility.

A series of consultation meetings by the project's Technical Working Group (TWG) was conducted to evaluate the market aspects, technical and financial requirements for the commercial irradiation facility. Focus Group Discussion with stakeholders from the Visayas Region was conducted in Iloilo City on 29 January 2015. The TWG also visited the irradiation facilities at Vinagamma, Ho Chi Minh City, Vietnam and Thai Irradiation Center, Pathumtani, Thailand on 2-9 May 2015 to learn from the experiences of those with commercially operated gamma food irradiation facilities in nearby Southeast Asian countries. Consultation with private stakeholders on the results of the feasibility study was also completed.

The Project TWG during the technical visit at Vinagamma, Ho Chi Minh City, Vietnam

Industry Manpower Development Program

The Training Section of the Technology Management and Training Division (TMTD) of PHilMech is committed to develop the capabilities of agricultural extension service and other change agents. It is determined to maintain a critical mass of experts on agricultural mechanization and postharvest technologies through dissemination of research results or knowledge products by way of conducting training courses and other related activities.

In 2015, there were three major projects, namely: (1) Technical Support to Industry Manpower Development; (2) Technical Capability Enhancement of the Industry Stakeholders on Mechanization & PH Technologies; and (3) Special Project. The section organized and implemented 17 batches of training courses, writeshop/faculty meetings, symposia and other training-related activities.

Project/Activities	Date	Venue	Number of Participants
1. Technical Support to Industry Manpower Development			
1.1 Curriculum and Instructional Materials Development			
• Writeshop/Faculty Meeting for the preparation of Training Design	January 21	PHilMech	15
	January 28	PHilMech	5
	May 19	Siquijor	5
1.2 National Technical Conference on Agricultural Mechanization & Posthavest Technologies	March 17-20	PHilMech	66
1.3 Techno Talakayan on Postharvest & Mechanization	May 27	PHilMech	194
2. Technical Capability Enhancement of the Industry Stakeholders on Mechanization & PH Technologies			
2.1 Training Courses in Support to Rice Mechanization			
• Writeshop on the Development of Instructional Materials	April 13-15	Baguio City	12
	June 1-3	Baguio City	15
• Training Course on the Operation and Management of Agricultural Machineries for Farm Service Providers (FSPs)	March 23-27	PHilMech	31
	September 1-4	Bacolod City	48
• Specialized Training Course on the Mechanization of Rice Crop Establishment	May 11-15	PHilMech	40
	November 9-13	PHilMech	24
2.2 Training Courses on Mechanization & PH Technologies			
• Training Course on the Mechanization & PH Technologies for Rice, Corn, Cassava & Cacao	April 28-30	Bohol	25
• Training Course on the Mechanization & PH Technologies for Corn & Cassava	June 15-17	Dapitan	55
	Sept. 15-16	Siquijor	48
2.3 Training Courses in Support to Organic Agriculture			
• Training Course on the Mechanization & PH Technologies for Organic Coffee	July 14-17	Baguio City	36
	September 1-4	Bacolod City	42
3. Special Project: Technical Capability Enhancement of NAFC-FLGC Beneficiaries on Mechanization & PH Technologies			
3.1 Training Course on the Operation and Management of Farm Level Grains Center (FLGC)	February 16-25	Bacolod City	23
3.2 Follow-up Activities (Monitoring, mentoring & coaching of cooperatives/FLGC beneficiaries)	July - September	Visayas Mindanao	9 FLGCs

Technical Support to Industry Manpower Development

The training section developed the designs for the training courses in collaboration with the commodity focal persons, technical staff and other partners in the industry.

Specialized Training Course on the Mechanization of Rice Crop Establishment

Technical assistance through the provision of resource speakers was provided to Department of Agrarian Reform - Region 6, Department of Agriculture – Regional Field Office 6 and Office of the Provincial Agriculturist - Quezon during the conduct of Training on Postharvest Facility Management of TIMPAL ARC; Training Course on the Operation and Management of RPC I; and Training Course on the Operation & Maintenance of Selected Agricultural Machineries, respectively. Also, it provided technical assistance to DAR Region 2 on the conduct of training on postharvest technologies for their beneficiaries.

The Techno-Talakayan on Postharvest and Mechanization was conducted during the 37th anniversary of PHilMech and was participated by the technical staff from the municipalities of Nueva Ecija; officers and members of different FOs/NGOs/ Manufacturing Sector/Media; and former PHilMech Officials/ Staff.

Furthermore, the National Conference was attended by Regional Coordinators/technical staff for Rice, Corn and High Value Crops nationwide and PHilMech technical staff to enhance their awareness on the recent developments on agricultural mechanization and postharvest technologies of the different priority commodities.

Technical Capability Enhancement of the Industry Stakeholders on Mechanization and PH Technologies

The Section had implemented various training courses in support to the Rice Mechanization Program, to the Mechanization and Postharvest Technologies and to the Organic Agriculture Program.

The 376 participants were from DA-RFOs, Provincial Local Government Units, Municipal Local Government Units, and farmer organizations nationwide. For the Rice Mechanization Program, the Training Course on the Operation and Management of Agricultural Machineries for Farm Service Providers (FSPs), Specialized Training Course on the Mechanization of Rice Crop Establishment and Writeshop on the Development of Instructional Materials (two batches each) were conducted. PHilMech and the LGUs of Dapitan and Siquijor collaborated on the conduct of the Training Course on Mechanization and PH Technologies for Corn and Cassava. Also, two batches of the Training Course on the Mechanization and PH Technologies for Organic Coffee were conducted.

Special Project

The third batch of the Training Course on the Operation and Management of Farm Level Grains Center (FLGC) under the project, "Technical Capability Enhancement of NAFC-FLGC Beneficiaries on Mechanization & PH Technologies" was conducted. Fiive cooperatives (FLGC Beneficiaries) in Visayas participated.

On the other hand, follow-up activities (monitoring, mentoring and coaching) for the nine cooperatives of the 2nd and 3rd batch trained FLGC beneficiaries were also completed.

The last batch of the training course for the remaining five cooperatives in Luzon will be conducted on the first quarter of CY 2016.

PHilMech Industrial Promotion Program (PIPP)

The Technology Management Section of the Technology Management and Training Divison (TMTD) implements the PHilMech Industrial Promotion Program (PIPP) wherein private local agricultural machinery manufacturing sector is tapped in the fabrication and commercialization of PHilMech generated mechanization and postharvest technologies. The project aims to hasten technology transfer and encourage public private partnership to attract more investors into agricultural mechanization.

One of the major activities of PIPP is the Licensing Protocol. PHilMech Licensing Protocol was developed to intitutionalize a sytematic and uniform procedure for technology transfer and licensing . The said protocol involves the following: (1) Submission of letter of intent, (2) Plant inspection/evaluation, (3) Issuance of technical plan and drawings, (4) Prototype fabrication/provision of technical assistance, (5) Issuance of license to manufacture.

