

## ***COUNTRY REPORT: THE PHILIPPINES***

# **Strategic Approach to the Improvement of Agricultural Productivity Towards Food Security in the Philippines**

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*By*

*Rossana Marie C. Amongo<sup>1</sup>, Ph. D., Ma. Victoria L. Larona<sup>2</sup>, Ph. D.  
and Louie D. Amongo<sup>3</sup>*

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<sup>1</sup> Assistant Professor VI and Associate Dean, College of Engineering & Agro-industrial Technology, University of the Philippines Los Baños.

<sup>2</sup> University Research Associate II. Agricultural Mechanization Development Programme, Institute of Agricultural Engineering, College of Engineering & Agro-industrial Technology, University of the Philippines Los Baños.

<sup>3</sup> University Extension Associate II. Department of Development Broadcasting and Telecommunication, College of Development Communication, University of the Philippines Los Baños.

## **INTRODUCTION**

In an agricultural country like the Philippines, agricultural mechanization is essential to increase the land, labour and crop productivity. Mechanization of farm operations offers several advantages which include timeliness of operation, efficiency in performing farm operations, reduction in labour man-hours, and increasing land and labour productivity.

The government through the Department of Agriculture implements the Agricultural and Fisheries Modernization Act of 1997 (AFMA) with the overall goals of poverty alleviation and social equity; food security; rational use of resources; global competitiveness; sustainable development; people empowerment; and protection from unfair competition.

One of the provisions of AFMA to attain its goals is the formulation of medium- and long-term plans by the Department of Agriculture to address food security, poverty alleviation, social equity and income enhancement concerns. AFMA also gives priority to the development and promotion of appropriate agricultural machinery and other agricultural mechanization technologies to enhance agriculture and fishery mechanization in the country.

The Philippine National Institute to APCEM, the College of Engineering and Agro-Industrial Technology, University of the Philippines Los Baños through the Agricultural Mechanization Development Programme, Institute of Agricultural Engineering implements programmes for the development, promotion and popularization of agricultural mechanization technologies in the Philippines.

## **SOARING FOOD AND ENERGY PRICE AND THEIR CHALLENGES ON FOOD SECURITY AND SUSTAINABILITY IN THE PHILIPPINES**

The recent worldwide problem on food, energy and environment has led to different scenarios in the Philippines. This year, the price of rice has soared to its highest in 34 years, causing social and political unrest. Like other developing countries, the Philippines is not free from the ill effects of the surging prices of the staple food. According to Grenfell (April 2008), the Philippines was among the hardest hit in the rising prices of rice which caused an inflation rate from 2.6 percent in March 2007 to 6.4 percent in March 2008. The price of rice in the Philippine market soared to \$ 1.15 per kilo in March 2008 from as low as 50 cents few weeks earlier. This period also made most of the urban poor line up in the streets to buy rice. Thus, millions of Filipinos faced food insecurity and hunger.

To address this pressing problem, the government provided stop gap measures. One of which is the importation of rice from other countries like Viet Nam, Thailand and the United States amounting to 2.2 million tons. The government also imposed lower tariffs and doubled the import quotas to encourage more participation from the private importers (Grenfell, 2008). The Department of Agriculture has also implemented a rice conservation programme like cutting the consumption of rice in most fastfoods and restaurants. There was also a plan to improve the agriculture sector by launching the programme "FIELDS" meaning -- F for fertilizer, I for irrigation and infrastructure, E for extension and education, L for loans and insurance, D for

dryers and other post-harvest facilities, and S for seeds in the middle of the rice crisis. This is to give assistance to rice farmers and other stakeholders in the rice industry and billions of pesos were allotted for this emergency agricultural programme. The private sectors were also encouraged to practice corporate farming or to ensure that employees are given rice subsidies through planting of rice by the country's biggest corporations (Palatino, 2008).

However, some government officials were saying that the rice crisis was just an artificial phenomenon. They blame it to rice hoarders and smugglers for distorting rice inventories in the country. They believed that the Philippines is only experiencing a rice distribution crisis and that supply is stable. Many speculations came out because of the soaring price of rice. Some says that this is a political matter. Others say that it is a rice cartel scenario. Peasant groups on the other hand, believed that rice importation is the reason behind the worsening rice crisis and placing the country in greater food insecurity.

The 2<sup>nd</sup> and 3<sup>rd</sup> quarter of the year shows the peak price of rice and corn based from the data of the Bureau of Agricultural Statistics (2008) as shown in Table 1. The last quarter of 2008 gave a different picture of the rice industry. After the rice harvest season, the price of rice went down and became more stable. However, food security and sustainability specifically for rice is a far fetch reality to every Filipino. Figure 1 shows the variation of farm gate price of rice and corn while Figure 2 shows the market price of the two most important commodity in the Philippines.

Table 1. Comparative Monthly Average Farm Gate Price (FGP), Wholesale Price (WSP) and Retail Price (RP) of Palay, Rice and Corn from March to November 2008.

CEREALS	MONTHLY AVERAGE PRICES (Price/kg)								
	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV*
PALAY (FGP)	13.02	15.56	16	18.18	17.08	14.92	13.57	13.26	13.23
CORNGRAIN YELLOW (FGP)	10.84	11.04	10.74	11.04	10.79	10.51	10.45	10.84	11.28
CORNGRAIN WHITE (FGP)	11.55	13.09	13.81	14.85	13.12	11.97	12.02	12.4	12.52
WELL MILLED RICE (WSP)	25.6	30.18	31.38	35.98	35.3	33.1	30.66	29.84	28.97
WELL MILLED RICE (RP)	27.57	32.2	33.69	38.37	38.76	36.7	34.59	33.54	32.55
REGULAR MILLED RICE (WSP)	23.61	28.12	29.48	33.98	33.01	29.7	26.82	26.03	25.46
REGULAR MILLED RICE (RP)	25.26	29.8	31.3	35.78	35.51	32.82	30.01	28.78	28.15
CORNGRAIN, YELLOW (WSP)	13	13.25	13.26	13.42	13.34	13.14	12.35	12.88	13.01
CORNGRAIN, YELLOW (RP)	17.94	18.3	17.71	17.81	18.23	18.7	18.06	18.05	18.14
CORNGRAIN, WHITE (WSP)	12.63	13.57	14.24	14.86	14.6	12.68	13.72	14.87	14.67
CORNGRAIN, WHITE (RP)	15.59	16.42	16.57	18.06	19.32	17.13	17.5	18.12	18.36

Source: BAS, 2008.

