Compendium of PHilMech RD&E Abstracts 2012-2017











PHILIPPINE CENTER FOR POSTHARVEST DEVELOPMENT AND MECHANIZATION 2018

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Department of Agriculture PHILIPPINE CENTER FOR POSTHARVEST DEVELOPMENT AND MECHANIZATION CLSU Compound, Science City of Muñoz, Nueva Ecija 2018

FOREWORD

The Philippine Center for Postharvest Development and Mechanization of the Department of Agriculture continues to generate, extend and commercialize appropriate and problemoriented technologies for Filipino farmers and fisherfolk.

For four decades now, PHilMech has been relentless in searching for practical solutions to pressing postharvest industry problems guided by its research and development agenda. From 2012 to 2017, PHilMech conducted researches on the design and development of postharvest



technologies and systems, storage pests and innovative control methods, mycotoxins and their control, socio-economics and related policy studies, and loss assessment in the major postharvest operations of various commodities.

The compendium of PHilMech RD&E abstracts is the agency's contribution to the academic and scientific community. It is an easy reference guide for fellow researchers, agricultural extension workers and the academe interested in mechanization and postharvest research and development.

With this publication, we are privileged to share to you the different studies conducted by PHilMech from 2012 to 2017 with a commitment to provide more innovative research breakthroughs in the coming years for a sustainable and mechanized agriculture.

BALØWIN 6. JALLORINA, Ph.D. Director IV, PHilMech



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FIELD TESTING OF GRAIN PROBE MOISTURE METER

Arlene C. Joaquin, Maria Elizabeth V. Ramos, Romualdo C. Martinez, and Richard P. Avila

2017

A frequency-based capacitance type grain probe moisture meter was developed by PHilMech, as a low-cost alternative instrument for accurate and rapid moisture content measurement of paddy and corn in bags. The prototype unit consisted of a standard grain probe, a 100-gram capacity test chamber, a grain selector switch and handle for ease of sampling. Calibration models between frequency and moisture contents were established and validated with a relatively high coefficient of determination (R2) of 0.94 and 0.97, for paddy and corn, respectively. Laboratory testing conducted between moisture content readings of grain probe moisture meter and standard reference oven method resulted to mean absolute error of 0.24 and 0.34 for paddy and corn, respectively. Likewise, field testing results conducted in selected provinces revealed a mean percentage error of 3.9 % for paddy and 3.2 % for corn; an indication of a highly acceptable level of accuracy based on standards set by the National Standard and Technology Institute (NIST) and United States Department of Agriculture - Grain Inspection, Packers and Stockyards Administration (USDA-GIPSA). Initial fabrication cost of the prototype unit grain probe moisture meter has the advantage of simultaneously performing grain sampling and moisture content determination.



DEVELOPMENT OF ROLLING CORN MILL FOR VILLAGE-LEVEL OF OPERATION

Michael A. Gragasin, Irwin V. Salapare, Jayvee P. Illustrisimo, and Romualdo C. Martinez

2017

The efficiency and availability of corn mills operating in the country play a vital role in achieving food self-sufficiency. Majority of operational corn mills in the country are situated along the highway where three-phase electrical line is available. Current design of operational corn mills still utilizes emery stone for its degemination process, steel roller for its milling process and oscillating sifter that all require huge amount of power. The purpose of this research was to develop a technically viable and financially feasible new type of mobile corn mill that can be used in the countryside particularly in the remote areas.

The developed corn mill system is comprised of the degerminator, rotary mill, and rotary grader and equipped with a pre-cleaner (destoner and winnower), two elevators and a suction blower. It is powered by 4DR6 60 HP, 4-cylinder diesel engine.

Based on the results of performance tests, the developed rolling corn mill had an input capacity of 940 - 1,100 kg/h with product recovery of 66 to 71%. Result of laboratory analyses showed that the corn grits product has a degerminator efficiency of 82 to 88 %. Cost of milling was estimated at Php 0.86 per kg output. The estimated cost of the developed corn mill was Php 850,000 per unit.

The developed corn mill technology can be used by farmer cooperatives and local entrepreneurs for in custom-milling business and the processing of corn for food and animal feeds.



DESIGN AND DEVELOPMENT OF PROBE METER FOR MOISTURE DETECTION OF SELECTED GRAINS

Arlene C. Joaquin, Maria Elizabeth V. Ramos, Romualdo C. Martinez, and Elvin B. Santos

2016

A prototype unit grain probe moisture meter was developed for quick moisture content measurement while doing grain sampling of paddy and corn in sack. The prototype unit was composed of a standard grain probe, a 100-gram capacity test chamber, a menu panel for overall control and measurement and a handle. Initial circuit designs using cylindrical test chamber were considered and calibrated during the early stage of development but failed to yield acceptable performance until the circuit design used in the prototype unit. The prototype unit probe moisture meter was micro-controller based, with LED display and adopted a capacitive sensor oscillator circuit. A two-parallel plates made up a test chamber and acted as sensor results of calibration experiments for paddy and corn showed linear relationship between frequency readings and standard oven moisture content measurements.

Using linear regression technique, a calibration model for paddy was established with a relatively high correlation coefficient (R²) of 0.94 and a relatively low standard error of estimate (SEE) at 0.85. Model validation tests showed excellent results with residuals mean square value of 0.68. Likewise, resulting calibration model for corn yielded a promising outcome with equally high correlation coefficient (R²) of 0.97 and standard error of measurement (SEE) of 0.56. Validation tests also generated a very good result with residual mean square value of 0.52.

DESIGN, TESTING AND EVALUATION OF COMPACT RICE MILL WITH IMPELLER HULLER

Michael A. Gragasin, Jayvee P. Illustrisimo, and Romualdo C. Martinez

2016

Rice mills play a vital role in the food self-sufficiency program of the Philippine government since these could affect the supply of rice in the market. This research aimed to develop a new type of village-level rice mill with impeller huller that could provide a comparable milling recovery with traditional rice mill with less capital investment operating and maintenance costs. Test trials revealed that the coefficient of hulling, hulling efficiency and head rice recovery of the impeller huller of the newly developed rice mill were 0.990, 86.8%, 87.7%, respectively. Likewise, it is capable of efficiently milling palay with moisture content of 10 to 18 % without significantly affecting its milling recovery and hulling efficiency. Its unique and innovative design had successfully made it compact yet powerful with milling capacity of 250 to 300 kg/hr and capable of producing both brown rice and white rice, a distinct feature not possible to traditional village-level compact rice mills. Cost of milling was estimated at Php 0.87/kg with internal rate of return of 82.5%.

The newly developed rice mill technology is highly favorable for locations with no existing rice mill installed in their areas as this can be easily connected to household or single-phase electrical line. The technology is also ideal to be used by brown rice producers and organic rice suppliers.



FIELD TESTING OF IMPACT-TYPE HULLER FOR HULLING-ON-DEMAND

Reynaldo P. Gregorio, Romualdo C. Martinez, Maria Elizabeth V. Ramos, Pepito Soriano, and John Paul V. Gonzalez

2016

PHilMech developed an impact-type huller for hulling-on-demand for brown rice production. The technology addresses the supply of brown rice by means of "hulling-on-demand" approach. The concept of making brown rice available when it is needed defines the hulling-on-demand and addresses the problem of short shelf life problem associated in bulk production of brown rice.

The project aimed to develop an improved impact-type huller and verify its performance at field conditions under hulling-on-demand scheme. The project identified operational deficiencies, modified and optimized the huller performance. It also identified parameters for commercial application.

The prototype unit was fabricated by Mr. Reynaldo Sumang, a local fabricator from Muñoz, Nueva Ecija following the plans and blueprints prepared from the project entitled, "Development of Impact-type Huller for Brown Rice Hulling".

Cooperatives from Ifugao and Tarlac engaged in brown rice production were selected as cooperators for the field trials. The huller was operated singly by each member for their produce. The high mobility of the unit was identified to be main desirable factor for its acceptance.

PHilMech modified the brown rice huller for ease of mobility, ease of operation, low maintenance and low power requirement. It exhibited an input capacity of 100-120 kg/h and coefficient of wholeness of 0.77 and 0.98 coefficient of hulling. The huller consumed 375 watts-hour to produce 60 to 80 kilogram of brown rice.

The cooperator in Tarlac has signified purchasing additional units of the brown rice huller as soon it is made available commercially. The huller was found to be suitable for hulling-on-demand under Tarlac operational field conditions.

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DEVELOPMENT OF COMMERCIAL-SCALE FULLY-AUTOMATED AND COMPLETE DRYING FLUIDIZED BED DRYER SYSTEM FOR HIGH MOISTURE PADDY (FLUIDIZED BED DRYING SYSTEM FOR COMPLETE DRYING OF PADDY PHASE III)

Reagan J. Pontawe, Nestor T. Asuncion, Roselyn B. Villacorte, and Romualdo C. Martinez

2016

A fully-automated commercial-scale fluidized bed dryer system with 1 ton/hr output capacity was developed, installed and evaluated using high moisture paddy. The NVAKMPCO-GC in Solano, Nueva Vizcaya. The developed technology is a system composed of fluidized bed drying chamber, tempering bin assembly, biomass furnace as the heating system, conveying system, airflow system, dust collector system, automated control system and bagging bin. Complete drying of paddy with \geq 28 % (w.b.) initial moisture content was attained after two passes of fluidized-bed drying at 2 min exposure to 70 °C drying temperature and 3.21 m/s superficial air velocity, followed by 60 min. air tempering period (30 min without ventilation and 30 min with air ventilation) for a total drying time of 2.07 hours. Rapid drying of high moisture paddy with 31.5% (w.b.) initial moisture content resulted to 82% reduction in drying time as compared to recirculating batch dryer at the same drying temperature of 70 °C. Specific heat energy consumption was only 3.17 MJ/kg of water removed and 19.88 kW-hr/batch of electrical consumptions of the fluidized bed drying system. Paddy dried on the system produced low Head Rice Yield Reduction Ratio (HRYR) of 0.039 which denotes that the head rice yield recovery passed the PAES for maximum 5% Head Rice thus a clear indication that the system did not significantly affect the quality of dried paddy. The drying cost was calculated to be Php 1.14 per kilogram of wet paddy. Net present value of Php 35,664,095.00 with BEP of 4,506.00 bag and Internal Rate of Return of 82.16% resulted for the commercial-scale fluidized bed dryer to be financially viable at payback period of less than two years. Partial budget analysis of the commercial set-up vs recirculating batch type dryer gained additional income of Php 5,131,743.00 and reduced cost of Php 752,928.00. The optimum drying parameters of using fluidized bed dryer is 70 °C drying temperature at 2 min fluidization time, 3.21 m/s superficial air velocity, 4.5 in. H₂O static pressure, 10 cm grain depth and 60 min ambient air tempering period.



DEVELOPMENT OF CENTRIFUGAL HULLER FOR ADLAI

Reynaldo P. Gregorio, Romualdo C. Martinez, Maria Elizabeth V. Ramos, Pepito Soriano, and Lore Joy O. Alarcio

2016

A centrifugal huller was developed through adapting the impact huller for brown rice milling. Performance for different varieties of adlai was established particularly Pulot, Kiboa and Gullian. The developed huller was field tested in Malaybalay, Bukidnon as part of the High Value Commercial Development Program.

The adlai huller is composed of three major components, namely: the centrifugal huller, the cleaning unit and the separation unit. Hulling is achieved by means of the centrifugal force exerted on the grain through the rotational inertia in the hulling impeller and effect of impact to a rubber ring surrounding the impeller huller. The cleaning unit is composed of an aspiration system separating the hull from the hulled and unhulled adlai grain and channeled to the separation unit. The mixture of hulled grains and unhulled adlai are separated through a perforated screen rotating at low RPM. The unhulled adlai grains are returned to the centrifugal huller by means of an aspirated return mechanism.

Result from previous study on the evaluation of milling for adlai that uses centrifugal huller was used as benchmark in selecting the RPM of the huller. Since hulling was the final product of this study, the separation was developed to achieve the optimum recovery of the whole grain recovery and separation. The feeding rate was identified as the contributing factor in setting the optimum operation of the huller.

Pulot exhibited the best variety used with a grain-to-hull ratio of 0.6406. It also has the largest dimension among the adlai grain used in the previous study. Having a limited supply of adlai during the testing, pulot variety was used for the succeeding test trials. Based on the results of laboratory trials, the developed machine has a maximum whole grain recovery of 57.07% at an input capacity of 174.72 kg/hr when the feed opening is adjusted at two-thirds. The lowest whole grain recovery was observed at 38.81 % when the feed opening is adjusted at full with and input capacity of 253.59 kg/hr.



FIELD TESTING OF IMPROVED DRYING TECHNOLOGY FOR FERMENTED CACAO BEANS

Romualdo C. Martinez, Robelyn E. Daquila, Maria Elizabeth V. Ramos, Vanesa C. Largado, Rene O. Pabilonia, Jowell C. Barayuga, and Aris. L. Barbero

2016

The Greenhouse-Type Solar Dryer (GTSD) retrofitted with biomass furnace was developed as a further improvement of the Multi-Commodity Solar Tunnel Dryer (MCSTD) to facilitate convenient regular mixing of the fermented cacao beans during periods of continuous rainfall. The GTSD had a dimension of 13.2 m x 7.56 m x 3.48 m (L x W x H) with a capacity of 612 kg fermented cacao beans. Results of the drying trials showed that drying time was 77.5 hours in the GTSD as compared to that of the 129 hours drying time in the greenhouse dryer commonly used by the cacao processors. The temperature inside the dryer ranged from 40.5 °C – 55.2 °C during daytime compared to the ambient temperature range of 28.3 °C – 35.5 °C. With supplemental heating at night, the temperature ranged from 27.7 °C – 38.2 °C as compared to the ambient temperature of 23.6 °C - 28 °C. The quality analysis of the samples showed that GTSD produced well dried and browner cacao beans as compared to the Cocoaphil greenhouse dryer. The average bean recovery in GTSD was 44.8 % as compared to 43.6% in MCSTD and 41.4 % in Cocoaphil greenhouse dryer. The average drying cost in GTSD was Php 3.54/kg as compared to Php 7.46/kg in MCSTD. The GTSD had a benefit-cost ratio of 9.65 while MCSTD had 3.85. The payback period in GTSD was 0.59 year while MCSTD was 1.47 years. Internal rate of return in GTSD was 170.7% while in MCSTD was 67.7%.



DEVELOPMENT OF FULLY-AUTOMATED PILOT-SCALE SYSTEM (FLUIDIZED BED DRYING SYSTEM FOR COMPLETE DRYING OF PADDY PHASE II)

Reagan J. Pontawe, Nestor T. Asuncion, Roselyn B. Villacorte, and Romualdo C. Martinez

2015

Drying of high moisture paddy was examined using a pilot-scale continuous-flow fluidized bed dryer system with grain flow rate of 500 kg/h. Complete drying of paddy with \geq 28% (w.b.) initial moisture content was attained after 2 passes of fluidized drying at 2 min exposure to 70 °C drying temperature and 4.9 m/s superficial air velocity, followed by 60 min tempering period (30 min without air ventilation followed by 30 min of ambient air ventilation) for a total drying time of 2.07 h. Around 82% reduction in drying time was recorded in drying paddy with 31.5% (w.b.) initial moisture content as compared to using conventional recirculating batch dryer at 70 °C drying temperature. Quality analysis of dried paddy samples showed that reduction in head rice yield was 4 % which is within the 5 % limit set in the Philippine Agricultural Engineering Standards. Specific heat energy consumption was 2.84 MJ/kg of water removed. Sensory evaluation showed that the color and taste of rice samples dried in the fluidized bed dryer were acceptable.



DEVELOPMENT OF AN IMPACT-TYPE BROWN RICE HULLER

Reynaldo Gregorio, Michael A. Gragasin, and Romualdo C. Martinez

2015

A compact brown rice huller utilizing the technology of centrifugal hulling or impact-type hulling system was developed to achieve the food sufficiency for brown rice consumer. The developed machine has a capacity of 150 kg/hr input capacity, a husking ratio of 98% and whole grain ratio of 78%. It has a small footprint with a height of 1030 mm, width of 590 mm and length of 899 mm. It has a total weight of 95 kg. The compact brown rice huller consumes a measly 373 watts from a single-phase electric motor.

IMPROVEMENT AND FIELD TESTING OF THE HORIZONTAL CONVEYOR FOR ONION SORTING

Raymund Joseph P. Macaranas, Maria Elizabeth V. Ramos, Remigio C. Nodora, Jr. and Romualdo C. Martinez

2015

A mechanized onion sorter was modified into a horizontal conveyor provided with stationary loading and unloading hopper to function as a semi-mechanical sorting facility that requires human action to sort onions in terms of quality and size. Quality is the most important reason for sorting onion. Quality requirements specifically refers to condition or state of freshness, color, shape or form of onions. At present, it is only by touch and senses of sight and smell that these factors of quality are determined. It was found that full mechanization on sorting onions had detrimental effects on quality because of machine configuration made mostly of metallic materials and composite materials with surfaces that had negative effect on the outer layers of onion during its mechanical sorting process. The first two modifications had a capacity of 118 and 101 sacks per day of red onions at 25 kg per sack. This was lower than the compared to manual operation with an evaluated capacity of 128 sacks per day. Importantly, it had a negative effect on the quality of sorted onions during and after the process in terms of 19% and 1.24% in losses due to damaged and spilled or scattered onions, respectively. The efficiency of the first modified model had high percentage of damages in mechanical onion sorting. The sorting efficiency of the second modified unit was 33% for small sized onions, 43% for medium sizes and 55% for sorting large onions. Since it still had damages, a third modification was done. The third modification which was a horizontal-conveyor had zero loss because no onion was damaged or spilled during the sorting operations. Performance tests resulted to capacities of 927 and 1,100 sacks per day of red onions and yellow granex onions, respectively. Moreover, results suggested that using a conveyor for sorting was more efficient than the first two modifications as it had sorting efficiency of 100% for sorting small sized onions, 87% for medium onions and 97% for sorting big onions.