In 2015, four manufacturers fora were conducted nationwide to introduce PHilMech mature generated technologies and licensing protocol to encourage partnership among local manufacturers in the technology transfer and commercialization. There were 24 manufacturers who signified intent to apply for license. To date, there are 26 License to Manufacture certificates issued to manufacturers who have complied with all the requirements under the PHilMech Licensing Protocol.

Lastly, with the Department of Agriculture's aggresive promotion of farm mechanization to help make the agricultural and fishery sector become globally competitive, a special forum for the manufacturers was conducted at Apacible Hall of the Department of Agriculture in Quezon City on December 18, 2015. The activity was conducted to encourage and increase the participation of the local manufacturing sector in the supply and distribution of agricultural machineries. Secretary Proseso J. Alcala attended the event to know from the representatives of the local manufacturing sector how the governmnet can support the industry. Officers and members of the Metal Industry Association of the Philippines (MIAP), Agricultural Machinery Manufacturers and Distributors Association (AMMDA), Philippine Die and Mold Association (PDMA), Philippine Plastic Industry Association (PPIA) and other local manufacturers also participated in the activity.

Manufacturers' forum to introduce PHilMech generated technologies

Intensifying the Promotion of PHilMech Generated Technologies

In its effort to accelerate the promotion of generated technologies, PHilMech has shifted its driving force. Not only does it focus on research and development, it also makes technologies accessible to the end users by having them available in the market through industrial promotion.

With this, the Technology Management Section has conducted nine batches of demonstration of PHilMech generated technologies throughout the country in 2015. Among the technologies demonstrated were the manual rubber-bib coffee pulper, cassava digger, compact corn mill, fluidized bed dryer, cocowater processing system, brown rice huller, adlai mill, cashew-nut sheller, multi-commodity solar tunnel dryer, and other technologies for organic coffee system.

These activities were attended and participated in by agricultural extension workers of concerned provincial and municipal local government units; representatives from the DA Regional Field Offices nationwide; local manufacturers; farmer leaders; processors; SUCs and other potential technology adopters.

Table 1 below shows the details of the technology demonstrations conducted last year.

Demonstration of PHilMech Cashew-nut Sheller at El Nido, Palawan

Region/Province	Date Conducted	No of Participants	Technology Demonstrated
1. Amadeo, Cavite	29-Jan-15	59	Manual Rubber-bib Coffee Pulper
2. Alfonso Lista, Ifugao	13-Feb-15	50	PHilMech Cassava Digger
3. PHilMech	19-Mar-15	40	Various PHilMech Technologies
4. Tagbilaran, Bohol	30-Apr-15	57	PHilMech Compact Corn Mill
5. Lamut, Ifugao	21-May-15	20	PHilMech Brown Rice Mill
6. Asniero, Dapitan City, Zamboanga del Norte	16-Jun-15	76	PHilMech Cassava Digger and Adlai Mill
7. El Nido, Palawan	8-Jul-15	11	PHilMech Cashew-nut Sheller and MCSTD
8. DA-RFO CAR, BPI Complex, Baguio City	17-Jul-15	34	PHilMech Technologies for Organic Coffee
9. Milagros, Masbate	3-Sep-15	38	PHilMech MCSTD
Total Participants		385	

Technical Support to Intellectual Property Rights

This project of the Technology Management and Training Division of PHilMech ensures the protection of Intellectual Property Rights (IPR) on various technologies and/or materials developed by PHilMech staff in compliance to the Intellectual Property Code of the Philippines or RA 8293.

Currently, there are three registered utility models; three utility model applications; and six patent applications. There are also six registered copyrights.

Copyright Registration		
Title	Registration Number	Class of Work
1. Ex-Ante Analysis for the Development of Brown Rice Just-in-Time Hulling Technology Vol.4No.2	B2015-20	B
2. Gintong Tuklas Komiks: Mga Bunga ng Tagumpay	B2015-21	B
3. Gintong Tuklas Komiks: Lunduyan ng Tagumpay	B2015-22	B
4. Gintong Tuklas Komiks: Lasap ng Tagumpay	B2015-23	B
5. National Postharvest Dev't. Masterplan (Industry Situationer) Info Bulletin No.1	B2015-123	B
6. Value Chain Improvement of Robusta and Liberica Coffee	B2015-179	B

For the PHilMech publications, there are two registered copyright for technical bulletin, one for information bulletin and three for comics on success stories.

In support to the agency's manpower development program, an in-house Seminar Workshop on Patent Search was conducted on June 23, 2015 at PHilMech headquarters. The main objective of the seminar was to provide project leaders and researchers a comprehensive view on prior art search of their respective project/technology to be applied for IPR claims.

Date Issued	Utility Model Registration	Registration Number
Nov. 11, 2015	1. Natural Rehydration and Energizing Bottled Coconut Water Beverage	2-2015-000266
Aug. 24, 2015	2. An Apparatus for Cleaning, Grading and Sorting Soybean Seeds Sorter, Cleaner, Grader	2-2013-000490
May 21, 2014	3. Pharmaceutical Grade Pectin From Mango	2-2013-000466

Date of Application	Utility Model Application	Registration Number
May 23, 2014	1. Coffee Depulper	2-2014-000329
May 23, 2014	2. Multi-Fuel Auto-Fed Biomass Furnace for Grain Dryers	2-2014-000328
Apr. 24, 2014	3. Tractor Drawn Cassava Digger	2-2014-000201

Date of Application	Patent Application	Registration Number
Aug. 27, 2015	1. Fluidized Bed Drying System	1-2015-000278
Mar. 16, 2015	2. PHilMech Multi-Commodity Belt Drying System	1-2015-000074
Feb. 4, 2015	3. PHilMech Compact Cornmill System	1-2015-000122
Jul. 21, 2010	4. Hook for Cable Transport	1-2010-000214
Jul. 18, 2008	5. Method for Inhibiting Crown-rot Disease causing Pathogenic Fungi and Crown Rot Disease in Banana Fruit Using *Bacillus amyloliquefaciens* DGA14	1-2008-000247
Jul. 18, 2008	6. Method for Inhibiting Crown Rot Disease in Banana Fruit Using *Trichoderma harzianum* DGA02	1-2008-000248

Applied Communication Program

The Applied Communication Division of PHilMech packages and disseminates different Information, Education and Communication (IEC) materials, so that audiences become aware and interested about PHilMech technologies and systems.

Doing these tasks of developing IEC materials and disseminating these to intended audiences are the two sections of the ACD—the Science and Technologiy Information Packaging Section (STIPS) and the S & T Information Dissemination Section (STIDS). For the year 2015, a total of 62,301 IEC materials were produced and disseminated by ACD (Table 1).