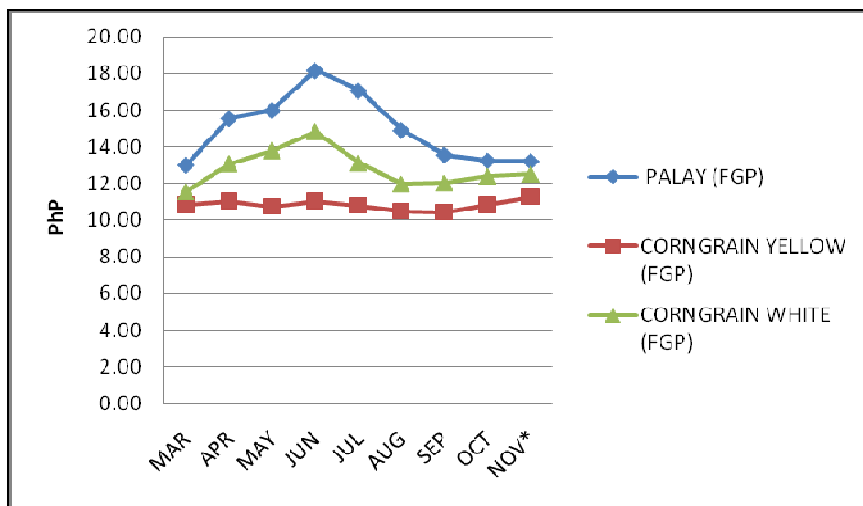


Figure 1. Farm gate price of rice and corn in the Philippines, Mar- Nov 2008.  
 Source: BAS, 2008.

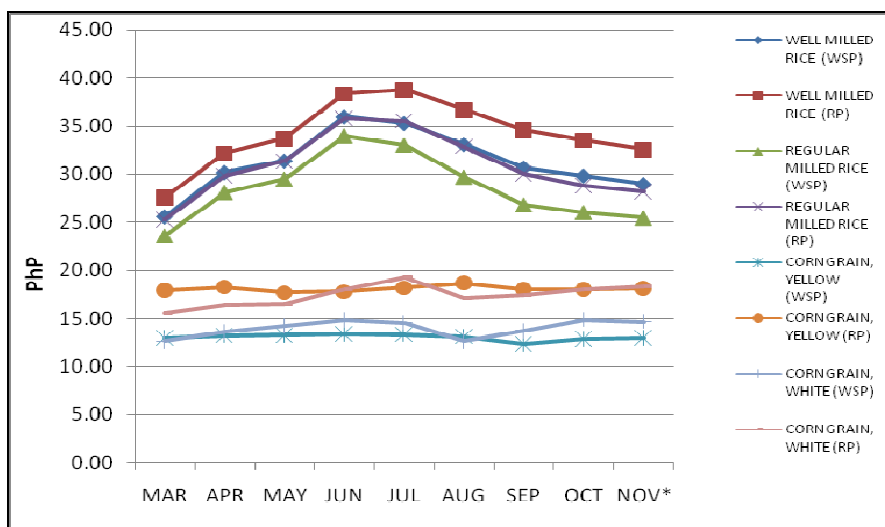


Figure 2. Wholesale and retail prices of rice and corn in the Philippines, Mar- Nov 2008.  
 Source: BAS, 2008.

In the energy sector, the spiraling fuel prices and the alleged inability of the government to regulate the price hike also caused social unrest. The government is trying to put much effort to limit the dependency of the country from importing fuels from other countries. The Philippines has limited oil and natural gas resources and, consequently, imports most of its energy needs. The energy consumption is dependent upon traditional hydrocarbon sources. In 2006, oil consumption at 35.25 per cent accounted for the majority of the country's primary energy supply mix followed by biomass (15.70 per cent), coal (13.49 per cent), hydro (6.28 per cent) and natural gas (6.42 per cent) as shown in Figure 3.

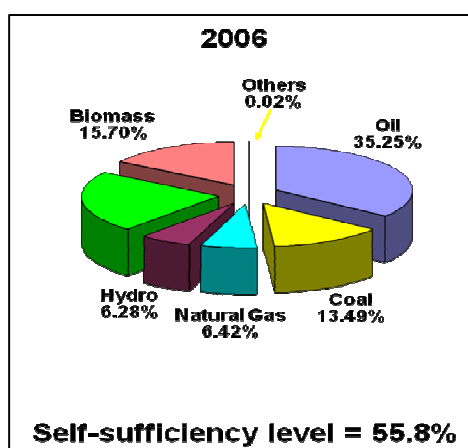


Figure 3. Primary energy supply mix, 2006.  
Source: Marasigan, 2008.

The level of self-sufficiency level was reported at 55.8 per cent. The Philippine Energy Plan in 2005, which is a major reform agenda of the present administration, was designed to move towards energy independence by first attaining a level of 60 percent self-sufficiency by 2010. Part of the strategy is to increase the country's oil and gas reserves by about 20 percent and to reduce coal imports by 20 percent. The development of biofuels, as mandated under the Biofuel Act of 2006, is also expected to have major contribution to the energy mix needed to eventually meet the goal of self-sufficiency (EIA, 2008).

In 2006, our energy supply is mostly consumed by the transport sector (62.55 per cent) and only about 3.02 per cent is used by the agricultural sector as shown in Figure 4. However, the effect of price increase of oil trickles down to the food supply chain. Since most of the agricultural products are distributed all over the country using the different modes of transportation that utilizes oil, the effect of price increase are usually pass on to the different agricultural products in the market.

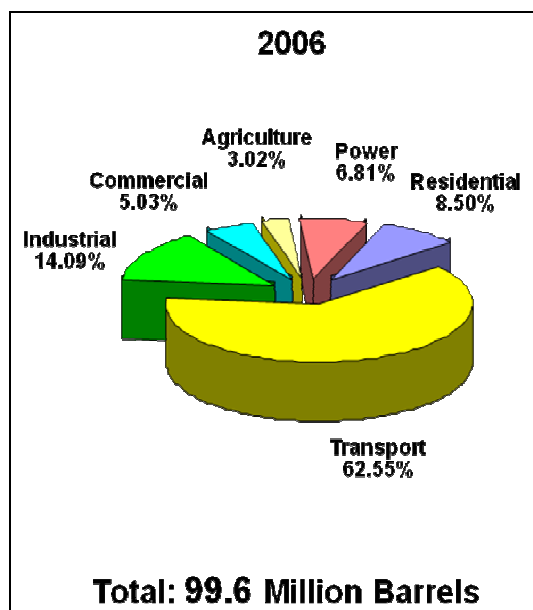


Figure 4. Sectoral Oil Consumption, 2006

Source: Marasigan, 2008.

The recent rice crisis coincides when the price of crude oil in the world market was at its peak which is in the month of July 2008 as shown in Figure 5. At that time, the price of oil in the local market soared to a nine-year high. Because of our dependency to oil, the Philippines is one of the hardest hit among oil-consuming countries in the region. Although the Philippines is one of the few countries where oil consumption has been declining in the last decade. Figure 6 shows the oil production and consumption of the country in the last decade.