DEVELOPMENT OF POSTHARVEST TECHNOLOGY FOR ADLAI (STUDY 1. THRESHING, DRYING AND MILLING)

Reynaldo P. Gregorio, Romualdo C. Martinez, and Alpha L. Salarzon

2014

Two types of milling systems were evaluated for suitability to adlai, namely, rubber-roll type and centrifugal-impact type. Based on obtained results, the clearance between rolls for the rubber-roll should be adjusted to 3-4 millimeter. The residence type is 15 seconds as compared to rice milling at 1 min, resulting in a higher capacity output for adlai. Using a SB-10 model rubber roll milling equipment, its observed capacity was 12 cavans per hour and up to 60% milling recovery. Existing rice mills could very well adapt to milling adlai.

The threshing drum RPM for adlai should be between 600 to 700 RPM using an ACT Model Palay Thresher. The optimum moisture content of the grain should be 15 to 17% during threshing, and best performed during the early hours of the day. This will limit the amount of spillage and shattering losses. Using the information on the terminal velocity of adlai at 3.0 meters per second, the existing blower of a rice thresher should be calibrated to produce lower air volume. With the decrease from the existing drum RPM at 900, the resulting rotational speed has been found to be well suited to the blower.

The equilibrium moisture content of adlai at ambient room condition is at 10% moisture content. Adlai is not susceptible to grain cracking when subjected to thermal stress, thus higher drying rate could be implemented. Based on experiments, a drying temperature of 60 degrees could be used up to 14% and 45 degrees during the finishing drying. The varieties tested during the experiments were Gulian, Tapol, Kiboa and Pulot.



DEVELOPMENT OF FLUIDIZED BED DRYING SYSTEM FOR HIGH MOISTURE PADDY

Reagan J. Pontawe, Donald V. Mateo, and Romualdo C. Martinez

2014

Drying of high moisture paddy remains a major problem especially during wet season when sun drying is not possible. A number of heated-air dryers has been introduced to alleviate the problem. Flatbed dryers, recirculating dryers among others, of these, fluidized bed drying system offers better solution when drying high moisture paddy. The four drying temperatures (70, 80, 90 and 100°C) investigated showed high moisture paddy with \geq 24% (wet basis) initial moisture content attained complete drying with 13±1% (wet basis) final moisture content after four hours using fluidized bed dryer.

Of the four different drying temperature investigated in combination with three fluidization time (2,3 and 4 min) with constant static pressure (6 in H_2O), grain bed depth (0.1 m) and airflow rate of 0.23 m³/s (10.31 m/s velocity), 70°C with 3 mins fluidization time proved to be the most successful achieving only 0.0109 Head Rice Yield Ratio, a passing Philippine Agricultural Engineering Standards for HRY recovery. Samples dried at 90 and 100°C produced almost 1 HRYR indicating almost all kernels were broken. The specific heat energy consumption was low with only 2.51 MJ/kg using the fluidized bed dryer.

Sensory evaluation showed that samples dried at 80°C temperature and fluidized for 3 mins significantly achieved the highest level of acceptability (α <0.05) in terms of color, aroma, taste and mouth-feel along with the other samples and relative to the control (sundried). Moreover, paddy dried at 70°C with 3 mins fluidization was not significantly different to the control in terms of the color, taste and mouth-feel.

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DEVELOPMENT OF IMPROVED VILLAGE CORN MILL FOR WHITE CORN

Michael A. Gragasin, Romualdo C. Martinez, and Jayvee P. Illustrisimo

2014

This research has successfully developed an innovative compact corn mill with milling capacity of 155 kg/h. The research aimed to improve the existing commercial design of village-type corn mill which satisfies the minimum product recovery of 64% and degerming efficiency of 80% as set by the Philippine Agricultural Engineering Standard (PAES) for corn mill. Majority, if not all of the available corn mill in the Philippines, have not fully satisfied both these two basic quality standard of PAES.

The newly developed technology features a degermer using hexagonal dented screen huller with counter flow auger, innovate the grading assembly by introducing a three-layer rotary slotted hole perforated sheet cylinder, and an improved hammer mill with 36 spokes that is made of flat steel bars, sharpened at one side.

Performance tests revealed that the newly developed technology has an output capacity of 160.8 kg/h with product recovery of 64.7%. The degerming efficiency of the cornmill is high at 94.7%. The total operating cost is estimated at Php1.71/kg. The power consumption at full operation is 4.17kW/h.

The economic analysis revealed that the technology is economically viable with a financial internal rate of return of 31.15% and a payback period of 3.93 years.



DEVELOPMENT OF COMMERCIAL BELT DRYER FOR GRANULATED CASSAVA

Michael A. Gragasin, Romualdo C. Martinez, and Lynet R. Cruzat

2014

This research has successfully developed a technically feasible and economically viable commercial model of cassava belt dryer. The developed drying technology had an input capacity of 1,000 kg/hr with five conveyor belts circuit. AMTEC test results revealed that the dryer had achieved an input capacity of 1,158kg/h with an output feed rate of 509kg/h with cassava product recovery of 44.2% from initial moisture content of 51.0%w.b. to a final moisture content of 14%w.b. An average moisture reduction rate of 40.2%/h was achieved. The average drying air temperature during the test was 97.9°C.

Cost-benefit analysis showed that the newly developed technology is financially feasible given an estimated financial internal rate of return of 17.12%. The total drying cost per kilogram output was estimated at Php1.23. By accounting all the costs involved in drying, the farmers could realize net benefits of Php0.60/kg or a total of Php6,138/ha for using the technology given its higher product recovery of at least 46% as compared to the traditional sun drying method of only 38%.

Cost-benefit analysis showed that the newly developed technology is highly feasible with an estimated financial internal rate of return of 17.12%. The total drying cost per kilogram output was estimated at Php 1.23/kg. The utilization of cassava belt dyer will provide higher dried cassava product recovery of at least 46% as compared to the traditional sun drying method of 38%. By accounting all the costs involved in drying, the farmers could realize net benefits of Php0.49/kg or a total of Php6,112/ha for using the developed technology.

The full-scale PHilMech commercial cassava belt dryer with biomass furnace showed great potential for drying granulated cassava to address the requirements of the cassava industry in the Philippines.



DESIGN AND DEVELOPMENT OF A CASSAVA HARVESTER (PHASE 1: DEVELOPMENT OF THE CASSAVA DIGGER)

Raymund Joseph P. Macaranas, Maria Elizabeth V. Ramos, Remigio C. Nodora, Jr Terence Marion Q. Ancheta, and Romualdo C. Martinez

2014

A prototype cassava digger was developed in collaboration with the Agricultural Engineering Research Institute (AERI) of Thailand. The cassava Digger was a tractor drawn implement aimed to reduce the drudgery of manual digging or uprooting of cassava tubers. It consisted of the main frame that holds the digging elements together wherein the frame itself is provided with three-point hitch link connectible to the tractor; the digging component consists of a digging plate and soil-loosening fork which is both held or connected to the base support. The entire assembly when hitched to the tractor served as a digging implement for cassava harvesting. The angle of the digging plate with respect to a horizontal plane is set to about 20 degrees by adjusting the hitches.

At this adjustment, the depth of dig was about 280 mm in average and enables the digger to dig an entire cassava tuber of about 200 mm deep. A 90 HP tractor was used to effect the digging operation with an average speed of 6.0 KPH on varied soil conditions. Tested in the provinces of Isabela, Quirino, Pampanga and Bataan, the results of tests showed that the harvesting capacity ranged from 0.23 - 0.24 ha/hour in a muddy and moist clay/loam-type soil with high-weed density and 0.34-0.37 ha/hour in a dry clay/loam-type soil. Further field performance testing covering an area of about 0.5 hectare, the cassava digger reached an actual field capacity of 0.15 ha/hour (1.2 ha/day) in a high weed density soil of clay loam rolling terrain and 0.42 ha/hour (3.4 ha/day) on flat terrain of sandy loam soil. The test was conducted to a minimum length of 20 meters cassava plantation of 0.7 to 1 meter row spacing. Results of cost benefit analysis comparing the mechanized versus traditional harvesting of cassava showed positive incremental income of Php 3,100/ha for cassava growers. Tractor-owner investor, on the other hand, would have a potential gross revenue of about Php 1,153.75/ha.



DEVELOPMENT AND EVALUATION OF IMPROVED DRYING TECHNOLOGIES FOR FERMENTED COCOA BEANS

Romualdo C. Martinez, Robelyn E. Daquila, Arlene C. Joaquin, Reynaldo P. Gregorio, Maria Elizabeth V. Ramos, and Jason G. Bajar

2014

The general objective of the project was to develop improved drying systems for fermented cocoa beans. The first was the Multi-Commodity Solar Tunnel Dryer (MCSTD) with a biomass furnace system for supplemental heating. Retrofitting was done to enable continuous drying during evenings and rainy periods. Load capacity was also increased from 320 to 400 kg. The heat generated by the furnace was transferred to the dryer through three ducts installed along the length of the tunnel dryer beneath the drying tray) for indirect heating of air. Results of drying trials showed that drying time was four to five days in the retrofitted MCSTD as compared to five to six in the non-retrofitted solar tunnel dryer and 6 to 87 days in the greenhouse dryer commonly used by cocoa processors. During daytime, drying temperature inside the dryer ranged from 40 to 50 °C without supplemental heating. With supplemental heating during night time and during rainy periods, drying temperature ranged from 35 to 40 °C. The beans have better brown color and lesser appearance of molds on the bean surface. The second drying system was the fixed-bed dryer with biomass furnace. It was designed to eventually integrate with the currently used two-box fermentation system in terms of dimension and capacity. The drying bins were made of stainless steel sheets to resist the corrosiveness of the acidic fermented beans. The prototype dryer had a nominal bin capacity of 320 kg of fermented beans. The furnace could be fueled either by rice hull or firewood. Results of drying tests showed that cocoa beans could be dried in three to four days during any weather condition. The beans have very good physical appearance and no visual signs of molds on the bean surface. Bean cut tests showed that beans dried using both dryers are well dried and with no visible molds inside the beans. Likewise, the level of reducing sugars of beans dried using both dryers are higher indicating better quality. Finally, the SHEGA III, a commercially available moisture meter jointly developed by PHilMech and a local electronics manufacturing company originally developed for rice and corn was re-calibrated for cocoa beans. Results showed that the re-calibrated SHEGA III was suitable for measurement of cocoa bean moisture content.



RETROFITTING OF REVERSIBLE AIRFLOW SYSTEM TO EXISTING Flatbed Dryer with Biomass Furnace

Nestor T. Asuncion, Robelyn E. Daquila, and Romualdo C. Martinez

2014

A reversible airflow system was successfully retrofitted to an existing flatbed dryer in order to eliminate the drudgery of manual grain mixing process during drying. The major components of the reversible airflow system were (1) ducts, guides and vanes to direct air flow in either upward or downward direction, (2) exhaust ducts for downward air flow direction, and (3) plastic canvas and frame to serve as plenum during downward air flow direction. Results of three drying trials showed that wet paddy with initial moisture content of 24 to 26% were dried to final moisture content of 13 to 14% in 14 to 16 hours at drying temperature of 40 to 50 °C. The air flow direction was reserved after seven to eight hours of drying operation. Moisture content gradient after drying between the top and bottom layers of the grain bed ranged from 0.7 to 1.0 %. Quality analysis of dried paddy samples showed that reduction in head rice yield was within PAES standard limit which did not exceed 5%.

DEVELOPMENT OF FLATBED DRYER (FBD) DRYING SIMULATION SOFTWARE (PHASE 1 – MICROSOFT WINDOWS APPLICATION WITH BASIC FUNCTIONALITY)

Romualdo C. Martinez

2014

Under this project, user-friendly flatbed dryer (FBD) drying simulation software was developed as an educational and analysis tool for simulating rice drying scenarios initially prior to actual conduct of drying experimentations. The simulation model was based on the near-equilibrium models originally developed for drying shelled corn by Thompson (1967) and Thompson (1972). The model was modified for rice, using thin-layer drying equations developed by Martinez (2001). The software was designed to have an intuitive and easy-to-use software user interface. Phase 1 of the project developed a beta version that would run as desktop application under current Microsoft Windows platform. It had basic functionalities to run simple flatbed drying scenarios. It is envisioned that succeeding software versions would have more comprehensive functionalities and would run online in the Knowledge Bank website of the International Rice Research Institute for easy access via desktops, laptops, tablets and smartphones.



EX-ANTE ANALYSIS FOR THE DEVELOPMENT OF BROWN RICE JUST-IN-TIME HULLING TECHNOLOGY

Michael A. Gragasin, and Romualdo C. Martinez

2013

The potential of brown rice just-in time hulling technology (JITHT) was analyzed through qualitative and quantitative research using 174 respondents among current brown rice consumers, retailers and millers in different areas of the country. The process and findings that emerged in this research has helped resolved management decision and marketing research problems of whether PHilMech shall proceed in the development of brown rice JITHT; and if there are potential buyers, and what shall be the technical features of the proposed JITHT to become acceptable to the target users.

This research has successfully established the basic technical specifications and financial parameters that will lead to the viable operation of the proposed JITHT. Given the current low level of household consumption of 2.80 kg/wk, the proposed JITHT is highly feasible at the consumer's level if the capacity shall be 12 kg/hr and at selling price of Php 8,500 per unit. Likewise, the proposed JITHT could well fit the business operations and requirements of 'regular rice retailers' given a capacity of 104 kg/hr and a selling price of Php18,500 per unit. This group of rice retailers is basically those stores in the ordinary market that packaged brown rice as healthy or organic rice.

Using Probit regression analysis, the research has also established the socio-economic factors that may influence the potential adoption of the proposed technology both at the consumers' and retailers' levels.

The development and the eventual commercialization of the proposed JITHT shall be aggressively pursued by the government to promote wider consumption of brown rice in the country. This policy program and direction shall be embraced by the government as one of the enabling mechanisms to collectively achieve and sustain food-self-sufficiency in the country in the future.

PERFORMANCE VERIFICATION OF PHILMECH COMPUTER VISION SYSTEM (CVS) FOR QUALITY ANALYSIS OF RICE AND CORN

Andres M. Tuates Jr, Aileen R. Ligisan, Shiela Marie A. Villota, Arlene C. Joaquin, Oliver Agustin, and Ofero A. Capariño

2013

The PHilMech low-cost computer vision system (CVS) designed to analyze the quality of rice and corn was further investigated to determine its technical performance, acceptability and economic benefits prior to its commercialization. The CVS uses an ordinary scanner as the image acquisition device. Using a computer model, the acquired image is processed to extract shape and color features which can correlate at varying classifications of grain samples. The performance of the CVS was compared to the traditional manual method being adopted by the National Food Authority (NFA) and the Agricultural Machinery Testing and Evaluation Center (AMTEC).

The performance testing and evaluation showed that the accuracy of obtaining the results in classifying rice and corn using the CVS was comparable to the manual method of analysis. But, the processing time to complete the analysis using the CVS technology (6-7 minutes) was five to eight times faster compared to the manual method (30-60 minutes). The developed CVS will automate the existing practice in determining the milling quality of brown rice, milled rice and yellow corn and minimize the tedious and subjective manual method of evaluation.



PERFORMANCE VERIFICATION OF PRPC DRYER RETROFITTED WITH PHILMECH MULTI-CROP BIOMASS-FED FURNACE SYSTEM UNDER COMMERCIAL LEVEL OF OPERATION

Maria Elizabeth V. Ramos, Raymund Joseph P. Macaranas, Remigio C. Nodora, Reynaldo P. Gregorio, Nestor T. Asuncion and Romualdo C. Martinez

2013

The fourth prototype of LSU-type PRPC dryer was field tested at Isabela. The dryer was retrofitted with a PHilMech REM rice hull biomass fed- furnace (RHF). Initial testing of the dryer system was terminated because of the excessive smoke emitted by the furnace. Although the quality of the palay dried using the dryer was acceptable based on the technical parameter and results of grain analysis, the cooperator declined further tests because of the poor furnace performance and the too many laborers needed to operate the dryer. In view of the negative feedback on the furnace, a sequel study was undertaken wherein the PRPC dryer was retrofitted with a new PHilMech MCB furnace. During the commissioning, it was noted that the MCB furnace had solved the excessive smoke and several labor requirement during operation. However, the inefficient loading and unloading of grains during drying was noted. Thus, modifications of the elevator-conveyor system were done.