Under the ACD-STIPS, traditional and new media are used in the design and production of postharvest and mechanization messages. Publications and audio-visuals comprised the traditional media while the website, facebook and twitter comprised the new media.

For PHilMech publications, the ACD produces both popular and technical publications. Popular publications include newsletters, magazines, comics, leaflets, flyers, brochures, primers. Technical publications include Postharvest and Mechanization Journal, technical bulletin, technology bulletin, technology leaflets.

Section Projects	IEC Materials	Number of copies/prodn	Target audience
1.Creating Awareness on Postharvest and Mechanization Through Print, Website and the Social Media	• PHilMech Newsletter		PHilMech trainees, visitors, exhibit viewers, extension workers, partners, internet users
	--Ist Quarter	3,000	
	--2nd Quarter	3,000	
	--3rd Quarter	3,000	
	--4th Quarter	3,000	
	• Annual Report	1,000	
	• PHilMech leaflet	5,000	
	• Info Kit	1,000	
	• Website		
	--News /feature updates	12	
	--Replies to queries	34	
	• Facebook		
	--Posts/shares	143	
	• Twitter		
	--Tweets	79	
2.Publishing Journals and Other Technical Publications of PhilMech	• Technical Bulletin	1,000	Partner SCUs, SLS end-users, researchers, academe, internet users
	--Value Chain Improvement of Robusta and Liberica Coffee		
	--Compact Corn Mill	1,000	
	• Information Bulletin		
	-Corn Postproduction Modules for Farmer-based Agribusiness-enterprise	1,000	
	• Cassava digger flyer	4,000	
	• Techno-briefer		
	--Development of Improved Compact Corn Mill	1	
	• E-publications	4	

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3. Dev't. Support Communication on Postharvest and Mechanization	• Technology Kits (with fliers, brochures, primer) --A Guide to Coffee postharvest and processing --A Guide to Soybean postharvest and processing • Technology leaflets --MCSTD --Compact Corn Mill • Instructional Videos --Coffee production and processing system --Soybean production and processing system	 8,000 8,000 5,000 5,000 1 1	PHilMech trainees, extension workers, visitors, exhibit viewers, would-be investors, partners
4.Communication Support for Rice Mechanization Program	• Rice Mechanization Bulletin --Angat Ani Tomo 3 Blg 1 --Angat Ani Tomo 3 Blg 2 --Angat Ani Tomo 3 Blg 3 --Angat Ani Tomo 3 Blg 4 • Rice Mech Program kit --Folder kit --Program primer --Brochures (3 kinds) --Techno briefers (in CD) • Technology Calendar	 5,000 5,000 5,000 5,000 5,000 5,000 5,000/kind 2,000* 5,000	Extension workers and implementers of the program
5. Public Awareness for Postharvest and Mechanization Technologies	• Billboard • Exhibit Materials	2 18	Investors, recipients of the technologies
6. Developing Easy-to-Access IEC Materials on Postharvest and Mechanization	• Postharvest module	4 sets	Recipients of the technologies
	TOTAL	62,301	

Audio-visual materials packaged include promotional, instructional and inspirational videos .

All these IEC materials are packaged through the various communication projects of ACD-STIPS, to wit: Creating Awareness on Postharvest and Mechanization through Print, Website and the Social Media; Publishing Journals and Other Technical Publications of PHilMech; and Development Support Communication on Postharvest and Mechanization.

Similarly, the ACD-STIDS has continually promoted and showcased postharvest and mechanization technologies through the mixed media.

For 2015, STIDS has implemented four communication projects that focused on creating awareness and interest on

postharvest and mechanization. The section has considered a wide range of audience, from the program implementers, extension workers down to the recipients and investors of the technologies. Its dissemination means include participation to exhibits, conduct of briefings and production of IEC materials.

SOA courses and graduates

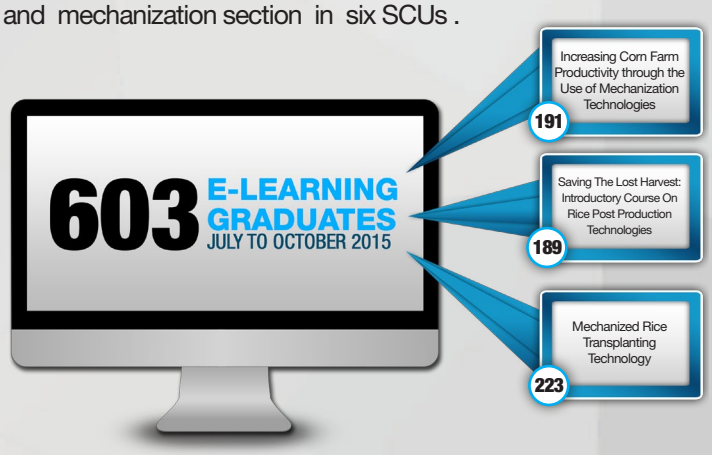
Last year, STIDS participated in 12 agricultural trade fairs and exhibits like BAR Agri-Fishery Forum, Corn Congress, Agri-Link and Makina Saka. It featured developed and emerging technologies of PHilMech like cassava digger, coffee postharvest system, compact corn mill and matured coconut water processing technology. Here, exhibit visitors gave queries, comments/suggestions and requests for technical assistance.

The STIDS has also maintained its Visitors' Bureau to address interests of potential clientele. Last year, the bureau used informative videos and educational presentations to brief 88 batches or 2,441 farmers, foreigners, policy makers and students.

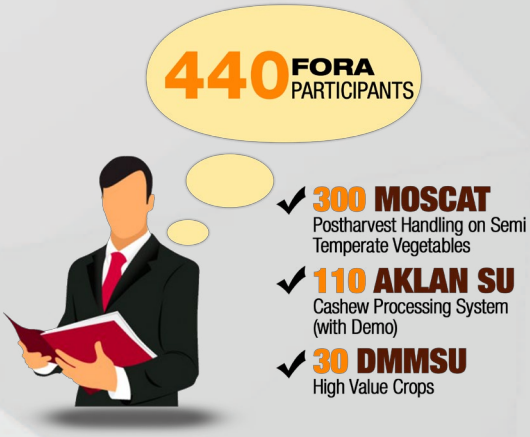
The section as well has updated its holding of books and subscriptions for its scientific literature services (SLS) to serve knowledge needs of researchers. For the 2015, SLS added 12 books to its holdings and subscribed to 9 journals/magazines. SLS served 813 users.