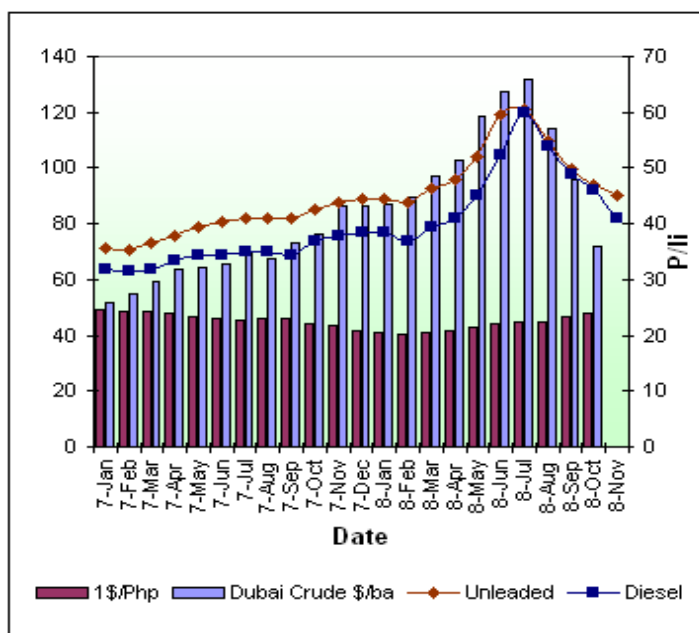


Figure 5. Average Philippine gasoline prices 2007-2008.

Source: <http://www.alternative.com/biofuel/2008/05/15>.

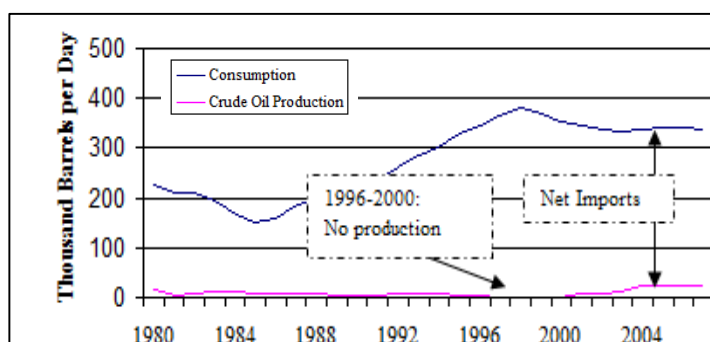


Figure 6. Oil production and consumption in the Philippines, 1998-2007.  
 Source: EIA, 2008. (\*2007 figures are estimates).

The government came up with different solutions to address our dependency to oil and to stabilize the prices thru its line agency, the Department of Energy. DOE has two major agenda under the present administration as presented in their energy plan framework. One is energy independence and savings which they targeted 60 per cent self-sufficiency level by 2010 and the other is power market reforms whose goal is to have a fair and reasonable energy prices in a competitive environment (Marasigan, 2008). To achieve these goals, the DOE has undertaken the following activities:

- Enhancing Energy Security by aggressive exploration and development of indigenous energy resources from fossil fuel and renewable energy.
- Increased use of alternative fuels
- Strengthened energy efficiency and conservation programme
- Implementing energy sector reforms in the power sector by expanding rural electrification and moving towards open access of power; downstreaming the oil dependency from other countries and exploring more sources of oil and natural gas in the country.

## **IMPACTS OF GLOBAL CLIMATE CHANGE ON AGRICULTURAL PRODUCTION AND CHALLENGES FOR AGRICULTURAL TECHNOLOGY AND FOOD SECURITY IN THE PHILIPPINES**

The world is facing a global crisis—climate change.

In 2007, the United Nation-organized Intergovernmental Panel on Climate Change (IPCC), the foremost scientific authority on the issue stated in its report that there are new and stronger evidence that most of the warming observed over the last 50 years is attributed to anthropogenic activities. These increased greenhouse gas concentrations are attributed to fossil-fuel use, land use change and agriculture.

According to the IPCC, global rise in temperature for the last 100 years rose between 10 to 20 centimeters. It further predicted that the 21st century sea level would rise between 9 to 88 cm.

The IPCC further added that 11 of the last 12 years (1995-2006) ranked among the warmest years that were recorded. This was seconded by the World Meteorological Organization revealing that 2005 was the warmest on record.

Manifestations of such warming include the widespread thinning of glaciers and decrease in snow cover, changes in heat and chemical composition of oceans, sea level rise and extreme weather events such as heavy precipitation and tropical cyclones. These climatic patterns have significant impacts on agriculture and food production.

### *The Philippine scenario*

The Philippines, which is already considered a biodiversity hotspot is also a climate hotspot. According to Dr. Leoncio Amadore (2007), although it cannot be conclusively proven that a single event, was or was not, affected by global warming, current scientific evidence strongly suggests that hurricanes and typhoons tend to become more destructive as ocean temperatures rise. Extreme weather events that our country has experienced recently “have one thing in common – persistent torrential rains, causing landslides and flash floods, killing people and destroying properties and the environment along its path.”

A one meter rise in sea level, for example would significantly devastate major provinces in the Philippines (Table 2).

Amadore further added that from 1975 to 2002 intensifying tropical cyclones caused an annual average damage to property of Php4.5 billion (around US\$90 million), including damage to agriculture amounting to Php3 billion (around US\$ 60 million).

The National Disaster Coordinating Council (NDCC) reported that typhoons that hit the Philippines in 2006 affected at least 11 million Filipinos and inflicted damage to agriculture and infrastructure amounting to almost Php20 billion (around US\$400 million). This excludes the Php500 million worth of assistance and donations (2006) and the Php10 billion that was allocated by the Philippine government in the 2007 national budget to rehabilitate direct-hit areas.

Another major anomaly brought about by warming is drought, where lands planted to rice are directly affected. In fact, the 12-year study on rice yields conducted by Peng and Cassman (2004) revealed that a one-degree Centigrade increase in overall daytime temperature would decrease yields by 15 percent. They found out that since 1979, temperatures at the International Rice Research Institute (IRRI) were increasing fastest at night. During the day, temperatures were up at an average of .35 degrees Centigrade. Nighttime temperatures are three times higher at 1.1 degrees Centigrade. Cassman noted that these increases are similar to those “found elsewhere in the Philippines and globally.” He further added that the increases are “two times greater than previous indirect estimates of the effects of global warming on rice yields” done by computer models.”



Table 2. Top 20 Provinces in the Philippines which are vulnerable to a one meter rise in sea level (Greenpeace, 2007).

RANK	Province	Region	Area vulnerable to a 1 meter sea level rise (in square meters)
1	Sulu	ARMM	79,728,300
2	Palawan	Region 4B	64,281,600
3	Zamboanga del Sur	Region 9	37,818,900
4	Northern Samar	Region 8	33,882,300
5	Zamboang Sibugay	Region 9	32,740,200
6	Basilan	ARMM	30,294,000
7	Cebu	Region 7	27,888,300
8	Davao	Region 11	27,005,400
9	Bohol	Region 7	23,895,000
10	Camarines Sur	Region 5	22,680,000
11	Quezon	Region 3	21,124,800
12	Tawi-Tawi	ARMM	17,390,720
13	Masbate	Region 5	14,256,000
14	Negros Occidental	Region 6	13,996,800
15	Camarines Norte	Region 5	13,591,800
16	Capiz	Region 6	10,748,700
17	Catanduanes	Region 5	10,643,400
18	Samar	Region 8	10,635,300
19	Zamboanga del Norte	Region 9	10,570,500
20	Maguindanao	ARMM	9,169,200

For a country where the adaptive capacity of human systems is low and vulnerability is high due to its geographical features, low economic development and exposure aggravated by poor access to resources, the Philippine government must take major steps to curb the rising global greenhouse gases and initialize the development of mechanisms to sustain the agriculture sector.