Results of the drying tests showed that moisture reduction rate ranged from 0.622 %/hr to 0.880 %/hr with drying temperature of 57.40°C to 61.37°C. The airflow rates taken from the sides of the dryer were from 3,781.91cfm to 3,903.99 cfm which were higher than the typical airflow rate of 6-ton capacity batch recirculating dryer. Average rice hull consumption rate ranged from 27.30 kg to 38.36 kg/hr. The heating system efficiency ranged from 52.44 % to 58.87% which was higher than the 50% minimum level set by PAES. Also, the drying efficiency ranged from 82.97% to 89.63% which was higher than the 75% minimum level set by PAES. Overall, the technical parameters showed that the modified PRPC dryer has passed the standards set by PAES for a recirculating batch type dryer fired by a multi crop biomass furnace.

Partial budget analysis of PRPC drying vs. sun drying showed negative benefits for PRPC at Php 36.47. Calculations was also done at 1000 cavan utilization and resulted to positive benefits. Plotting the figures on costs and income from partial budget would show us at what level of operation the BEP of PRPC would have positive returns.



DEVELOPMENT OF DRYING SYSTEMS FOR GRANULATED CASSAVA AS ANIMAL FEED INGREDIENT

Reagan J. Pontawe, Romualdo C. Martinez, Danilo A. Briones, Reynaldo P. Gregorio and Manolito C. Bulaong

2012

The project was conducted to develop systems of drying granulated cassava for animal feed ingredient. It involved establishment of some physical properties and drying rates of cassava from three methods of granulation, re-calibration of SHEGA III and IRRI moisture meters for granulated cassava, development of high-capacity belt dryer with biomass furnace and adaptation of flatbed dryer for granulated cassava. Results of laboratory experiments showed that bulk density of freshly granulated cassava ranged from 598 to 633 kg/m³. Particle size distribution showed that existing granulating machines produced large variation in particle size and large amount (24 to 35 %) of undesirable small particles (<6 mm).

Resistance to airflow experiments showed very low pressure drop values of not more than 1 mm at superficial air velocity of 0.3 m/s and bed depth of up to 0.2 m. Laboratory drying experiments showed that granulated cassava could be dried at 50 °C up to 80 °C without gelatinization of the outer portion of cassava particle. At 80 °C and 0.05 m bed depth, drying granulated cassava from initial moisture content of 60 % to final moisture content of 13 % would take 2 h to 5 h depending on particle sizes. Manually chopped cassava with relatively large particle sizes tended to dry slower than cassava from granulator with relatively smaller particle sizes. Calibration experiments showed that the re-calibration curves for SHEGA III Moisture Meter (originally developed for paddy and corn) and the IRRI moisture meter (originally developed for paddy) were relatively suitable for estimating the moisture content of granulated cassava, with correlation coefficient of >0.90 and manually chopped error of estimate of <1.0. A pilot scale belt dryer with biomass furnace was developed, designed to dry granulated cassava with initial moisture content at the rate of 00 kg/h, drying temperature of 80 °C and drying residence time of 2.5 h.

The pilot-scale dryer was tested and results served as basis for the design and development of a fullscale belt dryer wit input capacity of 400 kg/h. Results of tests showed that the full-scale belt dryer with biomass furnace had great potential for drying granulated cassava, but further developments would be required to improve performance. Finally, results showed that retrofitting a mixer to a flatbed dryer would reduce drying time from 16 h to 12 h when drying 2.5 tons of granulated cassava at 45 °C. The developed mixer had great potential, but would require further improvements.

DEVELOPMENT OF A DRYING SYSTEM FOR EXPORT QUALITY COCO PEAT

Manolito C. Bulaong, Romualdo C. Martinez, Andres M. Tuates, and Shiela Marie A. Villota

2012

A two-stage drying system was developed for cocopeat. The first stage was a belt press which squeeze out excess moisture from the wet cocopeat sandwiched between two porous belts and reduce the moisture down to about 60-65%. The second stage was a rotary drum dryer heated by the PHilMech biomass furnace to further reduce the cocopeat moisture down to 16%, the moisture required for blocking. The belt dryer is a commercial unit from China adopted for cocopeat dewatering. At a belt speed of 3 m/min and cake thickness of 3.5 cm, the output capacity of the belt press was computed at 614kg/hr with operating cost of Php 0.58/kg. Fines were reduced from 43% to 27% before and after pressing as they were washed out of the belt press.

This fines reduction improved the peat expansion during blocking. Two types of rotary drum dryer were developed, a continuous flow design and a batch type design. The batch type design had an average output capacity of 49kg/hr using conduction heating at 250°C drum temperature with a biomass furnace converted to a direct-fired system. The continuous flow design had an average output capacity of 68kg/ hr using convective heating at 150°C drying air temperature and the PHilMech indirect-fired biomass furnace. Operating cost was computed at Php 4.34/kg output for the continuous flow rotary dryer. About 10% of fines were removed after drying using the continuous flow rotary dryer but this did not affect the quality of the dry cocopeat. A larger capacity rotary dryer will be designed to match the capacity of the belt press.






EVALUATION OF COOKING QUALITIES AND SENSORY ATTRIBUTES OF PARBOILED RICE

Shiela Marie A. Villota, Andres M. Tuates Jr., Ofero A. Caparino, Aldrin E. Badua, Raul R.Paz and Edgar Testa

2015

This project was implemented to determine the cooking qualities of parboiled rice and milled rice in terms of their physico-chemical properties and nutritional contents, and consumer acceptability of parboiled rice in comparison with brown rice. Results showed that parboiled rice requires more water for cooking ranging from 1:2.50 to 1:3.00 water ratio. The time of cooking is significantly ($p \le 0.05$) higher in parboiled rice (27.86 min) compared to milled rice (14.57 min). Likewise, water absorption (260.66%), volume expansion (213.89%), and grain elongation ratio (1.45) of parboiled rice were significantly ($p \le$ 0.05) higher than the non-parboiled rice. Moreover, the proximate compositions and nutrient content of parboiled rice including ash (1.002%), crude fiber (0.453%), crude fat (1.57%), crude protein (6.17%), calcium (5.385%), calories (360.55 kcal), thiamine (0.20%) and niacin (1.19%) were significantly higher $(p \le 0.05)$ than the mean values of milled rice. In the consumer acceptability tests, parboiled rice and brown rice were evaluated by selected evaluators from the Science City of Muñoz, Nueva Ecija. Results showed that parboiled rice significantly ($p \le 0.05$) achieved higher level of acceptability in terms of color (6.36), mouthfeel (6.66), taste (6.82), aroma (6.50) and particle size (6.74) based on a nine point hedonic scale. Over-all, cooked parboiled rice was significantly more liked than the cooked brown rice. Expectedly, parboiled rice being the most preferred by consumers, purchase intent was also significantly higher.



OPTIMIZATION OF PARBOILING CONDITIONS OF LOCAL RICE VARIETIES

Andres M. Tuates Jr, Shiela Marie A. Villota, Aileen R. Ligisan, Ofero A. Caparino, Aldrin E. Badua, Raul R.Paz, Edgar Testa, Dindo Labrador (Region IVB), Rey Adarna (Region XII), and Jean Neri (CARAGA Region)

2014

Parboiling is a hydro thermal treatment of paddy before milling. It consists of three steps: (1) Soaking of rough rice, (2) steaming of soaked rice and (3) drying of steamed rice. Parboiling changes the physical and chemical modifications in the grain, fills the void spaces and cements the cracks inside the endosperm, making the grain harder, hence, minimizing internal fissure and breakage during milling. Eleven rice sample varieties, namely: NSIC:Rc 118 (V1), NSIC:Rc 254H (V2), NSIC 238 (V3), Selection 64 (V4), Rc 158 (V5), 75 days (V6), NSIC 216 (V7), Japonica (V8), Rc 18 (V9), PHB 77 (V10) and Rc 218 (V11) were collected from four provinces of Agusan del Sur, North Cotabato, Palawan and Orriental Mindoro. Three soaking temperature settings (40°C, 50°C, 60°C) and three soaking time (1 hour, 2 hours, 3 hours) were applied followed by steaming at 121°C for 5 minutes using autoclave. The parboiled rice was dried to a moisture content of 14% (wb) before milling. The physical qualities of parboiled rice kernel were evaluated in terms of milling recovery, percent head rice and whiteness. Results showed that the quality of parboiled rice was significantly affected by the parboiling process such as soaking temperature and exposure time. The suitable soaking temperature and time of the selected rice varieties to obtain the highest milling and head rice recovery were as follows: V1 (60°C @ 3 hrs); V2 (60°C @ 2 hrs), V3 (60°C @ 2 hrs); V4 (60°C @ 3 hrs); V5 (60°C @ 3 hrs); V6 (60°C @ 3 hrs); V7 (60°C @ 3 hrs); V8 (60°C @ 3 hrs); V9 (60°C @ 2 hrs); V10 (60°C @ 2 hrs) and V11 (60°C @ 3 hrs). Through parboiling process, the milling and head rice recovery of selected rice varieties significantly increased ($p \le 0.05$) from 73.24% to 78.64% and 79.13% to 99.54%, respectively. However, a slight decrease in the whiteness value from 70.56 to 59.70 was observed. Assuming that twenty 20% of the country's rice production in 2013 of 18.4 M MT goes to parboiling, the industry can generate an additional income of about Php 17 billion, a substantial amount that could contribute in minimizing our rice importation. The present study recommended to conduct a sensory evaluation of the cooked parboiled rice to determine the consumers' acceptability as well as marketability of the product. Likewise, establishment of a parboiling plant in strategic locations is recommended to help the country in attaining self-sufficiency in rice.

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STORAGE OF ADLAI

Mia V. Dela Cruz , Luther A. Lacanilao, and Miriam A. Acda

2014

Storage of adlai in unmilled and milled form was conducted to ascertain the efficacy of three different storage containers such as hermetic SuperGrain bag, tin can and ordinary woven bag in maintaining the quality of adlai in storage for six months. A factorial experiment involving 4 kg of adlai with two levels of moisture content of 10.24% and 12.5% was conducted. Experimental set-up was conducted in ambient laboratory condition at 29.68 °C ± 1 with rh of 56.25%± 4.9. Destructive sampling was carried out every 1.5 months for a period of six months. Samples from each test containers were analyzed for the following parameters: microbial analysis, insect infestation, insect damage, aflatoxin analysis, germination and vigor potential. Results revealed that *Sitophilus* sp. and *Tribolium castaneum* were the species of storage insects predominantly attacking the unmilled and milled adlai, respectively. Among the storage containers and the moisture content tested, the combination of low m.c. of 10.24% and SuperGrain bag can effectively protect adlai from insect infestation up to 1.5 months in storage. Moreover, the hermetic SG bag minimized the heavy proliferation of fungal infection during storage. In terms of seed viability, it preserved seed quality and viability much longer than conventional polypropylene bag.



COOKING PROPERTIES OF ADLAI (COIX LACHRYMA JOBI)

Jerry James M. dela Torre, Romualdo C. Martinez, and Ofero A. Capariño

2014

In its bid to attain food self-sufficiency for the Philippines, the Department of Agriculture (DA) has identified Adlai (*Coix lachryma* jobi) as one of the potential supplementary crops to the staple food. As such, this project was implemented to determine the physicochemical properties of Adlai, boiling or steaming attributes, glycemic index and sensory acceptability to potential consumers. This study was confined to "pulot" variety or "glutinous" Adlai because of its relative abundance. Adlai and glutinous Angelica rice were generally similar in terms of physicochemical attributes except in crude protein and crude fat where the former contained more, as well as in total carbohydrates where it showed less. The cooking properties of Adlai : Rice composite samples (100% : 0%, 75:25, 50:50, 25:75 and 0:100) were not significantly different in terms of water requirement and expansion except for the longer cooking time of pure Adlai. When consumed as a steamed food, well-milled Adlai produced a high glycemic index. In the consumer acceptability test, blind servings were given to selected subjects from Muñoz Science City, Nueva Ecija. The results showed that plain rice was still favored in terms of overall liking. The second overall preference, minimal Adlai mix (Adlai:Rice = 25:75 %), was cited favorably for its taste, aroma and texture. Generally among the Adlai-Rice composite samples, the likes clearly outweighed the dislikes, with the latter pointing to hard mouth feel. As to the buying intent, the subjects were inclined to purchase the minimal Adlai mix, next to plain rice. Overall, the results suggest that consumer acceptability of Adlai largely rests on gradual familiarity



ENHANCING QUALITY AND SAFETY OF MORINGA PRODUCTS

Ma. Cristina B. Gragasin, Ofero A. Caparino, Lorena Miranda, and Don S. Ognayon

2014

The moringa (Moringa oleifera) industry was assessed to identify the gaps and challenges in moringa processing. Appropriate and improved processing systems for moringa leaves were developed to ensure good quality and safe products that will meet the standards of domestic and export markets. Rapid assessment has shown that moringa processing system and practices are very diverse, depending on the volume requirements of moringa products and purposes. One of the challenges in moringa processing is drying the leaves without sacrificing the nutritional quality and microbial safety of the finished product. Three drying systems and practices, e.g. Moringa Drying Process 1-MDP1 (air drying + roasting), MDP2 (cabinet tray drying) and MDP3 (belt drying) were selected from among the 10 processing systems surveyed. Air drying for two days of freshly harvested moringa leaves and subsequent roasting for 15 min improved the quality and reduced the drying time in MDP 1. The existing practice in MDP2, that is drying moringa leaves at 90°C at residence time of 90 min was improved by lowering the temperature to 70°C achieving the same safe moisture content (4.0 +0.65% w.b.) and water activity level (0.34 +0.01). The existing loading density of 0.75kg/m² in MDP3 was increased to 1kg/m2 without significant change in the moisture content and water activity. Likewise, the drying temperature and exposure time were reduced from 95°C to at least 85°C from 25 min to 20 min, respectively, with no significant differences in water activity. The nutritional contents of dried moringa leaves were concentrated by applying any of the three drying methods. Microbial analysis showed that the dried moringa leaves obtained from the three drying methods were within the acceptable limit of total microbial count. Therefore, the present study established improvements to MDP1, MDP2 and MDP3 drying practices while maintaining the high quality of dehydrated moringa leaves.







DETECTION OF WOLBACHIA BACTERIAL ENDOSYMBIONTS IN STORAGE POPULATIONS OF PHILIPPINE INSECTS AND MITES

Angelo A. Dela Fuente, Agnes M. Wy, and Mark Mangoba

2017

In stored product integrated pest management, arthropod-endosymbiont relationship, the most common of which is the arthropod-Wolbachia bacteria association, is a latest addition to the ecological variables that need to be noted to facilitate decision on and implementation of control methods and their combinations. This variable however is not explored yet in the Philippine stored product insects and mites, and the status of at least Wolbachia infection in local stored product arthropods is not known. Such studies require molecular biology techniques and possibly very few or no facilities yet in the country, including that of PHilMech has been organized to study endosymbionts in stored product arthropods. In this study, PHilMech established capability for molecular biology techniques and conducted detection of Wolbachia in some stored product insects and mites. Small molecular biology laboratory was set up to process available insects and mites from PhilMech's stock cultures and from the field to check for the presence of Wolbachia surface protein (wsp) gene which was positively detected on the cigarette beetle Lasioderma serricorne (a primary and secondary pest in processing and retailing industries), the corn weevil Sitophilus sp. (a primary pest of corn), and the sawtoothed beetle Oryzaephilus surinamensis (a secondary pest of grains). These results constitute a first report on the presence of Wolbachia endosymbionts in the mentioned Philippine host species. This endeavor begins PHilMech's investigation on stored product arthropod-endosymbionts association that would be considered in creating ecological profiles and in developing potential biological control methods, and launches the center's molecular biology capability that has even wider application in biotic factors identification and monitoring, biological control studies, pesticide resistance surveys, pest population genetics, senescence, fermentation, and food spoilage to name a few.



FIELD EVALUATION OF MICROBIAL AGENT FOR THE Management of Aspergillus flavus link growth AND AFLATOXIN PRODUCTION

Nelson C. Santiago, Benny P. Roderos, Frances M. Gallema, Lyn A. Esteves, Lynette Manlapig, Miriam A. Acda, and Alexander Joel G. Gibe

2017

Pre-harvest infection of corn (*Zea mays*) by *Aspergillus flavus* creates a major food and feed safety problem worldwide. Many strains of *A. flavus* produce aflatoxins, which are potent carcinogens. Removing aflatoxin from corn once they are produced is impractical and expensive. Research is therefore needed to develop strategies designed to manage *A. flavus* infection and aflatoxin formation both in the field and during postharvest handling. One of the most promising tools to manage aflatoxin in food and feed is biological control of aflatoxigenic fungi using microbes. The potential of *Trichoderma harzianum* (BT9) as effective biocontrol agents against *A. flavus* was determined in previous laboratory testing studies by Santiago et al., (2010), which showed a reduction in *A. flavus* infection and aflatoxin contamination when BT9 was applied in corn ear with husk. Hence, this study was conducted to validate the efficacy of *Trichoderma harzianum BT9* strain in managing *A. flavus* growth and aflatoxin contamination in corn under field conditions.