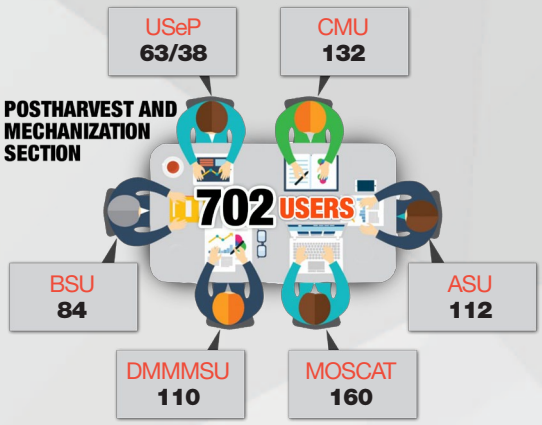
The Office of the Division Chief also implemented a project entitled, "Enhancing the Extension Delivery system on Postharvest and Mechanization through the State Colleges and Universities and the Techno Gabay Program".

Highlights of accomplishments in 2015 include the conduct of three School-on-the Air (SOA), three technology fora, three collaborative E-learning courses on postharvest and mechanization with the ATI and the installation of postharvest and mechanization section in six SCUs .



The SOA produced 859 graduates; the technology fora garnered 440 participants; E-learning courses produced 603 students; and the PH section in the SCUs gained 702 users.





PHDMS

REPORTS

Rice Mechanization and Sustainability Program of the Postharvest Facilities Distributed Nationwide

In accordance to the AFMech Law and as part of the agency mandate to generate, extend and commercialize appropriate and problem-oriented agriculture and fishery postharvest and mechanization technologies, PHilMech through its Agri-Infra Coordinating Unit (AICU) and in collaboration with the DA-Regional Offices (DA-RFOs), Local Government Units (LGUs) and other agriculture-related agencies completed 100% of the Sustainability Program activities and 99.5% of the Rice Mechanization Program activities for the year 2015-2016. Also, with strong partnership with the private sector and farmers' organizations, PHilMech through AICU, conducted national exhibits and consultation meetings that emphasized the campaign of the government to improve the livelihood of farmers through proper agricultural mechanization.

Primarily, the rice mechanization program aimed to: (1) enable rice farmers to increase their access and use of appropriate production and postproduction systems as mitigation measures for climate change and; (2) realize added income for farmers for at least 15% from efficient production activities, drying and milling operations. On the same note, the sustainability program of the government had the ultimate goal of ensuring the functionality and utilization of these postharvest facilities distributed nationwide thereby ensuring the continuity and proper usage of these postharvest technologies.

Through the supervision of the AICU head, 4 Cluster heads, and with the support of 16 Regional Field Coordinators, and 3 members of the Rice Mech technical group, the AICU was able to accomplish the following activities:

1. Provided 554 technical assistance to the project collaborators in the regional implementation of the DA Rice Mechanization and Postharvest Program (i.e. conduct of procurement, testing and evaluation, trainings and debugging) in 16 regions. Also, assistance to the R&D cluster during the conduct of regional data gathering and field visitations for rice mechanization was done.

Training Course on the Operation and Maintenance of Selected Agricultural Machineries

2. Conducted national and regional consultation meetings and workshops for the completion of the National Rice and Corn Mechanization Master Plan (2015-2022) at the Eurotel Hotel, North EDSA, Quezon City. Other consultation meetings were conducted during the first and second quarter of 2015 at the Apacible Hall at the Department of Agriculture central office.

3. Attended 395 consultation meetings, farmers' fora, regional workshops and conferences in representation of the agency through the RFC's and Regional Cluster heads of AICU.

4. Initiated the establishment of the Rice Farm for Mechanized System of Farming with primary activities conducted during the second to third quarter of the year.

5. Conducted 34 batches of assessment meetings and technical orientation of Rice Mechanization beneficiaries of combine harvester, 4-wheel tractor, reaper, rice transplanter, and rice mill. The activity evaluated and assessed the functionality and utilization of the facilities as well as remind recipients on their accountability to operate, maintain, and improve utilization of facilities; and

Consultation and assessment meeting with the beneficiaries of postharvest facilities in Camarines Norte

6. The AICU under the RM Sustainability project conducted four batches of Skills Training Course on the Operation and Management of Mechanized Rice Transplanting in Luzon A, Luzon B, Visayas, and Mindanao.

As per approved Financial Plan for 2015, the AICU budget amounted to P66,800,000 or 30% of the total allotted budget of the agency. Of the said budget, 28.89% is allotted to the Rice Mechanization Program amounting to P19,300,000.00.

Of this budget, 95.55% of the total budget was utilized (P63,826,608.15 M). Under the Rice Mechanization Program, the total percentage of the budget was at 96.02% or P18,532,6436.84 based on the total obligated budget of December 2015.

Other accomplishments under the project include the evaluation of nominees for the 2015 Rice Achievers' Awards; membership in the Technical Working Group during the 2015 Rice Achievers' Awards held at the Resorts World Manila, Pasay City; conduct of the AICU Technical Conference on February 16-18, 2015 at Camiguin Province; exhibit coordination during the two leg Makina Saka 2015 at the Ouans Worth Farm Resort at Lucena City and the Philippine International Convention Center at Pasay City on November 16-20, 2015 and December 1-3, 2015, respectively.

Establishment of Agricultural Tramlines for Upland Agriculture in the Philippines

The agricutlural tramline is a system of steel cable lines provided with carriers to transport agricultural products and inputs from isolated farm areas to the nearest road network and vice-versa. The projects' main objective is to develop upland agriculture through the establishment and utilization of Agricultural Tramline System (ATS) in key upland crop production areas to improve farm accessibility, increase agricultural productivity and increase income of farmers.

Notable impacts on the use of ATS are as follows: (1) reduced difficulty and time in hauling of agricultural produce and inputs, (2) less hauling cost, (3) improved physical conditions of the crops, and (4) increased production area coverage.

In 2015, a Php 30M fund was approved by the Department of Agriculture for the construction of additional ATS in selected "high value" crops producing areas nationwide. These new units are from the batch of upgraded tramline design with improved carrier, bigger sized cables, reinforcements and structures, and with safety features like rubber bumpers and emergency engine stop mechanism.

Eight units of ATS were completed in 2015. These are located in (1) Caliongan, Dalaguete, Cebu, (2) Aglimocon, Maayon, Capiz, (3) Ligaya, Sablayan, Occidental Mindoro, (4) Igmayaan, Don Salvador, Benedicto, Negros Occidental, (5) Kingbiks, Dupax Del Sur, Nueva Vizcaya, (6) Panaytayan, Mansalay, Occidental Mindoro, (7) Caliking, Atok, Benguet, and (8) Baballasiaon, Sta. Maria, Ilocos Sur. These new ATS are expected to serve around 3,000 farmer-beneficiaries and 575 hectares of production areas. A total of 126 ATS are now established in the country under the National Tramline Program.