1. Cut down fossil fuel consumption and instigate massive uptake of renewable energy combined with aggressive energy-efficiency measures;
2. Develop sustainable resource (food, water, etc.) management and distribution;
3. Promote the development and use of RE-based agro-industrial technologies and crop varieties that are more resistant to drought and flood;
4. Develop a comprehensive land-use and coastal development plan that integrates risk reduction;
5. Integrate climate change into the national, regional and local development planning process (Habito, 2006).

Jabines and Inventor (2007) stated that a proactive approach and strong political will is paramount in reducing the country's dependence on fossil fuels, particularly coal, as its energy source and embrace renewable energy and energy efficiency to cut carbon dioxide emissions by as much as 30 per cent by 2050. Thus, they suggested several mitigating actions:

- The government must stop the construction of new coal-fired power plants and phase out the existing ones;
- The government must pursue demand-side management and establish stringent standards for all energy-consuming appliances, buildings and vehicles. This can result in energy savings of as much as 30 per cent;
- Lastly, the government must eliminate all direct and indirect subsidies to fossil fuels to create a level playing field for new renewable energy players.

## **AGRICULTURAL TECHNOLOGIES FOR FOOD SECURITY AND AGRICULTURAL SUSTAINABILITY**

### **Summary of the R&D activities of the Philippine National Institute to APCAEM related to agricultural technology for food security and agricultural sustainability**

The research thrust of AMDP-IAE-CEAT focuses on corn mechanization, vegetable production machinery, primary processing machines for *Jatropha curcas*, bio-mass furnace, liquid-fuel burners and coconut particle dryer. For the year, AMDP continued its function as the research and extension arm of the IAE-CEAT, UPLB. R&D activities focused on core and faculty-based projects which implemented researches on corn mechanization, vegetable production machinery, primary processing machines for *Jatropha curcas*, bio-mass furnace, liquid-fuel burners and coconut particle dryer. The faculty-based projects which were within the thrusts and directions of the programme, complemented the AMDP R&D activities

The core projects were: Design and Development of a Multi-crop Pneumatic Seeder with Fertilizer Applicator; Development of a Burner for Crude *Jatropha curcas* Oil and Other Liquid Fuels, Development of Corn Sheller for High-Moisture Shelling, Development and Introduction of Appropriate Mechanization Technology for Local Vegetable Production; Design and Development of Pneumatic Dryer for Agricultural By-Products, and Development of Oil Expeller for *Jatropha curcas* seeds.

The faculty-based projects included: Anthropometric Survey of Farmers in the Calabarzon area, Development of Rice Hull/Corn Cob Furnace for Non-Power Applications, Design and Development of Corn Harvester, Mechanization of Heat Treatment of Carabao Mango for Quarantine Disinfestation and Disease Control, Evaluation of the Sustainability of a Drip Irrigation System and its Potential in Increasing the Level of Mechanization in a Corn-Based Farm, and Development of a Gravity-Driven Tramline for Hauling of Highland Tomato Other projects included: Process Development for the production of Biodiesel from *Jatropha curcas* oil with studies on a) Solvent Esterification Process from Crude *Jatropha curcas* Oil, and b) Solvent Extraction of Crude Oil from *Jatropha curcas* Seeds, c) By-product Separation of Glycerol Layer from Esterification of *Jatropha curcas* oil, and (d) Development of Treatment Processes for Wastes Generated during the Production of Methyl Ester from *Jatropha curcas* oil and Design and Installation of a Micro-hydro Generator.

The Training, Extension and Information Communication Section implemented three (3) major activities. These included the activities on: Introduction of Appropriate Mechanization Technologies in Cebu Province, Publication of printed materials for information dissemination of agricultural mechanization, and Promotion of AMDP developed agricultural mechanization technologies.

A collaborative research proposal with the Farmer Scientist Training Programme (FSTP) was submitted to BAR for funding. Related to this, the FSTP has been declared a national programme through the signing of EO 107. This would mean that AMDP would also be part of the FSTP programmes since they had acknowledged that agricultural mechanization is a necessary ingredient for progressive farming. The AMDP team also conducted monitoring activities to determine machine utilization and status of project in Cebu and visited DA-APC of Bohol to finalize request for a manufacturing training on AMDP planters.

In terms of publication activities, AMDP was able to complete five (5) publications in 2008. These are: the Philippine Journal for Agricultural and Bio-Systems Engineering (PJABE) 2007, PJABE 2008, the Philippine Agricultural Mechanization Bulletin (January to June 2007), the Philippine Agricultural Mechanization Journal (July to December 2007), and the Proceedings of the National Corn Mechanization Conference (February 2007). Articles for the 7<sup>th</sup> issue are being evaluated by referees for possible publication in early 2009. The Philippine Agricultural Mechanization Bulletin was renamed as the Philippine Agricultural Mechanization Journal in its July to December 2007 to highlight its nature as a non-refereed publication.

For the promotion of AMDP developed agricultural mechanization technologies, the Extension Group maintained a machinery display area for its client and other walk-in visitors; participated in agricultural machinery exhibits; prepared different types of working drawings of agricultural machines; and provided expert services to interested clients. Interested clients were briefed with the on-going research and extension activities of the Programme. Clients visited AMDP for varied purpose such as technical expert service or assistance, tour of the AMDP mechanization display area, use of reading and inquiry on AMDP technologies. Technical drawings were also given to local agricultural machinery fabricators.

AMDP is providing technical support to the Institute of Agricultural Engineering which currently serves as the secretariat to the Philippine Rice Postproduction Consortium (PRPC). U.P. Los Banos is the lead agency to PRPC which is composed of 5-member government-agencies and the International Rice Research Institute as collaborating agency. PRPC is an alliance of primary institutions in the Philippines concerned with rice postproduction research and extension to address numerous problems of the grains industry.

The AMDP R&D and Extension activities are being supported by logistic and administrative services through the General Services Section and Administrative Support Section, respectively.

#### R&D Activities (Core Projects)

*Design and Development of a Multi-crop Pneumatic Seeder with Fertilizer Applicator*

The general objective of the project with is to: design and develop a pneumatic seed planter suitable for corn and other row crops with fertilizer applicator for local manufacture.

AMDP has developed a multi-crop pneumatic seeder for fertilizer applicator. The prototype has undergone laboratory and field tests to evaluate its performance. Collaboration with local manufacturer is being established to commercialize and improve prototype.