Five farmers were selected as cooperator and source of samples. Newly harvested corn were randomly selected from pile of each farmer and subjected to shelling and piling treatments. The *T. harzianum* was applied as a harvest treatment to corn. Toxigenic *A. flavus* was also inoculated as a conidial suspension (1x105 spores/ml) into corn. Percentage kernel infection and HPLC analyses were used to quantify *A. flavus* infection and aflatoxin contamination.

Field testing using the formulated BCA showed a reduction in *A. flavus* infection when BCA was applied on newly harvested corn with husk not immediately shelled and immediately dried. Likewise, a reduction in aflatoxin contamination was also observed in this treatment during the testing.



SINGLE AND COMBINED USED OF SELECTED BIOCONTROL Agents Against insect pest in storage

Mia V. Dela Cruz, Vicky G. Mesa, Mark Anthony A. Mangoba, and Miriam A. Acda

2017

Laboratory studies were conducted to ascertain the efficacy of single and simultaneous release of predator *Xylocoris flavipes* (Rueter), parasitoid *Choetosphila elegans* (Westwood) and the two entomopathogens *Metharizium anisopliae* and *Beauveria bassiana* (Balsamo) in controlling the internal feeder *Rhyzopertha dominica* and the two external feeder *Oryzaephilus surinamensis* and *Tribolium castaneum* in storage.

Virulence of *M. anisopliae* and *B. bassiana* against the three test insects were carried out through pathogenecity studies using 1x108 spores/ml. Single and combined bio-control efficacy of *C. elegans* and *X. flavipes* were determined by infesting cracked corn with 50 adult test prey/host separately and in combination and held at two temperature regime (29.39±2 and 24.2 ±0.90C), 21 days after infestation, 10 predator and 10 parasitod were released separately and in combination. Percent progeny suppression was evaluated after two and four months in storage.

Acceptability/repellency of *C. elegans* and *X. flavipes* to *M. anisopliae* and *B. bassiana*-infected bettle larvae was detrmined using free and no-choice test.

Results showed that single application of *C. elegans* cause 40.7, 51.2 and 4.1% suppression in *R. dominica*, *O. surinamensis* and *T. castaneum* at 29.39 0C \pm 2, and the *X. flavipes* caused 36,70.0 and 45.6% suppression in *R. dominica*, *O. surinamensis* and *T. castaneum* respectively.

Simultaneous release of *C. elegans* and *X.flavipes* resulted in greater suppression when compared to suppression caused by either *C. elegans* or *X. flavipes* alone. Efficacy of combination of these two biocontrol agent in *R. dominica* suppression at 29.39 $^{\circ}$ C ± 2 and 24.2 ±0.9 $^{\circ}$ C are additive and synergistic respectively.

Choetosphila elegans was negatively affected by the two entomopathogens as low level of progenies were recorded in both free-choice and no-choice tests. The *X. flavipes*, on the other hand, indiscriminately preyed in both infected and uninfected pest larvae which resulted to higher pest mortality but shorter longevity in the adult predator.



STORAGE INSECTS ASSOCIATED WITH DRIED CACAO BEANS AND PROCESSED PRODUCTS

Benny P. Roderos, Miriam A. Acda, Alexander Joel G. Gibe, Frances Luisa M. Gallema, and Cay Neth Callejo

2017

Cacao (*Theobroma cacao* Linn.) is grown for its beans and processed into various products principally chocolates, cosmetics and pharmaceuticals. The climatic condition and soil characteristic of our country favor cacao growing but production cannot suffice both local and global demands. The quality of cacao beans becomes problem during storage due to insect infestation.

The study was conducted in Davao region and in Manila. Eighty percent of cacao beans are produced, processed and stored in Davao region while cacao beans and processed products are traded and further stored in Manila. The project aimed to establish baseline information on storage insects associated with dried cacao beans and processed products and estimated damage and weight loss during storage.

Two arachnids and 20 insects were identified associated with dried cacao beans and its products. The insects belong to the Orders Coleoptera, Psocoptera, Hemiptera, Lepidoptera and Dermaptera, characterized as either primary pests, secondary pests, scavengers or natural enemies. Of the 22 insects collected, seven were documented first time as associated with cacao beans and products.

Unfermented beans, which are more preferred by insects since they do not possess strong aroma, have higher insect density. An average of 6.87% insect damage and average weight loss of 0.99% was incurred after 3-5 months storage. In consideration of the weight loss incurred, monetary losses for fermented and unfermented beans were estimated at Php 0.74/kg or Php 735.00/ton and Php 1.29/kg or Php 1,287.00/ton, respectively.

The common postharvest problems identified were: limited or lack of postharvest facilities (fermentation boxes, moisture meter, mechanical dryer, storage facility), limited or lack of knowledge on proper storage practices, inadequate intervention options to employ when infestation problem arise, poor storage condition (poor sanitation and hygiene), and price reduction of commodity due to quality parameter defects.



EVALUATION OF ORGANIC ACIDS AND MICROBIAL Control agents against postharvest Diseases of Onions

Elijah Z. Davalos, Dionisio G. Alvindia, and Miriam A. Acda

2017

As a common food item, the culinary need for onion bulbs cannot be over-emphasized. Thus, its economic importance as alternate source of income is heavily relied upon by farmers. However, like all crop commodities, onion farming is beset with factors that affect production and handling. One of the most serious of these is pests. Under the study, diseases were noted to be sooty mold caused by *Aspergillus* sp., bulb rot of *Fusarium* sp. and *Sclerotium rolfsii* and soft rot by *Erwinia carotovora* while *Aspergillus* sp and *Erwinia carotovora* remained persistent under cold storage conditions. Alternative treatments aside from cold storage and to some cases chemical treatments were tested under the study. It comprises the utilization of organic acids and microbial control system that can possibly be incorporated with standard treatment for quality preservation. Candidate organic acids were acetic, citric and malic while MCA materials tested were DGA02, DGA14 and an epiphyte isolated from bulb peel, roots and soil particles associated with bulb samples. Organic acids and MCA undergo both in-vitro and in-vitro trials to determine minimum effective dose to be used for the storage trial. Results showed that organic acids around 0.5 to 10 % and MCA at 3 to 12.3% showed effectiveness in suppressing test pathogens.

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MANAGEMENT OF PRE AND POSTHARVEST DISEASES IN Shallot and bulb onions through (Trichoderma Harzianum Rifai) utilization

Nelson C. Santiago, Benny P. Roderos, Frances Luisa Muñoz, and Alexander Joel G. Gibe

2016

Rhizoctonia solani, Fusarium sp., *Sclerotium rolfsii*, Aspergillus sp. and Penicillium sp. are the soil-borne and seed-borne fungal pathogens infecting onions in the Philippines. These pathogens are commonly controlled using fungicides, which are usually unsuccessful. In addition, fungicides pose hazards to human health and the environment. A potential alternative to fungicide is the use of *Trichoderma* spp. as biocontrol agents. *Trichoderma* spp. are known for their antagonistic effects against several fungal pathogens. This project aimed to establish a biological control method using *T. harzianum* for the management of soil-borne pathogens (*S. rolfsii, R. solani* and *F. oxysporum*) infecting onion and extending the storage life.

The influence of pre harvest application of formulated *T. harzianum* on bulb rot diseases and on the shelf life of onion cv. Super Pinoy, Rio Bravo, and Tanduyong was determined through field trials conducted from November 2013 to March 2014 in Bunol, Guimba, Nueva Ecija, Porais, and Tanibong in San Jose City, Nueva Ecija and through storage study conducted from April 2014 to October 2014 at PHilMech; respectively. Likewise, the efficacy of *T. harzianum* against soil-borne pathogens (*S. rolfsii, R. solani* and *F. oxysporum*) infesting onion and on the shelf life was also determined in three field trials during the 2014 dry season, from November 2013 to March 2014 in Bunol, Guimba, Nueva Ecija, Porais, and Tanibong in San Jose City, Nueva Ecija and through storage study conducted from April 2014 to October 2014.

Results revealed that application of *T. harzianum* resulted in lower disease incidence and severity as compared with no application as in farmers' practice. In Red Creole cv Super Pinoy onion, significant differences were observed on disease incidence and severity at 60 and 80 days after transplanting (DAT) between *T. harzianum* treated plots and farmers' practice. For Yellow Granex cv Rio Bravo, treatment with *T. harzianum* was not able to suppress the growth of onion pathogens present in the soil but it slowed down its disease incidence and severity. Moreover, the level of disease observed in Shallot cv Tanduyong was too low to allow the comparison of treatments and to determine the effectiveness of *T. harzianum* in protecting the roots of the plants against bulb rot.

Yield and net income from plants treated with *T. harzianum* was higher as compared to farmers' practice for Red Creole cv. Super Pinoy and Yellow Granex cv. Rio Bravo while similar yield was recorded in Shallot cv. Tanduyong. In storage, samples from the farmers' practice showed higher rotting percentage as compared with the *T. harzianum* treated samples throughout the duration of the study. The efficacy of *T. harzianum* against soil-borne pathogens (*S. rolfsii, R. solani* and *F. oxysporum*) infesting onion was also determined for the three varieties of onion in three experimental areas. The *S. rolfsii, R. solani F. oxysporum* and *T. harzianum* was applied immediately after transplanting, 20 days after transplanting (DAT), 40 DAT, 60 DAT and 80 DAT.

Results showed that all treatments with *T. harzianum* were significantly effective in managing bulb rot diseases caused by *S. rolfsii, F. oxysporum* and *R. solani* and yield was significantly higher as compared to non-*T. harzianum* treated plots. In storage, onions inoculated with onion bulb rot pathogens consistently have higher bulb rot incidence as compared with samples treated with *T. harzianum* for the three varieties of onion.

RESISTANCE OF STORAGE INSECT PESTS TO PHOSPHINE

Miriam A. Acda, Mark Anthony A. Mangoba, and Vicky G. Mesa

2015

Storage insect pests comprising of *Rhyzopertha dominica* (F), *Tribolium castaneum* Herbst, *Oryzaephilus surinamensis* Linn., *Cryptolestes ferrugineus* Stephens, *Sitophilus spp.*, and *Liposcelis bostrychophila* Badonell were collected from different locations in the country and were subjected to the FAO recommended method for determining presence of phosphine resistance. Results showed that resistance is already widespread in *R. dominica*, *T. castaneum* and *O. surinamensis*. Resistance was also detected in some strains of *C. ferrugineus* while *Sitophilus* spp. remains susceptible to phosphine.

Extended exposure tests of 72h and 144h included developmental stages and results showed that the eggs were the most tolerant stage and R. dominica with a resistance factor of x1896, was the most difficult to kill. An apparent minimum effective concentration that will give complete kill of all stages of insects was 1.25mg/L for a fumigation period of seven days.



FIELD EVALUATION OF BIOCONTROL AGENTS IN MANAGING CROWN ROT DISEASE OF BANANA

Elijah Z. Davalos, Dionisio G. Alvindia, and Miriam A. Acda

2015

Export-driven banana cultivation, while providing social equity and financial security in the countryside, suffers considerable rejection rate due to crown rot disease caused by a complex of Colletotrichum musae, Lasiodiplodia theobromae, Thielaviopsis paradoxa and Fusarium spp. The disease is characterized by rotting of the cut tissue of the banana hand or cluster that ultimately destroys the whole commodity if left untreated. The impact is most felt in organic farming while chemical farming remains subject to residue contamination and food safety issues. Two species of epiphytes, Bacillus spp strain DGA14 and Trichoderma spp strain DGA02, were tested for antagonistic effect against pathogens that cause crown rot. To validate laboratory results, six field trials on commercial export scale were conducted along divergent farming systems, chemical farming (FEDCO-Davao City) and organic farming (Alter Trade-Dumaguete City). The trials were scheduled during the rainy season when selection pressure is at its most severe. Treatment solution was prepared using a BCA to water ratio of 1:12 liters. Thirty-two replicates per trial were designated for each BCA. Samples were submerged for 20 minutes in the Alter Trade trials while various treatment exposures were tested in the FEDCO trials. Treatment was assessed by quarantine officers of the importing country. Crown Rot Index (0 to 7 where 0 means disease-free), Visual Quality Rating (1 to 6, where 6 denotes excellence) and Peel Color (0 to 7, where 7 means yellow) were monitored. Results showed that regardless of treatment time, samples in the FEDCO trials showed a 100 per cent recovery in all three trials, 21 days after treatment (DAT), with CRI = 0, VQR = 6 and PC = 5, comparable with the standard pesticide treatment the company employs. Organically-grown bananas likewise showed a minimal rate of rejection (1.5 per cent) 29 DAT with average values of CRI (0.5), VQR (4.8) and PC (2.15) while control treatment resulted to 7.24 per cent loss in the first trial. As for the second and third Alter Trade trials, Control Check was totally deteriorated due to shipping delays whereas BCA-treated bananas suffered only 18% rejection prolonged shipping of 34 days and 34 per cent rejection rate 40 DAT for the third trial due to delay in shipping. Moreover, the cause of rejection was largely due to production diseases like freckle caused by Phyllosticta musarum and anthracnose caused by Colletotrichum gloeosporioides.



EFFECT OF ETHANOL VAPOR ON THE QUALITY OF BROCCOLI

Mia V. dela Cruz, John Louie P. Baligad, and Miriam A. Acda

2015

Storage of broccoli (*Brassica olaracea*) heads was conducted 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 200g of silica gel. Treated and untreated broccoli heads were stored at laboratory condition with 2 different storage conditions (17±0.3 and 22±0.2 °C). Destructive sampling was carried out at 0, 3, 5, 7 and 10 days after storage. Samples from each storage conditions were analyzed 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 °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.



TOXIGENIC POTENTIAL OF FUNGAL SPECIES FROM COFFEE BEANS IN THE PHILIPPINES

Dionisio G. Alvindia, Monica F. de Guzman, and Miriam A. Acda

2015

Green coffee beans from Coffea arabica in Benguet and Ifugao; Coffea canephora var. Robusta in Abra, Cavite and Ifugao; Coffea liberica and Coffea excelsa from Cavite were collected and assessed for the distribution of fungi with the potential to produce ochratoxin A (OTA). The presence of fungal species was evaluated both before and after surface sterilization. There were remarkable ecological and varietal differences in the composition of ochratoxigenic species present in these five provinces. Aspergillus ochraceus and Penicillium verruculosum were only detected from Arabica in Benguet and Ifugao whilst A. niger and A. japonicus was noted in Excelsa, Liberica and Robusta varieties from Abra, Cavite, and Davao. Contamination by Aspergillus and Penicillium species was found on 59% and 19%, respectively, of 57 samples from five provinces. After disinfection with 1% sodium hypochlorite, the levels fell to 40% and 17%, respectively. One thousand one hundred fifty nine isolates were identified to species level and comprised Aspergillus sections Circumdati (3 species), Clavati (1), Flavi (1), Fumigati (1), Nigri (2), and Terrie (1). Within section Circumdati, 67% of A. ochraceus produced ochratoxin A as high as 34979 ng/g. Within section Nigri, 18% of A. niger and 2% of A. japonicus isolates produced OTA ranging from 174–34850 ng/g. Of the 12 species of Penicillium isolated, only P. verruculosum was ochratoxigenic with maximum OTA production of 12 ng/g. Aspergillus and Penicillium species had vigorous growth in artificial media with 1.0 water activity (aw) while there was negative growth at aw range of 0.80–0.99.



DEVELOPMENT OF SPECTROSCOPIC TECHNIQUE FOR RAPID DETECTION OF AFLATOXIN IN WHITE CORN

Romualdo C. Martinez, Lyn A. Esteves, and Jester O. Pangan

2014

Aflatoxin contamination is a chronic problem in homegrown corn. Aflatoxins are a group of toxic compounds which when ingested can lead to acute illness and death, immunosuppression, or liver cancer. Considering that white corn is the main staple of about 14 million Filipinos, it is necessary to ensure that white corn is safe from harmful levels of aflatoxins. Ensuring safety of white corn and its products requires monitoring of aflatoxin. However, most of the methods currently available for detection of aflatoxin are expensive, complex, and time-consuming making them unsuitable for monitoring purposes. The objective of this research was to develop a spectroscopic technique for rapid detection of aflatoxin in white corn. To develop the technique, calibration samples with different levels of aflatoxin B1 were prepared. These samples were scanned using a UV-Vis-NIR spectrophotometer to acquire the spectral data and then analyzed for aflatoxin B1 content to get the reference data. The spectral data and the reference data were subjected to partial least square regression to develop the calibration models. Calibration models using UV&NIR and NIR spectra were developed for detection of aflatoxin B1 in Filipina variety of white corn. Based on internal and external validation, these models were suitable for a variety of applications including screening, quality control, and process control. Likewise, a model using the NIR region was developed for detection of aflatoxin B1 content in Tinigib variety and found suitable for screening purposes. These results highlight the potential of UV&NIR and NIR techniques for easier and faster detection of aflatoxin B1 in white corn if compared with currently available techniques. While currently available methods are generally expensive, complex, and time-consuming, requiring between 30 minutes and a few days to be carried out, the developed UV&NIR and NIR spectroscopic techniques are inexpensive, simple, and fast requiring around 60 and 40 minutes, respectively for triplicate spectra collection and aflatoxin B1 content prediction. Moreover, the spectroscopic techniques do not require reagents and chemicals and therefore do not present environmental hazards. They also do not require highly trained personnel. The developed techniques may have practical applications for screening white corn samples. As such, they can be powerful tools for monitoring the safety of white corn supply. However, the UV&NIR and NIR techniques are variety-specific and applicable only to Filipina and Tinigib varieties. Further studies are required to develop calibration models for other corn varieties and mixed corn varieties and permit wider application of these techniques. In addition, the UV&NIR and NIR techniques should be further validated using field samples to ensure its reliability.