Upgraded ATS

Meanwhile, PHilMech, in collaboration with the Department of Agriculture – Regional Field Offices (DA-RFOs) and different Local Government Units (LGUs), assured the smoothness of project implementation from site selection, social preparation, construction stage and up to the turn-over of the facility. Training of operators and recipients was conducted before project turn over. Topics include ATS parts and components, operation and maintenance, safety pre-caution and trouble shooting, and organizational and financial management. Information, education and communication materials on the agricultural tramline and other related postharvest and mechanization technologies were also given to the recipients.

Postharvest Facility in Support to the National Organic Agriculture Program

The Philippine Center for Postharvest Development and Mechanization (PHilMech) implemented this project, in collaboration with the Department of Agriculture – Regional Field Offices (DA-RFOs) and different Local Government Units (LGUs) nationwide.

The project's aimed to improve the postharvest operations in the organic agriculture sector through the establishment of appropriate and efficient postharvest facilities and equipment. This is to sustain the NOAP which was established with the promotion and commercialization of organic farming practices, cultivation, and adoption of production and processing methods, continuing research, the capacity building of farmers and the education of consumers, the extension assistance to the LGUs, peoples' organization (POs), nongovernment organizations (NGOs) and other stakeholders, documentation and evaluation of the program. (Section 5, RA 10068 OA Act of 2010)

In 2015, the project was allocated with P17,500,000.00 funds. This led to the provision of 10 units paddy huller, 10 units PHilMech-designed corn mill, and 12 sets of coffee processing facilities to the beneficiaries.

Ten units of paddy huller were distributed in Regions I (3units), III (4 units) VI (1 unit) and XII (2 units) while corn mill were granted 1 unit each in Regions IV-A, X and XII, 2 units in Regions VII, IX, and 5 in Region IX.

Meanwhile, eligible recipients of coffee processing facilities were located in Regions I (2 recipients), VI (6 recipients), and IX (4 recipients). The delivery of facilities (Coffee Pulper, Coffee Huller, Moisture Meter, UV plastic and super grain bag) is ongoing . Trainors' training was conducted in Bacolod City for recipients in Region VI and in Benguet for Region I recipients on September 2-4, 2015 and July 14-17, 2015, respectively. The training aimed to improve the technical capability of the participants to produce organic coffee through proper mechanization and appropriate postharvest technologies.

The provision of paddy huller and the PHilMech-designed compact corn mill included several activities, to wit: validation, coordination, and evaluation of proposed registered organization; supply; delivery; installation; testing of facilities from the supplier to recipient level; training of operations and maintenance to operators and members of the organization; and conduct of monitoring and technical assistance.

On-site installation and testing of Paddy Huller

Training Course on Mechanization and Postharvest Technologies for Organic Coffee

In addition, remaining projects of 2014 were completed. The first batch of "Training Course on Mechanization and Postharvest Technologies for Organic Coffee" was conducted in Benguet on July 14-17, 2015. Representatives from coffee recipients in CAR, staff of DOST and LGU representatives participated in the training. It comprised of lectures on OA general awareness, coffee postharvest situationer, production of coffee, harvesting, and post-production operations. Actual technology demonstration and facility turn-over were also conducted.

SUPPORT

CLUSTER REPORTS

Harmonized Agricultural and Fisheries RDE Agenda

With the enactment of RA 10601, otherwise known as the Agricultural and Fisheries Mechanization (AFMech) Law, PHilMech was tasked to lead in the overall research, development and extension (RDE) in agriculture and fisheries mechanization of the country. PHilMech ensures the development and adoption of modern, appropriate, cost-effective and environmentally-safe agri-fishery machinery and equipment to enhance farm productivity and efficiency in order to achieve food security and safety and increase the income of farmers. PHilMech also continues to implement various RDE projects for postharvest and mechanization concerns in grains and high value crops such as fruits, vegetables and rootcrops.

There is a need to come up with an updated framework and a coherent RDE agenda for postharvest and mechanization addressing various commodities. This is to ensure relevance of RDE programs and projects to the needs of the industry. This is also in support to PHilMech's role under RA 10601 of formulating, organizing and implementing a unified national Agricultural and Fisheries Mechanization RDE agenda.

Thus, a series of consultation meetings or workshops for priority commodities are being conducted as a strategic approach in coming up with relevant programs, projects and activities. Said activities will address the current and future postharvest and mechanization needs of the country regarding grains and high value commodities including fishery, livestock and poultry.

A National Consultation Workshop on the Formulation of Agricultural and Fisheries Mechanization RDE Agenda for Livestock and Poultry was conducted on November 25-27, 2015 at the Hotel Stotsenberg, Clark, Pampanga.

The RD&E consultation meeting on postharvest and mechanization for rootcrops was also conducted on May 15, 2015 at Sapang, Moncada, Tarlac. Likewise, a consultation meeting on organic agriculture and fisheries was conducted on September 10, 2015 at Bacolod Pavillon Hotel, Bacolod City.

Furthermore, a series of organizational workshop for the AFMech RDE Network was conducted. Said workshops were conducted to finalize the membership of the said network, formulate guidelines for the network operations and formulate the RDE planning framework. In addition, the strategic directions for the RDE Agenda were also formulated. Moreover, a series of consultation workshops (Luzon, Visayas and Mindanao-wide) was conducted to establish a unified RDE Agenda for the Agriculture and Fishery Mechanization.

Monitoring and Evaluation of Agency Programs, Projects and Activities

Monitoring and Evaluation (M& E) plays a vital role in the efficient and effective implementation of RD&E programs, projects or activities. It aims to measure and assess the performance of a specific program or project achieve the desired results. Likewise, it serves as a tool of the management in making the necessary decisions in accomplishing PHilMech goals and objective.

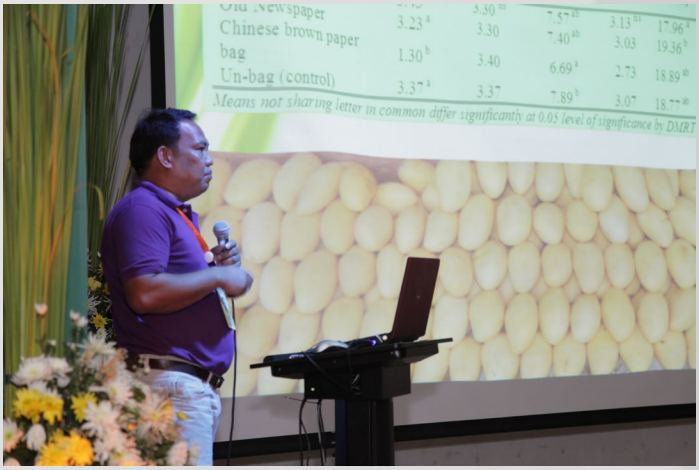
The Evaluation and Management Services Section (EMSS) of the Planning, Management and Information Technology Division is tasked to conduct and implement the M&E activities of the agency. Basically, the M&E function of EMSS includes three major activities: (1) the detailed M&E activities; (2) the annual Agency In-House Research and Development Review; and (3) the Midstream Agency Performance and Budget Review.