#### *Development of a Burner for Jatropha curcas Oil and other Liquid Fuels*

AMDP-IAE is currently involved in the development of a burner for *Jatropha curcas* oil and other liquid fuels in support of government and private agencies' ongoing concern for the utilization of fuels from renewable energy sources. It aims to: develop a burner for crude *Jatropha curcas* oil and other liquid fuels; test and evaluate the prototype; and develop a furnace using the burner as heat source

The burner is very easy to fabricate. Preliminary tests on the burner prototype, were done using kerosene, diesel, coconut oil and jatropha oil as fuel. Ignition was easy and do not require pre-heating in the case of the coconut oil and jatropha oil. Combustion was sustained as long as the fuel is fed continuously to the burner. AutoCAD design and detailed working drawings of the burner were already completed

Fabrication of the furnace for heating the water for the mango hot water tank treatment was completed. The furnace can accommodate two burners and will use a calandria-type vessel for heating.

#### *Design and Development of Corn Sheller for High Moisture Shelling*

A sheller for high moisture shelling was conceptualized at AMDP as a component for an integrated feed milling system important for the production of feeds for the livestock industry. The general objective is to design and develop a corn sheller suitable for shelling high moisture corn. It specifically, the project aims to design and develop shelling components that will enable the shelling of high moisture corn with minimal damage and to determine the moisture content range where the sheller will work suitably

Fabrication of the shelling assembly was completed. The shelling assembly was mounted onto the cleaning assembly of the two-drum sheller to conduct preliminary tests. The testing aims to determine effectiveness of shelling using newly harvested corn. Tests are currently being done to generate data on shelling capacity, shelling efficiency and percentage of grain damage for high moisture corn samples.

#### *Development and Introduction of Appropriate Mechanization Technology for Local Vegetable Production*

High value commercial crops (HVCC) provide significant contribution to the economy. In support to the government's thrust to improve the HVCC sector, AMDP conducts R&D project

on the development of farm technologies. The objective of the project is to sustain HVCC production and improve the farming and socio-economic conditions of vegetable farmers through the development and introduction of appropriate mechanization technology. It specifically aims to assess the present vegetable farming practices; design and develop identified technology needs; package these developed technology including those already developed; and pilot test these technology in different sites.

Significant accomplishments of the project in the past 2 years were the completion of the prototypes for power weeder/tiller; mini-hand tractor, garden rotavator and radish seeder; and fabrication of a plow attachment.

### Vegetable washer

A vegetable washer (Figure 7), which can be operated manually or by using a small engine or motor, was designed and developed. The washer is applicable for cleaning and washing vegetables like radish, carrots, ginger and root crops (e.g. cassava or sweet potato). The machine was tested using cassava. Results of the preliminary testing showed that the machine can clean around 20 kilos of cassava in one loading. The machine was operated manually.



Figure 7. Vegetable washer.

### Root crop slicer

The cutting mechanism of the existing UPLB root crop slicer was modified in order to cut rectangular slices to facilitate the drying of the cut materials.



Figure 8. The modified UPLB root crop slicer.

#### Biomass-fed soil sterilizer

A soil sterilizing machine (Figure 9), composed of an enclosed cylindrical heating chamber was fabricated and evaluated. Using the machine resulted to a much faster sterilization time and reduced the fuel consumption by almost half when compared to the traditional method of using a cooking vat. Results from the soil microbial analysis showed that the developed machine is comparable with the traditional method of soil sterilization. Further test and evaluation will be done for the machine.



Figure 9. The fabricated soil sterilizing machine

#### Sprayer

A plunger-type sprayer was fabricated in collaboration with the School of Environmental Science and Management (SESAM). SESAM will be using the machine in extinguishing grass

fires in forested areas while AMDP will be testing the unit for mango. An ordinary garden hose nozzle was used in which the discharge rate as well as the throw distance can be varied. Two prototypes were fabricated, one was made of brass and the other was made of ordinary PVC pipes (Figure 10).



Figure 10. The fabricated sprayer

#### *Design and development of pneumatic dryer for coconut particles*

The objectives of the project are to test the fabricated pneumatic dryer and design a heating system that will utilize heat from the carbonization of biomass. The pneumatic dryer is a semi-open system where part of the exhaust air is recirculated by a fan mounted on top of the drying chamber. The fan is of centrifugal type and its flow is controlled by the rpm of its shaft. The air is heated as it passes through a 6 spiral-type electric resistance heaters having a maximum heating capacity of 6.81 KW. Each heater is provided with a switch to manually control the drying air temperature. The particulates are feed at constant rate into the lower part of the dryer by a screw auger. The particulates are carried upward by the flowing hot air stream. The hot air stream causes the particulates to be suspended and ultimately carried them along and dried at the same time. The drying section is alternately made of stainless steel cylinders having varying sizes. The total length of the dryer is 412 cm. A cyclone is provided at the discharge end of the dryer to serve as collector of the dried product.

Tests were conducted to determine the drying rate and capacity using coconut meat “sapal” as feedstock, 92 °C drying air temperature and 59 per cent initial moisture content.

A retort type biomass carbonizing set up was designed to recover the heat to be used for the dryer. The retort type uses external heat sources to “cook” organic matter contained in a closed but vented airless chamber (retort). This is usually carried out in a metal or masonry chamber (furnace). The indirect method results in a higher yield of high quality charcoal with less smoke and pollutants and requires less skill and attention than the direct method. This method is compatible with heat recovery and waste utilization system.

#### *Design and Development of Oil Expeller for Jatropha curcas seeds*

With the on-going concern to develop technologies for the production of bio-fuels from renewable resources, AMDP embarked on a project for the design and development of oil

expeller from *Jatropha curcas seed*. The objectives of the project are to test and evaluate the UPLB coconut oil expeller using *Jatropha curcas* seeds as feedstock, and to determine its optimum operating conditions

The test and evaluation were conducted to determine the extraction rate, efficiency and costs of operating 1,000 liters per day plant. The machine performance was evaluated in terms of the following operating conditions: crushed and whole seeds; hulled and dehulled seeds; moisture content of the feedstock; and rotational speed of the expeller screw.

The capacity of the expeller in terms of input capacity ranged from 30 to 80 kg seed per hour. The wide range of the input capacity was significantly affected by the conditions of the seed and the operating conditions of the machine. Initial results showed that extraction efficiency of the expeller was affected by the operating conditions. Also, test results suggested that: (1) crushed seed yielded more oil than whole seeds; (2) oil recovery was higher at higher MC but not to exceed 12 per cent; (3) input capacity was high at faster screw speed but low in extraction efficiency and power input; (4) the expeller worked best when the hull content of the feedstock ranged from 40 to 80 per cent.; (5) the feedstock should be passed through the expeller at least twice to maximize oil recovery; and (6) mechanical extraction cost ranged from P 6.58 to P 7.30 per liter.

#### R&D Activities (Faculty-based Projects)

##### *Anthropometric Survey of Farmers for Agricultural Machinery Design in the Province of Laguna*

The primary objective of this project is to develop an anthropometric profile of farmers in the CALABARZON area. Specifically, it aims to: (1) collect and measure identified body measurements of farmers; (2) database the collected information; (3) determine the level of inter-individual differences of the farmers in terms of body statistics; and (4) determine the differences of body statistics in terms of gender.