NON-CHEMICAL APPROACHES FOR MANAGING POSTHARVEST DISEASES OF TROPICAL FRUITS (MODULE 2-MANGO AND MODULE 3-PINEAPPLE)

Dionisio G. Alvindia, Christine L. Domingo, and Miriam A. Acda

2013

This project entitled "Non-chemical Approaches in Managing Postharvest Diseases in Tropical Fruits (Module 1-Banana)" showed the effectiveness of biocontrol agents (BCA), salts, and hot water treatment (HWT) as single treatment or their combinations in controlling postharvest diseases and preserving the overall quality of banana fruit (Alvindia and Natsuaki 2007, 2008, 2009; Alvindia 2012; Alvindia and Acda 2012; Alvindia 2013a, 2013b). The technology was validated in a commercial scale applications and gains acceptance among the banana industry players, as to their usefulness as postharvest treatments for organic banana and/or pesticide-free banana, bound for special niche markets here and abroad. To determine the applicability of these sustainable technologies as alternatives to synthetic pesticides, their efficacy as postharvest treatments of mango and pineapple fruits was tested.

In export markets with strict restrictions on pesticide use such as Japan, HWT is the sole accepted postharvest protocol, which entails immersing green mature mangoes in a water bath for 10 minutes at a temperature range of 52-55°C. At this temperature and exposure period, arrests of diseases development in fruit are believed to be achieved. The technology however, as reported by the various companies in mango export business, is no longer effective in controlling postharvest diseases of mango such as anthracnose and stem-end rot caused by *Colletotrichum gloeosporioides* and *Lasiodiplodia theobromae*, respectively.

Meanwhile, pineapple fruit intended for export market are usually de-crowned making them susceptible to crown rot disease. Crown rot, caused by *Thielaviopsis paradoxa* is the most common and well-known postharvest disease of the pineapple fruit. The pathogen initiates infection from the cut end of the peduncle in the form of small, circular, water-soaked spots, which are very soft. The spots enlarge and coalesce forming a large black patch extending throughout the fruit. The internal tissues become soft, black, and watery and emit a foul smell. Crown rot of pineapple is controlled by the application of fungicides. However, fungicide treatment is less acceptable to consumers which encouraged pineapple processors and researchers to look for alternative methods of postharvest disease control.



FORMULATION OF TRICHODERMA HARZIANUM DGA02 For the control of crown rot disease of banana

Dionisio G. Alvindia, Monica F. de Guzman, and Miriam A. Acda

2013

Trichoderma is considered an effective antagonistic fungus to many plant pathogenic fungi and soil borne fungi (Bastos, 1996b; Conney and Lauren, 1998; Batta, 1999). For this bio-agent, the following types of formulations are commercially present: (1) wettable powder formulations such as Bio-Funguss (formerly Anti-Funguss), Binab Ts, Rootshields (also sold as Bio-Terks, T-22Gs), Trichodexs, Mycobacs, (2) granular formulations such as Bio-Funguss, Rootshields, T-22 Planter Box, Trichoderma 2000s (formerly TYs); (3) a pelleted formulation such as Binab Ts, and (4) a liquid formulation (conidial suspension) such as Promotes. These formulations are developed and available in Australia, Canada, Denmark, Germany, Italy Mexico, Netherlands, Spain, Sweden, and USA (Hynes and Boyetchko, 2006). Previously, isolated strain DGA02 of *T. harzianum* that was effective against banana crown rot-causing pathogens (Alvindia and Natsuaki, 2008). This study led to the present research, to develop and formulate the strain DGA02 of *T. harzianum* and test its efficacy against major postharvest pathogens of banana.



MICROBIOTA OF CACAO BEANS IN THE PHILIPPINES

Dionisio G. Alvindia, Agnes M. Wy, and Miriam A. Acda

2013

Nowadays, one of the most widespread concerns is food quality and safety. Cocoa is a very important ingredient in a number of foods, such as cakes, biscuits, child-food, ice-cream and sweets. Most of cocoa and by-products come from Africa, Central and South America. Significant amount of cocoa are produced too, in the Philippines, for local consumption and export. Cocoa beans are seeds from fruit pods of the tree *Theobroma cacao L*. Each pod contains 30 to 40 beans, embedded in a mucilaginous pulp. Fresh cacao beans have to be fermented to remove the astringent and unpleasant taste. Fermented beans are dried and roasted in order to obtain cocoa beans with desired characteristic flavor and taste.

Following opening of the pods, cocoa beans become contaminated naturally with a variety of microorganisms, originating from the environment, workers' hands, containers for transport, knives, pod surfaces, etc. The postharvest processing may contribute further to microbial build-up in cacao beans. Fermentation is the main stage in cocoa postharvest processing generally carried out in a traditional manner by spontaneous fermentation. First of all, there is colonization by yeasts, followed by lactic bacteria, and then by acetic bacteria, which are finally replaced by aerobic sporulated bacilli. Thereafter, drying follow to limits fungal contamination.

Microbial profile of cacao beans from harvest to processing is well documented in other producing countries. A similar study on cacao is lacking in the Philippines. As a tropical country, it is likely that environmental conditions in the Philippines are more conducive to microbial infection. Profiling of bacteria, yeast, and fungi at different postharvest stages is very a important information in conducting pipeline studies geared towards improving quality of cacao beans.





UTILIZATION OF CACAO POD HUSK AS FUEL BRIQUETTES

Andres M. Tuates Jr., Jeszel M. Suligan, and Ofero A. Capariño

2017

Cacao beans are primarily used in chocolate processing. However, the entire processing operation generates substantial quantity of pod husk of about 77% of the whole weight of cacao pods. Traditionally, the cacao processors prefer to collect the cacao beans only leaving the cacao pods in the field unutilized which generates foul odors and becomes inoculum of black pod rot, pathogens, etc. Cacao pod husk has a high heating value, large amount of dry matter and low ash content that can be utilized as source of alternative energy. Converting cacao pod husk into fuel briquettes will add value and at the same time address the problem of waste disposal. The general objective of the study is to develop an environmentfriendly fuel briquette sufficient to resist impact during handling and transport and produce the required heat for domestic cooking and also for industrial application. Six formulations in producing cacao pod husk-based fuel briquettes were developed using piston type briquetting machine. Results showed that the 10% binding agent and cacao pod husk with particle size of \leq 2.2 mm obtained the highest bulk density (0.75 g/cc), shatter resistance (99.93%) and break strength of fuel briquettes (0.114 kN). It was observed that the higher amount of binding agent and smaller particle size of cacao pod husk has resulted to higher quality fuel briquettes. The optimum formulated fuel briquette has an average energy density and thermal efficiency of 2,412.55 cal/cc and 26%, respectively. Likewise, the energy demand in producing a ton of briquettes is only 4.8% of the energy contained in a ton of cacao pod husk briquettes with a value of 3,741.1 kWh. Investment analysis showed a profitability with a benefit cost ratio (BCR) and internal rate of return (IRR) of 1.90 and 22.19, respectively. The investment cost can be recovered in 1.84 years. Pilot testing of the technology in selected cacao producing areas is recommended to determine the specific technical, financial, operational and management requirements needed to operate the project as a village enterprise.



DEVELOPMENT OF COMMERCIAL AND INDUSTRIAL PRODUCTS FROM CACAO SWEATING

Andres M. Tuates Jr., Princess D. Veneracion, Shiela Marie A. Villota, and Ofero A. Capariño

2017

Cacao beans must be fermented properly to produce good quality cacao beans for marketing and processing into various products and applications. Previous studies found that unfermented cacao beans produce less chocolate flavor. During the fermentation process, the generated cacao sweatings obtained from the traditional practice of fermentation, which uses wooden fermentation box are not edible and create foul odor and air and water pollution. The study attempted to collect a food grade sweatings using a stainless fermentary box, which were processed into wine, vinegar, ethanol and health drink. The products were characterized in terms of physicochemical properties and sensory attributes. Investment analysis was also analyzed to determine the potential profitability of producing the products. Results showed that the cacao wine with initial total soluble solids (TSS) of 25 °Bx contained 8.85% alcohol by volume, pH 3.45, and \leq 1.0% total titratable acidity (TTA). The TSS (8.3 °Bx), pH (2.99), and TTA (6.77%) obtained in vinegar conformed with the Philippine legal standard. The health drink contained 12 °Bx, pH 3.67 and \leq 1.0% TTA. The microbial analysis (e.g. aerobic plate count, yeast and molds, total viable count, E. coli) of cacao sweating, wine, vinegar and health drink obtained a value of <1 cfu/ml which complied with the standard safety level set by USDA. Sensory evaluation revealed that vinegar, wine and health drink were generally acceptable with vinegar as the most liked product. The initial investment of Php 330,000 is required to produce four cacao products such as vinegar, wine, health drinks and ethanol. In a month of operation, a total of 1,920 bottles of 250 ml vinegar, 640 bottles of 750 ml wine, 1,371 bottles of 350 ml health drinks, and 120 bottles of 4 liters ethanol will be produced with an operating expenses of Php 97,519 and estimated net income of Php 142,850.32. The suggested retail price of the different products are: Php 50/ bottle (vinegar); Php 100/ bottle (wine); Php 15/ bottle (health drink); and Php 2,000/ gal (ethanol). Pilot-testing and shelf-life study for the processed cacao-based products are recommended.



DEVELOPMENT OF A PILOT-SCALE PROCESSING SYSTEM FOR THE PRODUCTION OF PECTIN FROM MANGO PEELS

Ma. Cristina B. Gragasin, Ofero A. Capariño, Aileen R. Ligisan, Don S. Ognayon, and Sheryll May M. Villota

2017

A pilot-scale mango pectin production system developed by PHilmech was established at Profoods Corporation located in Mandaue, Cebu to verify its technical requirements and performance and financial viability. The technical performance was assessed based on the physico-chemical properties of the produced pectin; stability and acceptability of the pectin-based food products including yogurt and pineapple jam. Results showed that all the necessary equipment for pectin processing are commercially viable. The physico-chemical properties of the produced pectin conformed with the US Pharmacopeia specifications for pharmaceutical grade pectin indicating its superior quality. The produced pectin from mango peels contain 60-77% total dietary fiber wherein 53% of which correspond to soluble dietary fiber. Soluble dietary fiber is a jelly compound that binds cholesterol and sugar thus preventing or slowing absorption of these substances into the blood stream. Microbial profile of the produced pectin contained very minimal population of microorganisms (i.e. total bacterial count, molds and yeasts) that rendered it safe and stable for a year of storage and expected beyond one year. Overall acceptability during sensory evaluation by 40 respondents showed that the formulated yogurt and jams using mango pectin as stabilizer and gelling agent were comparable with the same products using commercial pectin. Based on the projected annual volume of pectin production of 580 kgs., the computed production cost of Php 7,633/kg is significantly lower than the cost of imported apple pectin (Php 37,000/kg). Putting up a pilot-scale mango pectin processing plant with an output capacity of 2 kg/day is viable venture at a low selling price of Php 8,495/kg. The investment cost of Php 4,427,770.89 can be recovered in 3.77 years with IRR of 36.82%.



SYNTHESIS AND CHARACTERIZATION OF NANO-COMPOSITES FROM COCONUT WASTE (COCONUT HUSK): A NEW POTENTIAL MATERIAL FOR NANO-FILTRATION SYSTEM

Juvy J. Monserate, Joel R. Salazar, Gerardo Ilagan, Andres M. Tuates Jr., and Ofero A. Caparino

2016

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 hectare and annual production of 15,667,600 tons. However, utilization of the by-products was given less attention. With the development of nanotechnology having 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 PLA, cellulose acetate from coconut husk, chitosan and ALA-MMT. FTIR analyses revealed carbonyl group, CH2 bending, asymmetric ester group that is a band characteristic of PLA and CA, asymmetric stretching of pyranose and CH2 bending bands revealing the polymer blend of the treatments used. 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 coconut water analysis, results showed significant difference ($p \le 0.05$) 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 passing through sieve mesh and pasteurization.



UTILIZATION OF BIODEGRADABLE COMPOSITES MATERIAL ON THE PRODUCTION OF FRUIT BAG

Andres M. Tuates Jr., and Ofero A. Capariño

2015

Plastics have achieved a dominant position in agriculture because of their transparency, lightness in weight, impermeability to water and their resistance to microbial attack. It is used as food and fruit packaging, fruit bag, food container, seedling bag, mulching film, protective for greenhouse, dryer shed and among others. However, this generates higher quantity of wastes that are difficult to dispose by the users farmers. The plastic residues remain on the soil for some years as large pieces and they are impediment to plant growth and also a potential hazard to animals if the land is subsequently put down to grass. To address these problems, PHilMech in collaboration with First in Colours, Incorporated (FiC) conducted a project aimed to develop and evaluate the biodegradable film for mango fruit bag during development. Cassava starch and polybutylene succinate (PBS) were used in the development of biodegradable film. The PBS and starch was melt-blended in a twin-screw extruder and then blown into film extrusion machine. The physico-chemical-mechanical properties of biodegradable fruit bag were determined following standard methods of test. Field testing of fruit bag was also conducted to evaluate its durability and efficiency under field condition. The developed PHilMech-FiC fruit bag was made of biodegradable material measuring 6 x 8 inches with a thickness of 150 microns. The tensile strength was within the range of low density polyethylene (LDPE) while the elongation is within the range of high density polyethylene (HDPE). However, it had higher density, thickness swelling and absorbed more water. It is projected that after 36 weeks, the film will be totally degraded. Results of field testing showsedthat the quality of harvested fruits using PHilMech-FiC biodegradable fruit bag in terms of percent marketable, non-marketable and export, peel color at ripe stage, flesh color, TSS, ^oBrix, percent edible portion is comparable with Chinese brown paper bag and old newspaper. Prior to commercialization, pilot testing of PHilMech-FiC developed biodegradable fruit bag for mango is recommended to evaluate its technical, economic benefits and effect to the environment.



UTILIZATION OF BIOMASS FURNACE BY-PRODUCTS AS FUEL BRIQUETTES

Andres M. Tuates Jr., Aileen R. Ligisan, and Ofero A. Capariño

2013

Carbonized rice hulls (CRH) and carbonized corn cobs (CCC) obtained during the utilization of PHilMech designed biomass furnaces were used as raw materials in the production of fuel briquettes. Two types of briquetting machines were used including piston and screw type machine. Different percentage concentrations of starch as binding agent during the formulation of samples (7.5 %, 10 % and 12.5 % for piston type, and 1.75 %, 2.0 % and 2.25 % for screw type) were applied. The briquettes were evaluated in terms of their physical and thermal properties. Partial budget analysis was also conducted.

Results showed that the average density of CRH briquettes produced in screw-type machine was higher than the briquettes produced in piston-type machine. This observation can be attributed to the higher pressure applied in the screw type machine. But, the briquettes made from the piston type machine were found to be more durable compared to the one produced in screw type machine, which can be associated with the high concentration of binding agent as required when using the piston type machine. The heating value of CCC (6,421 cal/g) and CRH+rice hull (4,832 cal/g) can be considered as substitute to charcoal which has a heating value of 4,793 cal/g. The resulting energy values and combustion qualities of the briquettes produced from the carbonized materials were sufficient to produce the required heat for domestic cooking as well as for industrial application. Partial budget analysis showed that the biomass fed furnace owner can earn an additional income of Php 138.44/bags for converting their by-products into fuel briquettes.



DEVELOPMENT AND PERFORMANCE EVALUATION OF A VILLAGE LEVEL COCONUT WATER PROCESSING SYSTEM

Ofero A. Capariño, Kristine S. Soliven, and Jerry James M. dela Torre

2015

This research attempted to convert the un-utilized coconut water extracted during copra processing into natural coconut water beverage. Preliminary experiments showed that the growth of microorganisms of un-pasteurized coconut water was prevented when kept for 24 hours under chilled condition, while there was a significant increase ($p \le 0.05$) in microbial load after 6 hours of storage under ambient condition. Pasteurization of coconut water at 90°C for 60 seconds demonstrated the lowest microbial count (< 5 cfu/mL) during four weeks of storage under chilled condition. Using the above data as reference, a village level coconut water processing system was developed. The processing operation and protocol comprise the following steps: harvesting matured coconuts; de-husking the coconut; handling and transporting of dehusked coconut to the processing site; pre-cleaning of coconuts; washing, sanitizing and rinsing of pre-cleaned coconuts; draining and air drying of washed and rinsed coconuts; extracting and filtering of the coconut water; pasteurizing the coconut water; precooling the pasteurized coconut water; chilling the precooled coconut water; filling and capping; packaging; and storage under chilled condition. The system is capable of producing 100% pure bottled coconut water, without any additives and preservatives, with a shelf life of 21 days under chilled condition. Overall acceptability during sensory evaluation by 100 respondents showed that the coconut water produced from the system was significantly ($p \le 0.05$) the most liked sample with higher purchase intention over other three (3) commercial brands. The system is capable to process 2,000 nuts, approximately 2,000 bottles (350 mL) coconut water per day. The technology has great potentials in adding value to unutilized coconut water and increasing income of the coconut farmers.