The detailed M&E activities primarily includes progress monitoring and on-site monitoring/field validation activities of both on-going and completed projects. This comprises monthly gathering/ collection of accomplishment reports from project implementers, and preparation of M&E reports for submission to the management and other concerned units and agencies of the Department of Agriculture. Reports that are submitted regularly include the Agency's Budget Accountability Report/ Physical Report of Operations (Quarterly) and Highlights of Accomplishments (Annual, Semestral and Quarterly).

Also, on-site monitoring/field validation is being undertaken to ensure that project activities were implemented as planned. This activity usually involves interview of recipients/cooperators and actual observation of on-going activities of the project. For 2015, various projects, were monitored in different locations nationwide. These include the Field Testing of the PHilMech Cassava Harvester, Agricultural Tramline System, Establishment of Modern Integrated Rice Processing Complex (RPC) in four provinces of the Philippines and the different components of Organic Agriculture.

In May 2015, the Annual Agency In-House Research and Development Review was conducted. This activity specifically aims to evaluate the extent of accomplishments of PHilMech R and D projects, its significant outputs, potential contributions and the manner of project implementation. For the period covered, a total of 13 completed projects were presented and evaluated.

Furthermore, PHilMech is not only concerned with R & D results but with the performance of the agency as a whole. Annually, a Mid-stream Agency Performance and Budget Review is being conducted to evaluate the agency's performance , both physical and financial. During the 2015 mid-stream review, project accomplishments by division were presented and some of the implementation issues were discussed and resolved to ensure that at the end of the year, the agency would be able to accomplish excellently its targets for the year.



Paper presentation during the agency in-house RD&E review

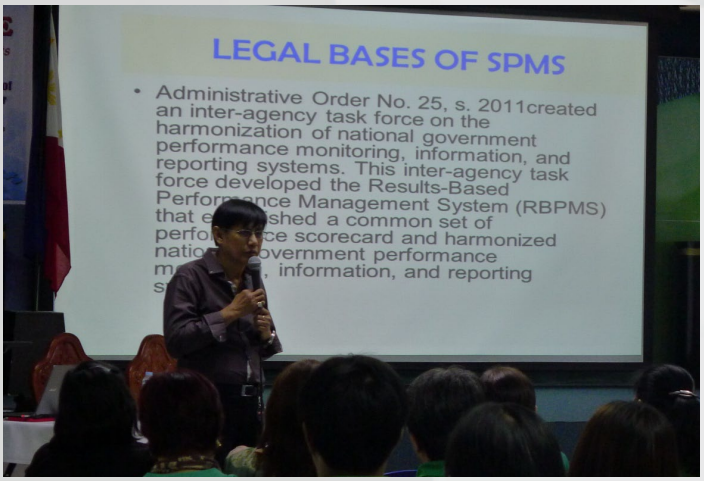
Administrative Support

The Administrative Division (AD) leads in the implementation of activities in support to the attainment of the PHilMech goals and objectives. These include activities related to the welfare and benefits of the employees, to wit: (1) renewal of magna carta eligibility for qualified personnel, (2) conduct of in-house training courses, (3) annual physical examination of personnel, (4) filling up of vacant positions and fast tracking of the hiring of contracted personnel to support the project staff in the implementation of the projects. New tools in measuring the performance of the employees using the new SPMS are also being used.

In support to the circular of the Department of Budget and Management (DBM) to minimize the issuance of checks, PHilMech adopts the List of Due and Demandable Accounts Payable (LDAP).

Request and dispatching of vehicles have also been computerized. Also, the bidding activities have been conducted successfully. The Annual Procurement Plan had been strictly implemented during the year.

Several improvements were also done. These include the renovation of the Liaison Office, repainting of the R & D building and perimeter fence, installation of canopy at the Training Hall, replacement of windows, repair of roads and others for the improvement of the working areas of the employees.



Conduct of SPMS briefing and workshop

Financial Resources

For CY 2015, PHilMech had a total budget of P221.362 Million of which P 213.111 Million was for the implementation of the current year's Program/Project/ Activities. Remaining balance of P 8.251 Million was carried over as continuing appropriation from the 2014 unobligated balances. Obligations incurred for the year totaled to P 210.872 Million which was 95.26% of the available allotment.

The agency also received P 26.667 Million from other government agencies as trust receipts. The funds were for the implementation of research projects and acquisition of postharvest facilities. Funding assistance amounting to P87,249.07 was also received from the Korean Government to finance collaborative projects.

Fund Source	Project Title	Amount
BAR	• Agency In-House Review	15,000.00
	• Occurrence of Ochratoxin A in Philippine Cacao Beans & Cacao Products	1,350,000.00
	• Feasibility Study on the Establishment of a Commercial Irradiation Facility for Agricultural Products and Other Purposes	357,260.00
	• Development of Centrifugal Huller for Adlai	468,364.50
	• Utilization and Promotion of Developed Postharvest Technologies for Sustainable Community-Based Coffee Processing Enterprise	2,087,500.50
	• Pilot Testing Integrated Soybean Production-Processing Technologies Towards Accelerating the Development of the Local Soybean Industry in the Philippines	2,500,000.00
	• Development of Commercial Scale Belt-Type Dryer with Combination Far-Infrared and Convection Heating for Rapid Drying of Mango Slices	2,000,000.00
	• Development and Promotion of Postharvest Equipment for Carrot Processing in BAPTC	850,000.00
PCAARRD	• Development of Village Level Rice Mill with Impeller Huller	923,031.00
	• Retrofitting of a Compact Rice Mill for Brown Rice Production	18,000.00
	• Design and Development of Hand Tractor Attachments	289,279.00
	• Development of Improved Postharvest Technologies for Coffee	6,664,953.00
	• Design and Development of Harvester for Medium-Scale Sugarcane Farms	4,621,708.00
	• Development of Sensor Devices for Cacao Quality Measurement	2,077,953.00
	• Piloting of the Hand Tractor-attached Transplanter and the Hand Tractor-attached Harvester in Selected Rice Growing Regions	327,015.00
	• Utilization of Cacao Pod Husk as Fuel Briquettes	1,817,159.00
PCC	• Design and Development of an Engine-Driven Baling Machine	300,000.00
AFACI	• Enhancing Agricultural Mechanization Technologies for Crop Production and Postharvest Processing of Cassava	87,249.07
	GRAND TOTAL:	**P 26,754,472.07**

Figure 1 shows the distribution of P 221.362 Million budget which covers the operational requirements of the Program/ Project/Activities (PPA's) of the agency.