The project focuses on the identification, measurement and collection of data on the size of the body and its components. It considers only the male farmers in the province of Laguna; and develop DBMS in order to facilitate easy encoding, storage and retrieval of data.

Agricultural machines and equipment intended for the Filipino farmers should be adapted to the physical stature of the user. However, there is no anthropometric data available for reference. The collection of anthropometric data of our farmers has already been completed for the male farmers in Laguna province. There is a need to do a similar activity for other parts of the country to assist the engineers to properly design machine and equipment. The project expects to provide the following outputs: anthropometric profile of farm operators (male and female) in the CALABARZON area; database of the anthropometric data; and written report. The project will be composed of four studies as follows:

Study 1: Anthropometry of male agricultural workers in the CALABARZON area

Study 2: Anthropometry of female agricultural workers in the CALABARZON area



Study 3: Determination of the level of inter-individual anthropometric differences of farmers in the CALABARZON area

Study 4: Database development

The survey tools and construction of materials and equipment to be used for measurements were completed. The sampling and sample size had already been identified

Collection of body measurements of farmers is about 40 per cent complete, while database development and data encoding is 75 per cent complete.

#### *Rice Hull/Corn Cob Furnace for Non-Power Applications*

This project is anchored on the efforts to harness renewable energy for agricultural and food processing operations. It shall attempt to develop technologies that use biomass fuels for drying agricultural and food products and emit combustion products within the limits for sustainable and clean environment. It specifically aims to design and develop rice hull furnace for recirculating and small capacity crop dryers; incorporate accessories for automatic control operations; test and evaluate performance for efficiency and clean air production; and postulate recommendations for adoption by farmers, processors, and cooperatives.

A prototype furnace had been fabricated based on the initial design concepts initially intended as rice furnace for crop drying applications that shall burn biomass fuels at high efficiency and less emission of combustion products to protect the environment. The furnace was made of low cost materials consisting of cement, volcanic cinder, sand, and gravel framed by mild steel framings. Figure 11 shows the fabricated unit of the furnace.



Figure 11. Fabricated rice-corn hull furnace

Preliminary tests had been conducted to ascertain the design parameters (fuel feeding rate, airflow rate, moisture content of fuels, etc). Results showed that the feeding rate ranged from 60 to 90 kg/hr excessively higher from the design-feeding rate; the speed was reduced further by installing a lower rpm range variable motor that resulted in feeding rate of 40 to 75 kg/hr.

#### *Design and development of a corn harvester*

The general objective of the study is to design and develop a low-cost corn harvester combine. Specifically, it aims to design a harvester with components for shelling, picking, shredding, and bagging; design a self-propelled harvester; and fabricate and field test the equipment in a farmers' field.

A corn production area in Bukidnon was visited to confer with BPRE staff about the development of a corn harvester. The team also gathered information on the Penha corn harvester and the agricultural mechanization activities of the Central Mindanao University.

Concept drawings were also made for the different components of the harvester. Fabrication of components is currently on-going.

#### *Mechanization of Heat Treatment of 'Carabao' Mango for Quarantine Disinfestation and Disease Control*

To develop a mechanized heat treatment of "Carabao" mango for quarantine disinfection and disease control. It specifically aims to develop a mathematical model of the temperature distribution in 'Carabao' mango fruit during heat treatment; and develop a mechanized system for heat treatment of 'Carabao' mango against postharvest diseases and/or insect pests.

In collaboration with another ongoing AMDP project ("Development of a Burner for *Jatropha curcas* Oil and other Liquid Fuels"), a calandria-type furnace is being tested for use as a source of hot water during treatment of mango. The furnace has a stainless steel vessel to be used for heating water to 90°C. To minimize heat loss and increase surface area for heat transfer, a refractory cement jacket is being fabricated to surround the water vessel completely.

A prototype hot water tank with a capacity of about 450 kg (20 crates of fruit) has been fabricated (Figure 12). The tank has a dipping compartment for treating fruit and a smaller mixing chamber where hot water from the furnace is mixed with the relatively cooler water of the tank. The mixing chamber is necessary to avoid scalding the fruit. Forced circulation of water through the stack of plastic crates is achieved through a false floor supporting the crates. Water from the mixing chamber is pumped under the false floor; pressure forces water through the perforated bottoms of the plastic crates.



Figure 12 . Hot water tank system

At present, a design for a hot water tank with an 8-crate batch capacity developed by the PHTRC of the College of Agriculture, UPLB is used by several exporters and processors. In collaboration with the PHTRC, the heating system of the tank was modified at the CEAT farm shop to increase heating rate. Return channels were attached to a U-shaped metal GI sheet trough acting as a water vessel for heating; the GI sheet was later replaced with a stainless steel unit for corrosion resistance. The space around the vessel was sealed with removable panels fabricated from castable refractory cement encased in a mild steel frame. LPG burners directly heated the bottom of the vessel, while hot flue gas accumulated in the surrounding space before escaping through a chimney on top of the heating compartment. Initial tests showed that this modification increased heating rate from  $446 \text{ kJ min}^{-1}$  to  $1,238 \text{ kJ min}^{-1}$ . This represented a 2.8-fold increase from the original heating rate. Estimated thermal efficiency (ratio of heat absorbed by water to heat produced by fuel combustion) of the original design was about 12 per cent; with the new design, the latest trials have shown an efficiency of 34 per cent. Temperature of water from the heating compartment of the modified tank was  $6.6^\circ\text{C}$  higher than the dipping compartment at the discharge pipe. However, water temperature in the dipping compartment remained uniform and within the required range of  $52\text{-}55^\circ\text{C}$ . Time to heat water from  $30^\circ\text{C}$  to  $55^\circ\text{C}$  was about 74 min, with a temperature change of  $0.35^\circ\text{C min}^{-1}$ .

Preliminary data on pulp temperature of mango during dipping in hot water at  $48^\circ\text{C}$  has been gathered. This will be used for initial attempts at modeling the distribution of pulp temperature during treatment. This will allow researchers to optimize treatments to reduce heating time and avoid heat injury.

#### *Development of a Gravity-Driven Tramline for Hauling of Highland Tomato*

The objectives of the study is to develop a prototype gravity-driven tramline, and to evaluate the performance of the prototype tramline

Fabrication of some major components such as the cable drums has been completed. Procurement of components continues to be the main factor in delaying completion of the project. Preliminary testing will be conducted at the grounds of AMDP/ABPROD, pending installation of temporary towers to serve as stations of the tramline.

Modifications were incorporated into the system based from the previous tests conducted.

#### *Evaluation of the sustainability of a drip irrigation system and its potential in increasing the level of mechanization in a corn-based farm in Kay-anlog, Calamba City, Philippines*

Theoretically, high cropping intensity and crop diversification may significantly influence decisions of farmers to acquire or rent farm mechanization and post-harvest technologies. There is a need, however, to generate local field baseline data to support or qualify the above assumptions and as evidence for advocacy and policy formulation purposes.

In areas of with long period of dry season, the best way to increase cropping intensity is through irrigation. It is assumed, however, that the irrigation system is technically sound, economically viable and sustainable. Among irrigation methods, drip or trickle irrigation is the most efficient in terms of water usage. Due largely to its high-investment requirement, its use is mainly limited to export-oriented farms, cut-flower production, building landscape, and high value crop production.