MARKET ANALYSIS OF MINIMALLY PROCESSED SHALLOTS AND BULB ONION PRODUCTS AND PROCESSED BULB ONIONS IN THE PHILIPPINES

Gigi B. Calica, Jan Mari C. San Pedro, and Renita SM. Dela Cruz

2017

This project was conducted with the general objective of conducted a market analysis of minimallyprocessed and processed onion products in the domestic and international food industries.

Result showed that the annual demand for minimally-processed and powdered onions were 6,194.41 tons and 3,309.63 tons respectively. Around 24% of the total average supply was locally produced and 76% were imported. At present, no local powdered onion is in the market.

Food manufacturing sectors categorized as fast-food and restaurant, snack-food manufacturing and meat processing have their own onion requirement preferences. Fast-food and restaurant ordered around 72% of the total annual demand for peeled (yellow) bulb onion, snack-food manufacturing sector utilized 100% of the peeled shallot, and meat processing sector required 76% of the total annual demand for powdered onion. The remaining percentages for peeled (yellow) bulb onion and powdered onion were consumed by the other sectors identified. Substitutes for the local minimally processed onions are imported products while onion oil for the powdered onion products.

Shallot minimal processing in llocos would be viable based on the pre-feasibility study prepared by the project team if the cooperative has a direct linkage to the end-user.

Marketing barriers identified for minimal processing include: the lack of direct linkage to end-users, high transportation costs and the availability of raw materials for minimal processing. On the other hand, onions produced in the country were not the processing varieties to produced powdered onion. Longer daylight varieties are the recommended processing varieties.

The minimal processing of onion shallots involving farmers' cooperative should be further studied and assessed in terms of technical, financial and environmental performance, and social acceptability.

Compendium of PHilMech RD&E Abstracts 2012-2017

PILOT TESTING AND COMMERCIALIZATION OF IMPROVED COMPACT CORN MILL

Michael A. Gragasin, Jayvee P. Illustrisimo, Romualdo C. Martinez, and Eduardo T. Cayabyab

2016

The developed PHilMech village-level compact corn mill was pilot-tested and simultaneously commercialized with partner local manufacturers as part of adopting the Agrinnovation approach of the agency. This very aggressive RDE approach has pushed this research to the ultimate goal of having a short duration but high impact research and development works.

The pilot testing successfully improved the technical performance of the corn mill with 14 % increase in the output per unit of energy used, from 38.6 kg/kWH to 43.9 kg/kWH before and after pilot-testing, respectively. The improvement in the technical performance of the new technology has significantly reduced the milling cost per kilogram of corn grits by 19 %, from the original cost of Php1.18 to Php0.95/ kg. In effect, the economic viability of investing in the technology was improved, given an estimated payback period of two years and six months with internal rate of return of 68.6 %.

The individual farmers, as one direct beneficiaries of the developed technology, have a total annual net benefits of Php 9,722 for patronizing the corn mill technology through higher milling recovery, reduction in transportation cost, and lower milling fee.

The early involvement of the local manufacturers during pilot-testing has validated the engineering design of the invention and confirmed that the prescribed materials and parts are readily available in the local market. But most importantly, it ensured a ready supplier once the corn mill technology is launched in the market



BENCHMARK STUDIES ON POSTHARVEST HANDLING OF LOWLAND VEGETABLES

Ma. Cecilia R. Antolin, Edgar F. Flores, Renita SM dela Cruz, Daisy O. Tesorero, Cesar F. Neric, Jr., and Kenny Bryalle Mendez

2016

The study aimed to establish baseline information on postharvest handling systems of lowland vegetables specifically tomato and bitter gourd. It covered top six producing areas of tomato namely: Pangasinan, Nueva Vizcaya, Nueva Ecija, Laguna, Iloilo and Bukidnon. There is much to be done in in order to improve the postharvest handling and marketing management of tomato. Farmers and traders lack knowledge on postharvest management. The present postharvest management system of tomato revealed high postharvest losses especially during peak season because of abundance of tomato in the market, non-application of technologies that may extend shelf-life and low price.

In Nueva Vizcaya last March-June 2014, 10.5 MT of tomato are thrown weekly due to spoilage (NVAT report). In Bukidnon, it was estimated that 25 to 30% of tomato productions during peak season are retained in the farm and trading post because of low price. In the actual loss assessment conducted, Bukidnon to Divisoria route exhibited the highest losses of around 13%. Some factors that may contributed to high losses are: farmers lack of knowledge on proper postharvest handling, delay transport due unavailability of truck to immediately transport the crop from farm to Bulua Trading Post, Cagayan de Oro City and the ship container vans do not have air condition unit. Tomatoes stay in the container van for 46 hours.

Other loss assessment conducted showed postharvest losses of 2.85% route from Nueva Ecija to Divisoria, 8% Nueva Ecija to Bulacan, 2%- Nueva Vizcaya to Tuguegarao City and 4% Leon, Iloilo to Capiz. With this significant losses incurred, there is a need to educate the different stakeholders on postharvest care of crops and pilot test technologies that extend shelf-life in commercial market.

Bitter gourd is known for its bitter taste, its fruits and leaves are used in food preparation and alternative medicines. Bitter gourd is more nutritious with higher levels of vitamin A and Calcium compared to other cucurbits. The study covers three provinces namely: Nueva Ecija, Batangas and Quezon. The results of the study showed that there is need to educate the farmers on the proper postharvest care of the crop and there significant losses in the present postharvest handling system.

Bitter gourd is highly perishable crop and farmers should market it immediately after harvest. The loss assessment study conducted at Sta. Rosa, Nueva Ecija to Divisoria exhibited 6% loss and after one day, the losses doubled to 16%. The case is also similar to Tiaong, Quezon to Divisoria route, postharvest losses was 11% and it increased to 15% after a day. The present potharvest sytem should be improved and good agricultural practices should be adopted by farmers.

BENCHMARK STUDIES ON THE POSTHARVEST HANDLING OF EGGPLANT AND SWEET POTATO

Renita SM. Dela Cruz, Ma. Cecilia R. Antolin and Sheila Marie Adamos

2016

The project aimed to establish baseline information on eggplant and sweet potato as bases for developing and providing appropriate and viable technologies. The industry situationer and supply chain for eggplant and sweet potato were identified based on the secondary data obtained through desk research and primary data from 202 eggplant.farmer-respondents and 350 sweet potato farmer-respondents. Commodity flows and actual loss assessment in major routes of eggplant and sweet potato from farm to retail market level were conducted. These were the routes from Pangasinan-Pasig Pangasinan-Divisoria, Quezon-Divisoria and Nueva Ecija-Divisoria for eggplant while Bataan-Divisoria and Tarlac-Tanauan City for sweet potato. Major postharvest problems identified for eggplant and sweet potato were noted with their potential technological interventions. Among the technological interventions, the mechanical root crop harvester to reduce harvesting loss was evaluated for sweet potato.

The postharvest system's loss of eggplant from farm to the retail level ranged from 4.78 to 8.05% for a period of two days from harvest to retail. Preharvest losses at a range of 14.94 to 31.05% which significantly reduced the income of eggplant farmers were mainly caused by insect pest and diseases. Aside from postharvest handling defects, the presence of bacteria and fungi could potentially degrade quality of eggplant while in transit to retail level two days after harvest (2DAH) at a range of 1.67 to 15.20%. Net income shares are shared fairly among the actors of fresh eggplant chain. Retailers being the downstream level have the highest cost share. and correspondingly are the least efficient with a profit-cost ratio of 0.16. Some of the identified potential technologies which could be further developed are the environmentally-friendly alternative control methods or GRAS-type control agent for insect pests and diseases. Aside from pre-harvest loss, moisture loss for only two days was also high at the retail level at a range of 4.39 to 7.53%. Evaluation of technically and financially viable surface coatings to retard transpiration/evaporation of moisture from eggplant should be pursued.

For sweet potato (SP), actual field loss assessment showed that harvesting loss due to uncollected and mechanically damaged roots during harvesting ranged from 15.96 to 17.94% of marketable harvest. Preharvest loss due to immature roots and insect infestation ranged from 6.17 to 35.2%. Moisture loss and disease infection contributed 15.03 to 15.25% postharvest loss from farm to retail level. In terms of quality, SP marketed produce from the farmer to the retailer was reduced from 4.89 to 3.85% or from the scale of 4.93 to 4.41 (5 as the highest and 1 as the lowest). The SP farmer has the highest income share followed by the retailer. Considering the risk in production (farmer) and the high cost of postharvest losses (retailer level), the income distribution is apparently equitable. Potential technology intervention to address observed problems in harvesting sweet potato roots was the introduction of mechanical root crop harvester to reduce losses and labor cost. Technical and financial performance indicated that mechanical root crop harvester can reduce harvesting loss due to uncollected roots and increase sweet potato farmer's income.



Results of this project serves as guide for other researchers and concerned agencies/institutions in identifying problem areas for action and applied research. Information generated by this report can also guide the policy makers to provide measures/policies for loss reduction. Furthermore, this will enhance awareness on the need to provide appropriate technologies and/or assistance or support to improve handling systems of sweet potato and eggplant.



ESTABLISHMENT OF BENCHMARK INFORMATION ON Postharvest and mechanization of selected Commodities: Cardava, Shallot and Bulb Onions

Gigi B. Calica, Karen Lingbawan, Joanne T. Ceynas, Maggie May N. Dulay, Zeren Lucky L. Cabanayan, and Renita SM. Dela Cruz

2016

The project aimed to provide benchmark information on postharvest and mechanization on cardava banana, cassava, shallot and bulb onions.

Results showed that the cardava banana production in Isabela were for local consumption while Mindanao catered the international market exporting fresh cardava, microwavable saba, and banana chips. Marketing the product in Isabela was either in counting method or in metric system while in Mindanao adopted the latter. Farmers were mostly market efficient in chains using metric system. Most efficient market in the international chains is fresh cardava banana export.

Patronizing the counting method, farmers incurred income losses of around Php 347.55 per week accumulating to around Php 16,682.40 in a year which could cover the needs of a family of five for two months in the country.

Postharvest losses incurred were 14.28% for local and 15.58% for export. Sources of losses were due to cuts during dehanding of harvests because of the equipment used, marketable rejects because they did not meet the standards of the importing countries but acceptable in the banana chips processing and wet market, and due to weight loss.

On the other hand, shallots were marketed cured and bundled in the local and export markets. Findings showed that retailer was more efficient than the other actors in the local market chain because he spent less than the others. However, in the export market, exporters were efficient because the product demands higher price in the international market. For the minimally processed chain, farmer was efficient because they paid very minimal amount for marketing the rejects shallot onions from the export market. Among the four chains, export trimmed shallot chain was more efficient than the other chains because of lower costs incurred and demanded higher price in the international market.

The average postharvest losses incurred by the shallot industry were around 23.87%. Noted major losses came from storage and the cleaning, sorting and bundling activities which were due to rotten, sprouted and weight loss.

Problems of the shallot industry were more on the postharvest handling such as curing, cleaning, sorting, bundling, and storing as well as marketing (waiting for the export market with no alternative market at hand) and processing of the product.
Bulb onion market chains include: farm to market and farm to cold storage to market. On the marketing efficiency, wholesaler/retailers were efficient among the actors involved in both chains because they incurred less costs than the others. Considering the whole chain's marketing performance, both chains were inefficient because they incurred high marketing costs.

On the first three months of red bulb in cold storage, minimal loss of 4.98% was recorded. However, on the fourth month, the loss increased three folds. After nine months in storage, rotting is the main source of loss in the cold storage accounting to 75%, while moisture loss and sprouting contributed 23% and 2%. Starting from the third month (June) up to the seventh month (October) of storage, income recovery was highly favorable but disposing onion from storage on the eight month (November) and ninth month (December) will be financially disadvantageous.

Considering physical and quality losses, the average postharvest loss for red bulb onions was around 49.17% (including the storage loss for seven months) and 30.77% for yellow bulb onions.

Postharvest problems were on the laborios harvesting practice and high cold storage fees and losses incurred by the actors and the waste management of rotten onions from cold storages.

Mechanization of some laborios activities of the four commodities under study was recommended to reduce the costs and postharvest losses resulting to market efficient chains. More so, strict implementation of existing laws should be enforced to prevent quality loss.

EVALUATING THE EFFECTS OF MECHANICAL TRANSPLANTER AND COMBINE HARVESTER ON RICE PRODUCTION, FARM INCOME AND RURAL EMPLOYMENT

Hernaiz G. Malanon, Renita SM. Dela Cruz, Sandy B. Bobier, Maggie May N. Dulay, and Zeren Lucky L. Cabanaya

2015

This study was conducted to evaluate the potential effects of rice mechanical transplanter and combine harvester on rice productivity, harvesting losses, farm income and employment of local labor. The study likewise establish the contribution of mechanical transplanter and combine harvester in enhancing rice competitiveness and attempted to evaluate the effect of using combine harvester in mitigating farmers' exposure to weather risk.

Field experiments comparing the yield of different planting methods revealed that mechanicallytransplanted paddy resulted to significantly higher yield compared to manually-transplanted paddy. The yield difference was estimated at 0.81 mt per ha. Meanwhile, using combine harvester reduces harvesting-threshing losses by 1.54% during the wet season and 0.54% during the dry season. Rice farmers were better off in using mechanical transplanter compared to manual transplanting as income is increased by Php 640.00 to Php 13, 755.00 per ha. Similarly, the use of combine harvester lowers harvesting costs by Php 3, 889.05 per ha and gains additional Php 546.00 - Php 735.00 ha-1 per cropping for losses prevented by using combine. Mechanical transplanter and combine harvester had potential to enhance rice competitiveness by lowering the production cost by Php 3.20/kg or 29% of the current production cost per kg.

Investment in combine harvester was favorable at average utilization of 111 ha/yr coverage area at 14% custom service charge. On the other hand, operating a mechanical transplanter for custom servicing was financially viable at full utilization of 90 ha/yr at prevailing service charge of Php 6,000.00/ ha.Combine harvester was shown to be an important means to mitigate risk exposure of rice farmers to adverse weather condition during harvest. The availability of combine harvester potentially reduced exposure of crop to weather risk by 93 to 95%.

As of 2014, combine harvesters already covered 4.16% of the total rice harvestable area in the country. In these areas, 5% of the labor service providers were totally displaced, 77% partially displaced while 18% not affected. Foregone income of totally displaced laborers was estimated at Php 69.55 million/yr while the partially displaced laborers are losing Php 218 million to Php 567 million/year. Mechanization technologies such as combine harvester and mechanical transplanter can bring enormous societal benefits but there are also serious equity consequences often borne by the displaced or marginalized poor who are negatively affected. The societal benefits tremendously outweigh the societal costs but the negative effect of mechanization cannot be discounted, hence, continuous efforts should be done to address the issue.

DEVELOPMENT OF POSTPRODUCTION MECHANIZATION SYSTEMS FOR SOYBEANS

Ma. Cecilia R. Antolin, Renita SM. Dela Cruz, Cesar F. Neric, Jr., Donald V. Mateo, Jenelyn A. Capito, and Romualdo C. Martinez

2015

The project was conducted in April 2011 to December 2014 involving three major stages, namely: benchmark study identifying the postharvest needs of the industry, development of appropriate postharvest and processing interventions and pilot testing the developed systems with cooperators. The project was funded by the Bureau of Agricultural Research (BAR) and the PHilMech, BAR providing 50% while PHilMech shouldered 50% of the total budget needed by the project. For the first stage, the project adapted the value chain framework employing focus group discussion, key informant interviews, and surveys of specific group of stakeholders. The development of appropriate postharvest and processing systems involved the assessment of existing technologies and development of systems to produce specific products. Lastly, the systems developed were pilot tested to determine their financial viability and social acceptability from the point of view of the potential technology users.

Results identified the stakeholders involved in production to marketing, their practices, flow of goods, financial distribution of earnings among stakeholders, constraints and potential interventions to improve product quality and meet consumers' demands, among others. Similarly, appropriate postharvest technologies for threshing and cleaning-sorting were identified and were found to be financially viable and acceptable among farmers. Different processing systems were also pilot tested and were immediately adopted and served as major sources of income among the early technology adopters. The project developed different postharvest and processing enterprise modules that can be used as ready references for interested entrepreneurs in making more informed investment decisions. Some specific recommendations were forwarded to enhance the sustainability of local production units and rural-based processors.



TECHNICAL AND SOCIO-ECONOMIC EVALUATION OF NON-REFRIGERATED STORAGE SYSTEM FOR SMALLHOLDER ONION FARMERS

Rodelio G. Idago, Renita SM. Dela Cruz, and Domingo R. Miranda

2015

The study was conducted to assess the technical and socioeconomic viability of non- refrigerated storage systems for smallholder onion farmers that comprise majority of the country's local producer. Non-refrigerated storage refers to storage technologies or practices that do not apply refrigeration system, which is typical in cold storage facilities, but rather utilizes ordinary ambient condition or higher temperature to prolong the shelf life of the crop. This low-cost storage system intends to provide alternative solution to high storage cost, insufficiency of cold storage facilities and ultimately provide smallholder farmers some window of flexibility in the disposal of their produce.