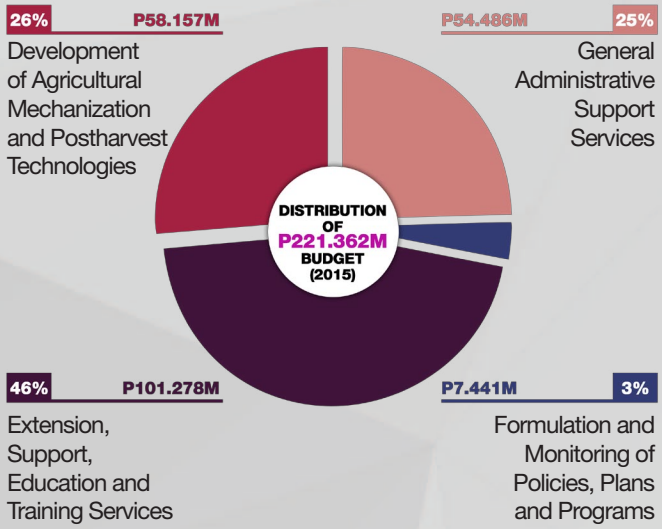


Figure 2 illustrates the distribution of budget by allotment class – Personal Services, Maintenance and Other Operating Expenses and Capital Outlays.

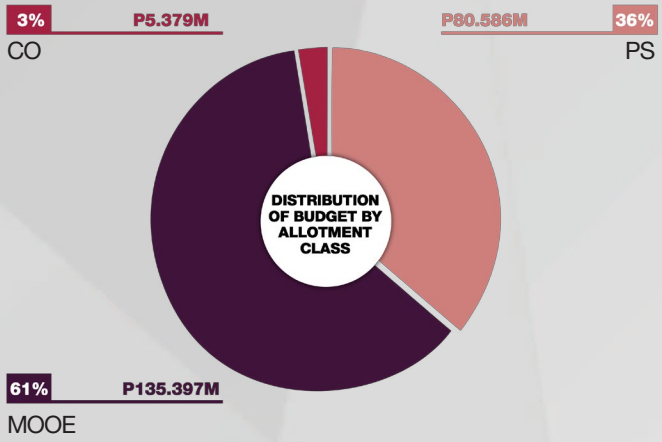
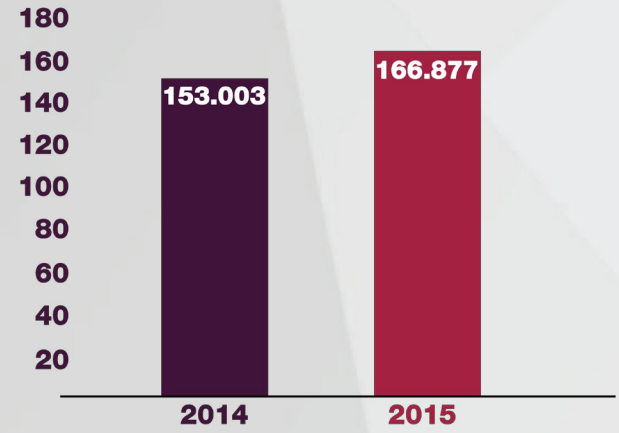


Figure 3 shows the comparative budget for Major Final Output (MFO) 1 for Technical and Support Services for 2014 and 2015.



PROJECT
IMPLEMENTERS' LIST

LIST OF PROGRAM/PROJECT IMPLEMENTERS

Research and Development

Development of Probe Meter for Moisture Detection of Selected Grains
A.C. Joaquin, ME.V. Ramos, R.C. Martinez

Development of Commercial-Scale Fully-Automated and Complete Fluidized Drying System for High Moisture Paddy
R.J. Pontawe, N.T. Asuncion, R. B. Villacorte, R. C. Martinez

Development of Improved Drying Technologies for Coffee
R.C. Martinez, R.E. Daquila, M E.V. Ramos

Field Testing of Improved Drying Technology for Fermented Cacao Beans
R.C. Martinez, R. E. Daquila and ME.V. Ramos

Field Testing of Impact-Type Huller for Milling-on-Demand
R.P. Gregorio, R.C. Martinez, JP.V. Gonzales

Developmemt of Compact Ultra Impeller Rice Mill
M.A. Gragasin, J.P. Ilustrisimo, R.C. Martinez

Development of Rolling Corn Mill
M.A. Gragasin, J.P. Ilustrisimo, I.V. Salapare, R.C. Martinez

Development of Centrifugal Huller for Adlai
R. C. Martinez, R.P. Gregorio, LJ.O. Alarcio

Effect of Gamma Irradiation on the Quality of Stored Brown Rice Using Different Packaging Materials
M.C.B. Gragasin, SM. A. Villota, O.A. Caparino, A. de Leon (CLSU), Z. de Guzman (PNRI)

Development of Commercial Products from Cacao Drippings
A.M.Tuates Jr., MP. D. Veneracion, SM.A. Villota, O. A. Caparino

Development of a Pilot-scale Processing System for the Production of Pectin from Mango Peels
MC.B. Gragasin, D. Ognayon, O.A. Caparino, A. R. Ligisan

Utilization of Cacao Pod Husk as Fuel Briquettes
O.A. Caparino, A.M. Tuates, Jr. J. M. Suligan, A. R. Ligisan

Development of Improved Postharvest Technologies for Coffee: Green Coffee Sorter
R.P. Gregorio, R.C. Martinez, JP.V. Gonzales

Synthesis and Characterization of Nano-composites from Coconut Waste (Coconut Husk): A new Potential Materials for Nano-Filtration System
J.J. Monserate, J.R. Salazar, G. Ilagan, A.M. Tuates Jr., O.A. Caparino

Development of Sensor Devices for Cacao Quality Measurement
R.P. Gregorio, R.C. Martinez, L.G. Bermudez

Design and Development of Harvester for Medium-Scale Sugarcane Farm
R.J. Pontawe, N. T. Asuncion, R. B. Villacorte, R.C. Martinez

Molecular Identification of Bacterial, Fungal and Yeast isolates from Cacao Beans
A.A. dela Fuente, D.G.Alvindia, M.A.Acda

Microbiota and Mycotoxin of Cassava
E.R.Regpala, D.G. Alvindia, M.A. Acda, C. L. Domingo

Development of Starter Culture for Enhanced Fermentation of Cacao Beans
D.G. Alvindia, N.C. P.Fabalena, M.A. Acda

Epiphytic and Endophytic Microorganism as Biocontrol Agens of Black Pod Rot *(Phytophthora spp.)* of Cacao *(Theobroma cacao)*
D.G. Alvindia, M.F.deGuzman, M.A.Acda