There exist in Barangay Kay-anlog of Calamba City, a 4-hectare corn-base farm with a drip-irrigated portion (about 2,000 m<sup>2</sup> ) being planted with high value crops such as ampalaya. During the field visit last January, 2007, about one third (1/3) of the farm is planted with other cash crops specifically squash and onion. The farm, owned and managed by Mr. Renato Alcantara, is generally rainfed but an existing deep well serves as the water source for the drip irrigation, backyard piggery and domestic uses.

Initial information indicates that within the contiguous areas of Barangays Kay-anlog, Ulango, and Punta with an aggregate area of about 800 hectares (see relative location in the attached Figure 13), there are only two farmers with deep well and it is only Mr. Alcantara who has a drip irrigation system, a four-wheel tractor, and a van. It is not surprising then to know that he has just been bestowed the model farmer of Laguna for year 2007.

That the drip irrigation has contributed significantly in the acquisition of Mr. Alcantara's tractor and van has to be analyzed and field-validated. Evaluating the sustainability of such irrigation system and its potential in influencing the farmer to further diversify and acquire processing machines is a step toward exploring the feasibility of transforming the Kay-anlog-Punta-Ulango Community into an agro-industrialized zone within 5 to 10 years.

The objectives of the project is to test under local field conditions the hypothesis that under favorable market environment, a technically sound and economically viable irrigation system will influence the decision of the farmer to acquire or avail farm mechanization and post-harvest technologies. Specifically, it intends to determine the technical and economic feasibility of the existing drip-irrigation system of a cooperator in a project site in Kay-anlog, Calamba City; determine if the drip irrigation system has contributed significantly to the decision of Mr. Alcantara in acquiring his existing farm machines; and to assess the feasibility of an expanded and sustained drip irrigation in convincing the farmer to acquire or rent more farm machines such as post-harvest processing equipment.

**Study 1.** Performance and operation and maintenance practices of the drip irrigation system of Mr. Renato Alcantara in Kay-anlog, Calamba City

While the farmer's verbal claim and record indicate that he been earning much from his drip-irrigated Bitter Gourd (locally called "*ampalaya*"), his actual maximum yield of four (4) fruits per plant during the study is still much lower than the potential optimum yield of 10 fruits per plant. The gap between actual and potential yield may be explained by a number of factors which include the following farm inputs: seed quality, soil and fertilizer management, pest and disease management, water management, and weed control.

The percentage of the yield gap explained by each of the different farm inputs is not known and may be the concern of future experiments, but initial findings (validation will be done under Study 3) indicate that the “*ampalaya*” plant may have not been supplied the right amount of water up to the soil depth where maximum of the roots are located (about 46 cm) due to the following field observations:

- The drip system is being operated in a manner that the average actual emitter discharge is just 50 per cent of the rated capacity;
- The preliminary measurement of the system emission uniformity is about 41 per cent as compared to the recommended value of 80 per cent;
- The system is being operated for just one hour every morning except on days with sufficient rainfall.

The above results of the study suggest that there is a need to examine the from the technical viewpoint the appropriateness of the installed drip irrigation set to the specific farm conditions and to find out if the system is being operated according to the design or specifications.

**Study 2.** Land and water resources characterization of Mr. Renato Alcantara’s corn-based farm in Barangay Kay-anlog, Calamba City

Soil physical properties relevant to the evaluation of the design of drip irrigation and improvement of its performance were completed .Deep aquifer is the most feasible source of water for irrigation in the area. Topographic mapping for the whole farm is going on.



Figure 13. Deep well rehabilitation process

**Study 3.** Evaluation of the appropriateness of the design and the operation and maintenance practices of the drip irrigation system in Kay-anlog, Calamba City

The study will be conducted when condition for determining soil depth penetrated by applied water is favorable. The wet season months hinder the conduct of data collection.

**Study 4.** Formulation of recommendations for the improvement of the performance of Mr. Alcantara’s drip irrigation system and how to enhance the capability of the corn-based farm as field laboratory for technology demonstration.

**Study 5.** Evaluation of the level of mechanization of Mr. Renato Alcantara's corn-based farm in Kay-anlog, Calamba City

Although not directly needed in the project, this study was added to start generation of baseline data to validate the proposition that a diversified and productive small-scale corn-based farm will enable the owner to hire or acquire farm mechanization technologies. Using two methods of evaluation, Mr. Alcantara's corn-based farm falls under low level of mechanization.

*Process Development for the Production of Biodiesel from *Jatropha curcas* Oil*

**Study I. Solvent extraction of crude oil from *Jatropha curcas* seeds.**

Optimization of the Production of Ethyl Ester from *Jatropha curcas* L. Using Sodium Hydroxide as Base Catalyst

This study aimed to determine the optimum conditions needed to produce ethyl ester from *Jatropha curcas* L. It included the search for the optimum time for the transesterification reaction, determination of the favorable and less costly oil-to- ethanol ratio.

The chosen ratio was 8:0.3:1 at 45°C for 4 hours since it gave a satisfactory outcome. The required amount of ethanol was at minimum to lessen the production and processing costs.

It was observed that as the ethanol increased, the ethyl ester component also increased when NaOH was at 0.1 mol ratio with the ethanol. In contrast, when NaOH increased together with the ethanol, the ethyl ester component became deficient. Generally, an increase in the amount of NaOH, will also correspond to an increase in the ethyl ester content during transesterification, when all other factors are kept constant. This trend was supported by this study.

In the transesterification process performed, the time was directly proportional with the content of ethyl ester (in percentage) produced. It was shown in this study that as the time increased, the ethyl ester content also increased, however, if the duration was too long, it had no significant effect on the yield.

Recommendation:

Study the effect of stirring rate. In the industry, the energy used in constantly-stirred process greatly contributes to the production cost. The study on optimization can be improved considering the volumetric yield and the ethyl ester composition by weight percent.

Parametric optimization of biodiesel production from *Jatropha curcas* L. Oil Using potassium hydroxide-Catalyzed Transesterification with Methanol

The mechanical extraction of oil from seeds, coupled with the right choice of oil refining methods, such as water degumming and neutralization, proved to be effective in producing quality oil.

It was proven through this experiment on the effect of different parameters (temperature, time, KOH: oil molar ratio, MeOH: oil molar ratio) with respect to methyl ester yield at set conditions (30-60°C, 1-2 hours, 0.3-0.5 mol per cent and 6-9 mol per cent, respectively for each factor in a 2-level factorial design) and amplified to central composite response surface methodology, exhibited a first-order or linear model. Process characterization screened out temperature and time from the experimental model. The significant terms within the region studied are methanol-to-oil and KOH-to-oil molar ratios. Methyl ester yield varied directly proportional to all the four variables but at a higher correlation with the significant factors. During the process optimization, it was found out that the lower limit of methanol-to-oil mole ratio was 7.68, and 0.43 for KOH-to-oil mole ratio. This combination done at 57.12°C for 2 hours, was the most economical combination that would produce quality methyl ester during the first thirty minutes, and during the end of the reaction.