Technical evaluation of the storage performance of non-refrigerated storage systems such as hanger and high temperature storages, and cold storage (as control) was conducted using Red pinoy cultivar. Technical parameters such as percentages of physiological weight loss, sprouting, rotting and marketable bulbs were recorded every 14 days interval from April 2014 to November 2014. Results revealed that percentage of physiological weight loss, rotting and sprouting increases with storage period for all storage systems with significantly (p<0.05) higher values observed for hanger (57%), followed by high temperature (49%) and cold storage (24%) in just five months. In seven months storage, losses reached 93%, 85% and 38% in hanger, high temperature and cold storage, respectively.

Application of profit maximization suggests that the optimum storage period for hanger and high temperature storage is 112 days with maximum profit of Php 225 and Php 250 per bag of 25 kg capacity, respectively. In the case of cold storage the maximum profit obtained is Php 290 per bag. Partial budget analysis between immediately selling half of their harvest versus storing it in non-refrigerated storage for 112 days suggests that a smallholder farmer will have incremental income of Php 56,486 to PhP 60,968 attributable to price increase. Economic analysis of storing onion in non-refrigerated storage to address the supply requirement for four months after peak season versus the traditional ambient storage resulted to NPV of Php 43, 161.21 and ERR of 19.03% suggesting that the society will be better-off using non-ref over the status quo.

While cold storage appeared to be the most technically and financially viable option for long-term storage requirement to provide the supply during the lean months, non-ref storage can provide the medium-term storage requirement between the peak and lean periods, thereby skewed supply of onion would be more evenly distributed across the year. While the application of cold storage provides the highest returns among the storage methods, it is however, most of the time, inaccessible to smallholder farmers because of volume requirement and high storage cost. This justifies the financial and technical practicality of non-ref storage for smallholder farmers due to simplicity of this low cost technology and the relatively smaller volume of harvest they manage.

ASSESSING THE FEASIBILITY OF ESTABLISHING A RICE PROCESSING CENTER IN SELECTED TOP RICE PRODUCING AREAS IN THE PHILIPPINES

Priscilla C. Castillo, Gemma O. Mallo, Kristine Mercado, Jamesiah Badua, Rowena Daligcon, and Genaro M. Tolentino

2014

The project was conducted to assess the feasibility of establishing a Rice Processing Center in the selected top rice producing areas in the Philippines. The methodology undertaken was actual site visitation, key informant interview of and focused group discussion among rice farmers, millers, traders and cooperatives. Very relevant secondary data in assessing the RPC feasibility were also gathered from the Bureau of Statistics, National Food Authority and from the result of 2008 Postharvest Facility Inventory Project of PHilMech. The SPSS tools and Feasibility Study program were used in the data processing.

Considered in the technical analysis were the volume of production, excess/ deficit ricemill capacity, palay process flow and capacity of postharvest facility of RPC. The current marketing grains practices, strategies and prevailing market prices of palay and rice as well as the consumption pattern were among the basic references in the marketing aspect of the study. The existing manpower of private ricemills and functions on the other hand were also looked into. In the financial aspect, the major assumptions and cost computations in the operations of a rice milling enterprise like cost of labor and handling, power, fuel, salaries, cost of raw materials, cost of ricemill's spare parts, sacks, other logistics and fixed cost like tax and license, repair and maintenance, depreciation and insurance were all considered. A 5.65% was included as discount rate on the total investments. A patronage refund of Php 50.00 per bag of milled rice as a form of incentive to farmers was also included in the financial analysis.

Results of the different analyses revealed that establishing one to two appropriate Rice Processing Center/s in the 19 provinces except in the province of Leyte was feasible. Rice Processing Center I which has initial allocation of Php 6M is viable in the provinces of Ilocos Norte, Palawan, Aklan, Bukidnon and Agusan Norte. Rice Processing Center II which has initial allocation of Php 16M is viable in Pangasinan, Isabela, Occidental Mindoro, Capiz, Negros Occidental and North Cotabato. Further, Rice Processing Center III which has initial allocation of Php 32M was found appropriate in the provinces of Nueva Ecija, Tarlac, Oriental Mindoro and Sultan Kudarat. Meanwhile, one RPC I and one RPC II were viable in the province of Ilo-ilo. Any type of RPC was viable in Camarines Sur.

ASSESSING THE LEVEL OF AND THE FACTORS DRIVING MECHANIZATION OF RICE AND CORN FARMS IN THE PHILIPPINES

Hernaiz G. Malanon, Renita SM. Dela Cruz, Joanne T. Ceynas, Zeren Lucky L. Cabanayan, and Jonel G. Patricio

2014

Accurate and timely information provides important guide in policy formulation process and basis in crafting RD&E programs. To formulate effective and sustainable program for mechanization, an assessment on the status and level of agricultural mechanization is imperative. PHilMech, in collaboration with UPLB-AMDP conducted this study to assess the level of agricultural mechanization of rice and corn farms in the country. This aimed to address the lack of updated and relevant information on mechanization as the government is steadfast in its effort to accelerate mechanization as a means to address food self-sufficiency, increase productivity and farm income and modernize agriculture.

Employing one shot cross-section survey design, interview of rice and corn farmers was carried out in major production areas of the country. The survey covered 13 rice-producing provinces (1,235 rice farmers) and 13 corn-producing provinces (1,235 corn farmers).

Results showed that rice farm operations such as threshing and land preparation were already highly mechanized in most areas while activities such as planting, fertilizer application, dike repair/ clearing and spraying were still done predominantly using manual power. Mechanized harvesting was gaining wider acceptability in Luzon. For corn farms, most areas reported highly mechanized shelling and fairly mechanized land preparation.

In terms of the level of farm power utilized in rice farming, farmers in Isabela, Pangasinan, Nueva Ecija and Kalinga reported highest utilization levels. Plowing, harrowing, threshing and harvesting registered highest power requirement. In corn farms, farmers in Mindoro Occidental and Tarlac reported highest power utilizations while farmers in Cebu registered lowest power usage.

Adoption of agricultural machinery was influenced by age, level of education, membership to farm organizations, area, agro-ecology (for rice farms), topography (for corn farms) and labor situation in the area (for labor-replacing technology such as combine harvester). Ownership of engine-powered machines is likewise influenced by age, education, area and agro-ecology.

Based on the findings, there is still much potential to mechanize key operations such as land preparation, planting, harvesting and threshing/shelling in key production areas of the country.

CORN POSTHARVEST MODULES FOR FARMER-BASED AGRIBUSINESS ENTERPRISES

Renita SM. Dela Cruz and Sandy B. Bobier

2014

On-farm postproduction modules were evaluated in terms of their financial viability when operated for own use and/or custom servicing. Secondary data gathering and key informant interviews were done involving machine service providers and users, machine manufacturers and dealers, corn traders and chichacorn processors. The financial indicators used were: net income for the first year, payback period, benefit-cost ratio, internal rate of return and net present value. Breakeven points were also determined as easy reference guides for decision making. Several modules were identified, each module represents operation or several operations producing specific product(s) and/or service(s) with existing users and/ or markets. The study did not include the postproduction operations of feed milling and processing corn for flour and oil. Technologies that are highly viable and conversely those that are not viable when operated for custom servicing were identified.

Operating a custom service enterprise for shelling and/or threshing and corn milling was profitable. Likewise, corn trading and chichacorn processing are also viable modules that capable stakeholders can engage in. On the other hand, the operations of multi-grain combine harvester and flat-bed dryers for corn drying were found to be viable under the 85% facility grant from the government. Investing and operating a multi-purpose pavement for sun drying and recirculating batch-type dryers for custom servicing was not financially viable as shown in previous studies even if cheaper biomass fuels are used.

Recommendations were forwarded such as: (1) minimal support of the government on technologies where operations for custom servicing is highly profitable such as custom shelling/threshing, custom milling, trading and chichacorn processing; (2) continue the provision of partial grants to technologies that could not be operated profitably but are needed to reduce losses and/or drudgery, however, operations should be monitored and/or controlled; (3) for the R&D units of PHilMech and other concerned agencies to localize the fabrication of machines to reduce price and to sustain and/or facilitate the conduct of skills training among technology users and/or service providers in the operation, repair and maintenance of machines and even the fabrication of simple facilities.



VALUE CHAIN ANALYSIS TOWARDS AN INTEGRATED BULK Handling System for Corn From Mindanao To Manila and Cebu

Gigi B. Calica and Nancy L. Eleria

2014

The study aimed to assess and formulate policies for an integrated bulk handling system for yellow corn grains from Mindanao to Manila and Cebu. Bulk handling is meant to address the problems on postproduction and marketing inefficiencies of the Philippine corn industry. The present practice is characterized by low adoption of modern technologies, high postharvest losses, and high transport and marketing costs as a result of inadequate market infrastructures. The government is promoting the adoption of bulk grain handling technology to reduce postproduction costs and losses. Using triangulation method of collecting data and employing value chain, financial and economic analyses, the study compared the traditional and the bulk handling system. The chain is better-off with the project however; multiple comparison tests of income indicated that farmer-clients/adopters were worse-off because of the non-inclusive of the social benefits. Reduction in postharvest losses with the project is significant as compared to traditional method. Feasibility study on bulk handling system showed good profitability with positive NPV and BCR of 2.28. The willingness of farmers to pay for bulk processing is Php 2.00/kg. A positive net present value and net social benefit (NSB) of Php 7, 047.71/ha signified that this government intervention is worthwhile.

Logistics regression odds ratio revealed a 0.373 and 0.774 increase in the probability of adoption as own capital increases and when farmers had other sources of income or occupation and as tenure and distance from the processing center increases. Moreover, income and distance contribute 16% and 2% of the total variability of technology adoption, respectively.

It is recommended that the government supports the farmers by strengthening its program on the access of credit with low interest rate, continue exploring potentials in the industry and link this program both to local and international markets, and aggressive promotion on the adoption of the project was recommended. A municipal ordinance on the use of standard moisture meter is also recommended. A patronage refund scheme for the farmers is proposed to implement by the processors to be assured of corn supply. Lastly, an appropriate design of a container van for the bulk handling system for corn grains is submitted for consideration and for future adoption.



DEVELOPMENT OF PRODUCTION AND POSTPRODUCTION MECHANIZATION SYSTEMS FOR SOYBEANS

Donald V. Mateo, Jenelyn A. Capito, Paul Kevin B. Lompero, and Romualdo C. Martinez

2014

Inventory, identification and evaluation of available machines for soybean production and postproduction operations were conducted in the areas where the crop was grown. Equipment for land preparation, mechanical weeder, soybean thresher, soybean cleaner/sorter, mechanical dryer and seed storage facility were identified. From the needs identified, soybean threshing, cleaning/sorting and drying were the technologies of immediate concerns that could address the farmers' needs. Testing and evaluation of different models and types of thresher were conducted on-site. These threshers were the multi-crop double drum flow-through, standard single drum throw-in for paddy, multi-crop single drum throw-in, multi-crop mini thresher and pedal operated thresher.

The most appropriate for soybean threshing was the double drum flow-through type where any variety of soybeans could be threshed where a threshing loss of 1.38 kg per hr was recorded. The multicrop thresher could also be used for varieties with fewer branches with a threshing loss recorded at 2.57 kg per hr. The standard paddy thresher was not recommended because of high losses (13.8 kg per hr) incurred. Pedal operated thresher was not practical to be used for its low capacity and inappropriate for soybean crop.

Cleaning and sorting of threshed soybean was also one of the most tedious and very slow process for the farmers. Traditional way of cleaning was the use of a piece of plywood, slightly slanted for the "good" grains to roll down. All impurities, broken and split seeds were left at the plywood. The process will take a whole day to clean four to five cavans or 230 kg to 300 kg of soybean per farmer per day. A soybean cleaner/grader/sorter was developed to solve the problem of the farmers and to get a good price for their produce. Results showed that the machine can clean, grade and sort soybeans at an average of 850 kg per hr, a very significant increase of 2,166% not only in cleaning but for grading and sorting as well.

ASSESSMENT OF OFF-SEASON ONION PRODUCTION UNDER PROTECTIVE STRUCTURES

Rodelio G. Idago, Renita SM. Dela Cruz, and Domingo R. Miranda

2014

The study intended to assess the viability of producing off-season onion using protective structure (PS). It provides alternative ways of addressing the supply gap during the lean months attributable to onion "s seasonality and limited storability. The use of PS was also an attempt to increase farmers productivity and to improve their coping mechanism amidst the challenges of varying and changing climate.

The PS was composed of protective cover using plastic and bamboo frames, raised beds and drainage canals. It was piloted in major onion producing provinces on-field at experimental scale of production. Off-season planting started on August and harvested in the months of November to December. Results suggested that off-season onion under PS is technically viable obtaining an average yield of 1.89 kg/m² or 1,890 kg for an effective area of 1,000 m². With this yield and actual farm gate price of Php 79/kg, against an investment cost of Php 55,250 it is financially viable. Likewise, it was economically viable if import price is greater than Php 41/kg if the government intends to substitute imported supply with locally produced onion through off-season planting.

The study also identified that direct seeded onions had shorter maturity period thereby reducing the crops exposure from the risk of inclement weather. For this reason, onion seeder will be necessary component of the mechanization support system along with small tractors that would facilitate land preparation activities such as making excellent raised beds and drainage canals.

While the use of protective structure appeared to be technically and financially viable, the study recognized that one major practical reason that would hamper adoption of PS is investment cost. Risk averse farmers would be reluctant to venture on off-season production. One possible scheme to pump prime the use of PS is for government to intervene by initially providing some of the materials such as UV treated plastic to lessen the direct cost from the farmers. This form in intervention is economically worthwhile since the societal cost can be offset by the benefit of having locally produced onion during lean months rather than resorting to importation.

With the challenges imposed by climate variability, not only for off-season but likewise for regular season, the application of PS is now becoming necessary to reduce economic losses brought about by changing climate.

ASSESSING THE LEVEL AND THE FACTORS DRIVING MECHANIZATION OF RICE AND CORN FARMS IN THE PHILIPPINES

Hernaiz G. Malanon

2013

Accurate and timely information provides important guide in policy formulation process and basis in crafting RD&E programs. To formulate effective and sustainable program for mechanization, an assessment on the status of agricultural mechanization is imperative. PHilMech, in collaboration with AMDP-IAE-CEAT-UPLB conducted this study to assess the level of agricultural mechanization of rice and corn farms in the country. This aims to address the lack of updated and relevant information on mechanization as the government is steadfast in its effort to accelerate mechanization as a means to increase productivity and farm income.

Employing one shot cross-section survey design, interview of rice and corn farmers was carried out in major production areas of the country. The survey covered 13 rice-producing provinces (1,235 rice farmers) and 13 corn-producing provinces (1,235 corn farmers).

Preliminary analysis of data from four provinces (Pangasinan, Isabela, Nueva Ecija and Kalinga) showed that rice farm operations such as planting, fertilizer application, dike repair/clearing and spraying were still done predominantly using manual power. Meanwhile, activities such as threshing, harrowing and plowing were already mechanized as 97%, 94% and 93% of the farms reported utilizing machines for threshing, plowing and harrowing operations, respectively. Accounting for the total area covered, 98%, 97% and 96% of the total area used mechanical power to do threshing, plowing and harrowing, respectively. Mechanized harvesting was practiced by 2% to 16% of the farms surveyed but it is gaining wider acceptability in Isabela and nearby provinces.

In terms of the level of farm power utilized, farmers in Pangasinan reported highest utilization levels while farms in Kalinga recorded lowest power utilization. Among the farm operations, threshing registered the highest power utilized, followed by plowing and harrowing. For the labor-intensive farm operations, harvesting exhibited the highest power usage while spraying recorded lowest power requirement.

Initial analysis revealed significant association between utilization and ownership of agricultural machinery and several factors that include socio-economic variables such as age of the farmer, educational attainment, number of available family labor, experience in rice farming, credit access; area of the farm; cropping intensity; land topography; type of ecosystem, presence of irrigation and ownership of draft animals.

DETERMINATION OF THE AVAILABLE POWER FOR UTILIZATION IN AGRICULTURAL MECHANIZATION

Renita SM. Dela Cruz and Sandy B. Bobier

2013

The study was able to establish the level and relative contribution of the different sources of farm power that are available for arable and permanent crop lands (temporary and permanent crops) as well as those for rice and corn. Based on the total arable and permanent crop lands, the level of farm power available as of 2011 was 1.23 hp/ha. The available power from human labor is 0.12 hp/ha while those from draught animals was 0.19 hp/ha. The bulk of the power is from mechanical power, contributing 0.92 hp/ha. Seventy percent of the total farm power is available for use in production operations while the remaining 30% is for postproduction operations.

The level of available farm power for rice and corn was 2.31 hp/ha. Again, mechanical power is the largest contributor to this level with 1.77 hp/ha. The power available from human labor was 0.15 hp/ ha while those from draught animals is 0.39 hp/ha. Based on the level of power found by Rodulfo et al. (1992), the level of power for rice and corn in 2011 had increased by 0.63 hp/ha over a period of 19 years.