Evaluation of Organic Acids and Microbial Control Agents Against Postharvest Diseases of Onions
E.Z. Davalos, D.G. Alvindia, M. A. Acda

Effect of Ethanol Vapor on the Quality of Broccoli
M.V. delaCruz, JL.P. Baligad, M.A.Acda

Screening and Evaluation of Plant Latex Extracts in Managing Postharvest Diseases of Tropical Fruits
A.M.Wy, D.G. Alvindia, M. A. Acda

Identification of Wolbachia Bacterial Endosymbionts in Storage Populations of the Philippine Psocids and Mites
A.A.dela Fuente,A.M. Wy

Field Application of DGA14 and DGO2 as Alternative Treatment in the Management of Anthracnose and Stem-end Rot of Postharvest Mango var. "Carabao"
E.Z. Davalos, D.G.Alvindia, M. F. deGuzman and M. A. Acda

Benchmark Studies on the Postharvest Handling of Major Lowland Vegetables
MC.R.Antolin, E.D. Flores

Establishment of Benchmark Information on the Potential Market of CNSL Derived from the By-products of Village-based Cashew Kernel Processors
D.O. Tesorero, R.SM. dela Cruz

Establishment of Benchmark Information on Postharvest and Mechanization of Selected Commodities: Shallot, Cassava, Cardava Banana and Bulb Onion (Red and Yellow)
G.B. Calica, K. R. Lingbawan, J.T. Ceynas, MM.N. Dulay, ZL. L. Cabanayan, R.SM. dela Cruz

Pilot Testing of Integrated Soybean Production-Processing Technologies Towards Accelerating the Development of the Local Soybean Industry in the Philippines
R.SM. dela Cruz, MC.R. Antolin, C.F. Neric, Jr.

Extension Support, Education and Training Services

Development of Micro-Enterprises Using the Multi-commodity Solar Tunnel Dryer
H.F. Martinez, D. M. Gamalog, G. M. Tolentino

Feasibility Study on the Establishment of a Commercial Irradiation Facility for Agricultural Products and Other Purposes
G.O.Mallo, P.C. Castillo, G.M. Tolentino, R. L. Bingabing, R.A. Comia, MR D. B. Negrite, and TWG members from collaborating agencies

Provision of Technical Assistance for Postharvest Enterprise Development
P.C. Castillo, R. B. Daligcon, G.M. Tolentino

Establishment of GIS-based Decision-Support for Postharvest Development and Mechanization
KL. B. Sebastian, MC. G. Halabaso, G.M. Tolentino, G. O. Gaoiran, J. E. Domingo, L. A. Gonzales, E.V. Circa, B.T. Belonio

Industry Manpower Development Program
E.T. Cayabyab, H.R. Calica, M.V. Pascua, AM.A. Cajucom, J.S.Garabiles

PHilMech Industrial Promotion Program
E.T. Cayabyab, E.C. Ablaza, MV.B.Castro

Intensifying the Promotion of PHilMech Generated Technologies
R.O.Verena, E.T. Cayabyab, V.O. Bolcio, Jr.

Technical Support to Intellectual Property Rights
E.T. Cayabyab, E.C.Ablaza, P.M. Mercado

Applied Communication Program
R.P. Estigoy, M.B. Gonzalez, B.G.S. Magararu, V.B. Caliguiran, J.M.G.Subaba, M.L. Jose, I.DC. Davalos, A.V. Hipolito, P.E.P.Castro, GM.Z.Carganilla, J.R. Aguilar, A.P. Bermudez, D.T. Esteves, R.D. de Guzman, J.C. Gaspar, C.G. Nartatez

Postharvest and Mechanization Development Services

Rice Mechanization and Sustainability Program of the Postharvest Facilities Distributed Nationwide
A.E. Badua, C.C. Balajadia, R.M. Hermoso, DD.T.Julian, D.L.Jamora, E.B. Testa, R.C. Marquez, MC. Aragon, KG.R. Torres, AD.V. Mangaoil, ML. F. Collado, A.A. Gavino, D. Labrador, M. S. Arino, N. D. Bengosta, R. A. Areno, JP.Acero, R.Amistad, B. Dimas, R.N. Adarna, J.D. Galicia, N. S. Sebastian, J.P. Portugal, G.B. Batara, F. Abalos, J. Oting, I. Madjus, Y. Butokan, J.P. Abobo, E. Ganana, G. Garcia, R. Punzalan, D. Jamora

Establishment of Agricultural Tramlines for Upland Agriculture in the Philippines
R.R. Paz, A.E. Badua, R.G. Calderon, P. Lampero, L. Dumalhin, E.M.C. Cornejo

Postharvest Facility Support to the National Organic Agriculture Program
R.R. Paz, A.E. Badua, N. S. Sebastian, R.R. Parica, C.C. Balajadia, R. M. Hermoso, DD.T. Julian, D. Jamora, E.B. Testa, ML. F. . Collado, A.A. Gavino, M. Arino, N. D. Bengosta, R. A. Areno, JP. Acero, R. Amistad, B. Dimas, R. N. Adarna, F. Abalos, D. Labrado, J. Oting, I. Madjus, Y.B. Congup, Y. Butokan, M.A. Bucsit, J. Arazo

Support to Research, Development and Extension

Harmonized Agricultural and Fisheries RDE Agenda

N.A. Pasalo, O.L. Cancer, D.A. Briones, E.F. Santiago, MA.C. Cordova, J.P. Santiago, PS. Fukasawa, N.M. Bene

Monitoring and Evaluation of Agency Programs, Projects and Activities

N.A. Pasalo, V.M. Barlis, E.S. Estigoy, H.G. Tomas, Z.J. Barza

Administrative Support

R.F. Concepcion, J.A. Foronda, L.A. Idago, L.DS. Ramos, C.M. Villanueva, RA.L. Morota, E.S. Corpuz, MV.S Tamani, C.S. Encarnacion, R.B. Ontong, A.G. de Guzman, G.P. Panuyas, A.Q. Aquino, P.D. Cardinoza, F.E. dela Cruz, S.DC. Joson, R.F. Ramos, C.B. Tan, E.C. Tumampo, JC.V. Samaniego. R.M. Cayog, F.G. Dator, G.R. Pasardan, G.M. Viterbo, L.M. Sanchez, A.D. Dela Cruz, I.E. Castañeda, K.R. Pascual

Financial Resources

RS.R.Reyes, R.S. Ortiz, J. N. dela Cruz, M.R. Dizo, J.C. Ballardo, MT.T. Dino, A.A. Tuates, J.Z Parugrug, MJ.Garcia, G.M. Miguel, J.M.Orola, M.J.C. Garcia

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