Few recommendations are forwarded in relation to future updating of level of available farm power in agriculture: (1) the computation of the level of farm power should follow a standard procedure or bases to have fair comparisons of the data over time (e.g., efficiencies of machines, productive service life, population of human labor and draft animals, etc.); (2) data on agricultural machines should be regularly updated, preferably every 5 years, by the concerned unit of PHilMech or other agencies; (3) data bank of the presence of all agricultural machines should be established/ maintained by PHilMech for easy retrieval. Specific recommendations related to agricultural mechanization will be formulated a soon as all the needed information from other studies and projects are completed.

The findings will (1) serve as basis of evaluating future programs on agricultural mechanization and (2) serve as guide in planning future directions and strategies for sustainable agricultural mechanization.



SURVEY OF AGRICULTURAL MACHINERY MANUFACTURERS AND DISTRIBUTORS IN THE PHILIPPINES 2012

Ma. Cecilia R. Antolin, Joanne T. Ceynas, Renita SM. Dela Cruz , *Delfin C. Suministrado, *Darwin C. Aranguren, *Romulo E. Eusebio, and *Agnes Jan D. Jumamil

*Agricultural Machinery Testing and Evaluation Center, UPLB 2013

The Agricultural Machinery Testing and Evaluation Center (AMTEC) in collaboration with and with funding support from the Philippine Center for Postharvest Development and Mechanization (PHilMech) conducted a national survey involving the manufacturers and distributors of agricultural machinery PHilMech covered CAR and Regions I, II and III while AMTEC covered the rest of the regions in the country. The primary goal was to update the Agricultural Machinery Manufacturers and Distributors directory" published in 2001.

As in the previous directory, the companies' contact information, the after-sales services offered, and their product lines are shown under one cover. In this survey, AMTEC focused on manufacturers and distributors.

The actual number of respondents surveyed was 310. The highest number of respondents surveyed was in NCR with 41 (13.2 %), followed by Region VI with 34 (11.0%) and the lowest number of respondents was in CAR with only four respondents (1.29 %). Of the 310 respondents, there were 144 (45.6 %) manufacturers, 68 (21.9 %) manufacturer-dealers, 39 (12.9 %) dealers, 16 (5.16 %) manufacturer-distributor-dealers, 15 (4.84 %) distributor-dealers, 15 (4.84 %) manufacturer-distributors, and 13 (4.19 %) distributors.

The sizes of the enterprise were classified according to the following: small, medium, and large. Results showed that the most number of enterprise are medium with 165 (53.5%), followed by small with 133 (42.9%), and large with 12 (3.60%). There are only three regions with large enterprises. The NCR has most number of large enterprises followed by Region IX, Region VI, and Region V. The after-sales service by the respondents were analyzed and classified according to the following: none, low capability, partial capability, and full capability. Of the 310 respondents, 23 (7.42%) have no after-sales service, 201 (64.8%) have low capability, 71 (22.9%) have partial capability, and 15 (4.84%) have full capability.

The output of this work can serve as a reference to government and private agencies, and even individual entities that have plans of acquiring agricultural machines and equipment for a specific purpose or scope of operation. It can also serve as advertisement of the respondent manufacturers and distributors. In line with the objectives of the project, the directory provides an indicator of the industry's growth in terms of number of enterprises and its distribution, and the types of products available.





ENHANCING ENTREPRENEURIAL CAPABILITY OF POSTHARVEST AND MECHANIZATION ADOPTERS/ INVESTORS THROUGH THE PROVISION OF BUSINESS DEVELOPMENT SERVICE

Danilo M. Gamalog, Jhoanna Keith B. Santiago, Priscilla C. Castillo, Kristine M. Mercado, Helen F. Martinez, and Genaro M. Tolentino

2017

The project was conducted to enhance the entrepreneurial capabilities of men and women adopters/investors of PHilMech generated technologies and systems in managing techno-based enterprises through the provision of business development services (BDS). To attain this, the project determined the gaps/needs of new and existing PHilMech technology adopter/investors and developed their capacities in terms of technical, entrepreneurial and managerial skills in operating their businesses. The project also provided technical assistance to clients interested with the PHilMech technologies to facilitate better understanding on the benefits of using the technology.

The BDS project conducted a total of 38 batches of technology briefing/orientation, 19 batches of exposure visits to successful technology users, 18 batches of capability/skills training activities and 16 batches of harmonization meetings to 84 client groups/enterprises involving 1,394 women and 531 men from April 2014 to March 2017. Out of the 36 clients served during technical briefings, 17 groups proceeded with the adoption of the MCSTD technology while six clients acquired a number of cashew nut sheller and charcoal-fired oven as a component of the cashew processing system to accredited PHilMech technology manufacturer.

A follow through on-the-job coaching and mentoring to 12 PHilMech technology adopters that requested further assistance were done to guide them in establishing/sustaining and managing their technology-based enterprises. Results of the BDS project interventions revealed that four enterprises from incubation stage were able to reach start-up stage, namely; Parista, FARIC and VITIBOFA for MCSTD-based enterprises and SKCI for cashew processing enterprises. While the four enterprises that were identified at the start-up stage; namely the Canossians, Gabriela, LABS and RIC-Magsaysay, prior to the acquisition of the PHilMech technologies were observed to have improved business activities in terms of financial, technical, production operation, entrepreneurial skills in operating their enterprise after the interventions.

Enterprises that remained under the incubation stage (ASAA, VMPC, KABALIKAT Women, and PAFPA), require more coaching and mentoring through the provision of BDS in order to recover business operation/have official status in the market place and established their business operations. On the other hand, enterprises that reached the start-up level of growth must be further nurtured to sustain their business operations, serve as model enterprises and inspire interested and new technology adopters.

Meanwhile, the harmonization of efforts initiated by the project among government and nongovernment agencies supporting the enterprises helped a lot in guiding and directing progress of the enterprises assisted.

Hence, it is recommended that the BDS project should be institutionalized within the premise of postharvest and mechanization enterprise development. There is a need to augment financial and manpower support to the BDS project to address the increasing demand for technical assistance, coaching and mentoring of PHilMech technology adopters.



ESTABLISHMENT OF GIS-BASED DECISION SUPPORT SYSTEM For Postharvest development and mechanization

Kristina Luz B. Sebastian, Maria Criselda G. Halabaso, Genaro M. Tolentino, Grace O. Gaoiran, Jennifer E. Domingo, and Louie A. Gonzales

2016

For over 10 years, PHilMech (also known as BPRE and NAPHIRE) has gathered, processed, cleaned, 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 75 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 machinery 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 material and input 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 machinery and equipment).

Data were gathered in collaboration with Municipal and Provincial Agricultural Offices, 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 are now in full service and 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.



ENHANCING THE EXTENSION DELIVERY SYSTEM (EDS) ON POSTHARVEST AND MECHANIZATION THROUGH THE STATE Colleges and Universities (SCUS) and the technogabay program

Rodolfo P. Estigoy, Isis DC. Davalos, Phyllis C. Castro, and Ruben D. De Guzman

2016

This project aimed to improve clients' access to information and knowledge on postharvest and mechanization by enhancing the extension delivery system of state colleges and universities (SCU's) and the Techno-Gabay program. It is anchored on the Agricultural Knowledge and Information System framework that links rural people and institutions to promote mutual learning, and generate, share and utilize agriculture related technology, knowledge and information. It integrates farmers, agricultural educators, researchers and extensionists to harness knowledge and information from various sources for better farming and improved livelihoods.

The project focused on six pilot SCU collaborators which include the Benguet State University (BSU) and Don Mariano Marcos Memorial State University(DMMMSU) in Luzon; Aklan State University (ASU) in Visayas and the Misamis Oriental State College of Agriculture and Technology (MOSCAT), Central Mindanao University (CMU), University of Southeastern Philippines (USEP) in Mindanao.

The six pilot sites were profiled to determine their extension delivery system (EDS) resources as basis in planning the activities to be done in relation the project objectives and to determine the existing extension programs and projects where postharvest and mechanization concerns can be integrated. The profiling of the EDS resources and extension programs served as the basis for annual planning of the designated Postharvest and Mechanization Team of the SCU and PHilMech.

Immediate outputs of the project include the conduct of information, technology and training needs assessment workshop to determine the current status of these SCUs as regards their needs in postharvest and mechanization.

To realize the objectives of the project, postharvest and mechanization sections were integrated into the SCUs extension services where several clients have accessed the information from this section. Information, communication and education materials from PHilMech were regularly provided to these sections. A total of 702 clients availed of the IEC materials from the Postharvest and Mechanization Section at the extension services of the SCUs.

To create awareness and sustain interest from the different clients of the SCUs, school-on-the-air (SOA), techno-fora, exhibits, demonstrations, radio broadcasts, popularized IEC materials and e-learning were conducted.



For SOA, a total of 2,199 farmer producers, extension workers, rural women graduated from the courses aired through radio to include postharvest principles, systems and handling of corn, rice and high value crops. For techno-fora on postharvest and mechanization, a total of 2, 088 farmers, extension workers, rural women and students participated and were oriented on the latest information and technologies from PHilMech. There were also a total of 1,022 clients who attended technology demonstration conducted by PHilMech and the SCUs on postharvest and mechanization technologies.

There were also 120 radio broadcasts aired over the SCUs radio programs on latest R&D breakthroughs and information on postharvest and mechanization. A total of 1,014 copies of IEC materials on postharvest and mechanization were popularized or translated into the dialects by the SCU collaborators. Similarly, a total of 603 students, extension workers and faculty graduated from the e-learning courses which was offered under the auspices of the Agricultural Training Institute and were developed by PHilMech.

For the EDS of the Techno-Gabay Program, a total of 187 FITS Centers were given starter kits for their postharvest and mechanization section. Also a total of 751 FITS Centers received IEC materials from PHilMech on a quarterly basis.

Gleaning from the initial outputs of the project, the collaboration with pilot SCUs proved to be effective mode in improving clients' access to knowledge and information on postharvest and mechanization. It has created widespread awareness among industry clients and sustained their interest on postharvest and mechanization. However, there is still a need to conduct a summative evaluation to be able to determine the short-term outputs and long-term effects of the collaboration with SCUs.



PROFITABILITY ANALYSIS MODULES OF SELECTED MCSTD-BASED ENTERPRISES

Priscilla C. Castillo, Kristine M. Mercado, and Genaro M. Tolentino

2015

The project aimed to develop profitability analysis modules of selected viable Multi-Commodity Solar Tunnel Dryer (MCSTD)-based enterprises. The methodology included the review and evaluation of the results of previous studies of successful MCSTD adopters. Several scenarios/cases based on actual operation were reviewed and packaged to present the viability of putting up an MCSTD-based enterprise. Field validation was also conducted through key informant's interview to update old data or fill-in missing information. The first draft of the manual on the profitability modules will be subjected to critiquing before mass production.

The four successful MCSTD-based enterprises engaged in drying and processing agricultural products were considered in the analysis. These enterprises are located in the provinces of Nueva Ecija, Pampanga, Bulacan and Marinduque. Each enterprise is different from one another in terms of organizational structure and operations scheme.

The modules prepared for the selected MCSTD-based enterprises included the following data and information as follows: Module 1 is drying multi-commodity particularly fruits and vegetables in season using two units MCSTD and run by a group of rural women (4 regular, 3 daily and 12 on- call basis). The total investment cost was Php 1,265,000 with a net income for a year of about Php 450, 206.

Module 2 is drying four kinds of crops (leaves of basil and soursop, cherry tomatoes and hot pepper) and using one unit of MCSTD and tea bagger. This is being run by a family of four. There are two separate process flow of operations for dried crops processed into tea and other value- added product. The total investment cost of Module 2 is Php 810, 500 with an income of Php 169, 251.84.

Module 3 has three units of MCSTD but drying only one commodity –young tilapia. It is run by a couple but employed four regular staff and 12 workers. The total investment cost is Php 5, 988,423.44 which was loaned out from ACEF. In 2013 operations, this Module earned about Php 764, 105.

Module 4 has one unit MCSTD drying one major crop abundant in the place-bread fruit. It also processed 'tannia' or gabi tubers, cassava and mango chutney. The dried breadfruit, cassava and gabi tubers are further processed into flour and bakery products. This module is run by private enterprise composed of six regular staff and six contracted workers but technically managed by the academe.

All the modules are financially good wherein all the investments are paid in three years except Module 3 which will be paid more than eight years. The IRR ranged from 31-36% while the BCR ranged from Php 2.21 to Php 2.85 for Modules 1, 2 and 4 while Module 3 has an IRR of 4.13% a little bit higher for loan's interest and just Php 1.01 BCR. The result of different analyses of the four MCSTD-based enterprises revealed that the success of each Module depends largely on the volume of crops processed/dried and not on the number of MCSTD units.

The manual on Profitability Analysis Modules of Selected MCSTD-based enterprises can be used to: (1) serve as reference for business proposal, (2) tool for exhaustive evaluation of the technology appropriateness, (3) guide in setting-up a viable MCSTD-based enterprise, (4) guide of investor in the operation and management of business (5) decision factor of investor and (6) ready reference in the conduct of training.

ESTABLISHMENT OF MODERN INTEGRATED RICE PROCESSING COMPLEXES IN THE FOUR PROVINCES IN THE PHILIPPINES

Genaro M. Tolentino, Von Eliel B. Camaso, and Anna Margarita S. Galvez

2014

This project is a grant project from the Government of Korea through the Korea International Cooperation Agency (KOICA). It aimed to increase the income of farmers and rice processing capacity of the Philippines.

The project employed three innovative concepts which served as guide in project implementation. These include: (1) integration of closely sequential postharvest operations and using modern technologies in one building (Korea RPC Model), (2) employing a professional management team and (3) providing an initial operating capital.

The four RPCs were established and turned over to the Philippine Government through the Department of Agriculture (DA) by the Korean Government in September 2011, March 2012, December 2012 and July 2013 in Sta. Barbara, Pangasinan; Pototan, Iloilo; Pilar, Bohol; and Matanao, Davao del Sur, respectively. These were initially managed by trained professional management teams led by NABCOR with the guidance of the RPC Management Boards.

Initial benefits from the project include: (1) increased farmers' income by Php 0.50 to Php 1.00/ kg.; (2) increased milling recovery of at least 4%; (3) improved milled rice quality; (4) reduced postharvest losses (4 – 6%) of the processed volume; (5) generated employment for 33 professionals, 35 laborers and 12 on-call laborers and (6) increased processing capacity of 48,000 MT for drying, 24,000 MT for milling and 8,800 MT for storage.



THE ROLE OF THE SOCIAL LABORATORY IN ACCELERATING THE ESTABLISHMENT OF MCSTD-BASED ENTERPRISES

Priscilla C. Castillo, Danilo M. Gamalog, Helen F. Martinez, and Genaro M. Tolentino

2013

The project was conducted to establish the role of the social laboratory in accelerating the establishment of new Multi-Commodity Solar Tunnel Dryer (MCSTD)-based enterprises thereby improving the productivity and income of micro entrepreneurs engaged in the processing of dried agriculture and fishery products. To attain this, the project determined the social laboratory's concept, roles and resources needed to hasten the adoption of the MCSTD. Then coaching and mentoring of the new MCSTD adopters was made to strengthen their capacities in managing their business. Finally, the progress of the enterprise were determined in terms of technical, socio-economic, financial viability, and its contribution to the community.

The social laboratory was an effective techno-transfer strategy because it played a major role in the establishment of new MCSTD-based enterprises in the different regions of the country. About 15 new MCSTD-based enterprises were established. Three of the enterprises namely (1)Keno Foods Inc, of Bustos, Bulacan (2) Chef Duque of MSC, Marinduque and (3) Remzon Organic Products of Floridablanca, Pampanga were found to be technically, economically and financially viable. The use of MCSTD generated income for the three enterprises, facilitated the creation of new enterprise, introduced unique products in the market, increased demand for raw material, environmentally sound and generated employment for people in the community.

All three enterprises gained technological and financial support from other agencies and passed through the three learning stages before they finally adopted the technology. Results indicate the importance of the social laboratory in technology adoption/diffusion and postharvest enterprise development. Hence, PHilMech should also vigorously push for the establishment of social laboratories in other parts of the country (at least one social laboratory/ region) in order to widen the reach of access to the technology. It was also recommended that similar undertaking should be done so that other processors/prospective investors will benefit from postharvest entrepreneurship.





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ABOUT PHILMECH

The Philippine Center for Postharvest Development and Mechanization, known then as the National Postharvest Institute for Research and Extension (NAPHIRE), was created on May 24,1978 through Presidential Decree 1380 to spearhead the development of the country's postharvest industry.

As a subsidiary of the National Grains Authority in 1980, the agency's powers and functions were expanded in line with the conversion of NGA to the National Food Authority.

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

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

For years now, PHilMech is engaged in both postharvest research, development and extension activities. It has so far developed, extended and commercialized its research and development outputs to various stakeholders in the industry.

With Republic Act 8435 or Agriculture and Fishery Modernization Act (AFMA) of 1997, PHilMech takes the lead in providing more postharvest interventions to empower the agriculture, fishery and livestock sectors.

Pursuant to Executive Order 366 or the government's rationalization program in November 2009, BPRE became the Philippine Center for Postharvest Development and Mechanization (PHilMech) with twin mandates of postharvest development and mechanization.

Department of Agriculture Philippine Center for Postharvet Development and Mechanization (PHilMech)

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