#### Recommendation:

In monitoring the behavior of methyl ester yield through time at the chosen optimum conditions, it can be seen that the time required for the production of high quality methyl ester at the optimum level is relatively short compared to the one to two-hour range studied in the experimental matrix. This leads to a probable solution to strike the effect of time on methyl ester yield for the next batches of optimization runs by decreasing the time interval, say for 10 minutes, since the transition of methyl ester yield through time was not seen by the wide time range specified in this study. The region of higher temperature in a narrower range may be studied for further information and model equation showing the significance of temperature on the methyl ester yield. These modifications would show the region of maximum methyl ester yield with respect to time and temperature.

Additional responses, like volumetric methyl ester yield and FFA yield may also be studied for further information on these factors that also significantly affects the quality and purity of biodiesel produced.

More optimization runs and replicates may also be done to strengthen the initial conclusions and add further information on the economic production of quality biodiesel.

#### Optimization of Ethyl Ester Production from *Jatropha curcas* L. Seed Oil Using Potassium Hydroxide as Catalyst

This study determined the optimum conditions for the production of ethyl ester from *Jatropha curcas* L. oil via potassium hydroxide-catalyzed transesterification using Response Surface Methodology.

Four factors were considered for ethyl ester production optimization – temperature, ethanol-to-oil molar ratio, potassium hydroxide-to-oil molar ratio, and reaction time. The experiment matrix was generated using the Central Composite Design under Response Surface Methodology. Each factor had two levels. The respective upper and lower levels set for each of the factors were as follows: 30 and 70°C for temperature; six and eight for ethanol-to-oil molar ratio; 0.2 and 0.3 for potassium hydroxide-to-oil molar ratio; and two and four hours for the

reaction time. The matrix consisted of a total of 28 standard orders. Ethyl ester content was evaluated at each of the 28 hours.

A linear was found to fit the experimental data. The general effects of the four factors on ethyl ester content were identified. For the design space considered, ethyl ester content increased as: (1) temperature decreased; (2) ethanol-to-oil molar ratio increased; (3) potassium hydroxide-to-oil molar ratio increased; and (4) reaction time increased.

The optimum points were generated using the Design Expert 7.1.4 Version computer programme. The optimum points were coherent. The one chosen was that in which ethanol-to-oil ratio was at minimum. At this point, the oil:ethanol:potassium hydroxide ratio was 1:7.49:0.29; the reaction time was 30°C and the corresponding time for this set of conditions is 3.96 hours. Given this set of conditions, 96.61 per cent ethyl ester content was predicted.

Upon verification of the optimum point, it was found out that at an oil-to-ethanol-to-potassium hydroxide ratio of 1:7.49:0.29 at 30°C, ethyl ester content was already 98.70 per cent in only 30 minutes. Thus, a time profile having an interval of five minutes was made. From this experiment, it has been found out that the minimum biodiesel requirements for ethyl ester content (96.5 per cent) was satisfied in just 10 minutes of reaction.

Recommendation:

The reduction of the design space by adjusting the factorial levels to be closer together may be conducted so as to obtain more accurate results. Other important responses aside from ethyl ester content such as volumetric yield may also be studied.

Additionally, the kinetics of transesterification for this particular system can be calculated.

An economic analysis of production using ethanol as reactant, and potassium hydroxide as catalyst for transesterification is strongly recommended. This will assess the competitiveness of having this system instead of the conventional methanol-sodium hydroxide.

## **Study II: By-product separation of glycerol layer from transesterification of *Jatropha curcas* oil**

The study aimed to determine the most economical alcohol (methanol and ethanol) to oil ratio, catalyst concentration (NaOH and KOH) and reaction temperature; and determine the physical and chemical properties of the crude and esterified *Jatropha curcas* oil.

The oil expressed from the seed of *Jatropha* is converted to biodiesel by a process called transesterification. In this process, the long fatty acid chains are removed from the glyceride molecule by reacting with alcohol and a catalyst. The reaction produces fatty monoesters (methyl esters) and free glycerin.

Glycerin is one of the most versatile and valuable chemical substances known to man. Because of its unique combination of physical and chemical properties it can be utilized in myriad



products. It is used as an ingredient or processing aid in cosmetics, toiletries, personal care, drugs, and food products. The production of biodiesel resulted to impure glycerol, which has little economic value. But once it is purified, it can be transformed into high-cost products.

During the first six (6) months (January to June 2008) of the study the crude glycerin layer produced from transesterification of *Jatropha curcas* oil was characterized in terms of its physicochemical characteristics. Acidulation of the *Jatropha* biodiesel's glycerin layer was done using hydrochloric acid. The effect of varying concentration (0.5 M to 12 M) of hydrochloric acid on the recovery of glycerin was determined. The highest recovery (94.93 per cent) was obtained using 1 M HCl. The effect of varying residence time (0.5 to 12 hours) was also determined in this study. Results show that there's no direct relationship obtained between the residence time and percent glycerin recovery. However among the residence time tested, 12 hours gave the highest recovery of 97.35 per cent. It was also observed that after 18 hours, the percent glycerin recovery started to level-off implying that settling had stopped.

The latter part of the study focused on the determination of the effects of residence time and acid concentration on the separation of glycerin layer from *Jatropha* biodiesel using phosphoric acid and sulfuric acid.

Results showed that as sulfuric acid concentration was increased from 1M to 3 M, glycerin recovery increased. However, further increase in concentration caused the recovery to decrease. The effect of residence time of acidulation using sulfuric acid on glycerol recovery was also studied. For 3M sulfuric acid, the glycerol recovery decreased as the residence time was increased. The optimum glycerol recovery was obtained using 6.3 M sulfuric acid and 5.74 hours is 94.36 per cent.

Using varying concentration (1M, 3M, 6M and 12 M) of phosphoric acid as acidulant showed that 12 M at 24 hours residence time gave the highest per cent glycerin recovery at 99.23 per cent. An increasing trend of glycerin recovery from 3M to 12M was observed. Using the 12M phosphoric acid, the effect of residence time (1hr, 6 hr, 12 hr, 18 hr and 24 hr) of acidulation was also determined. No trend was observed with the residence time on glycerol recovery. However the highest per cent glycerin recovery was observed at contact time equivalent to 6 hours which is 99.81 per cent.

### **Study III: Solvent Extraction of *Jatropha Curcas L.* Oil**

The general objective of the study is to develop a process for the separation of glycerol layer.

The utilization of agricultural crops for the production of possible fossil fuel substitutes, termed as biofuels, has been continuously explored. The seeds of *Jatropha curcas L.*, locally known as tubang-bakod, have been identified as one potential source of oil for production of biodiesel, a petroleum diesel substitute or additive, produced from transesterification of oil from vegetables and tree-borne oilseeds.

Oil extraction from oilseeds has been commonly done using mechanical or hydraulic presses and expellers. However, this method is tedious and inefficient, as considerable amount of oil may be

left in the meal during the process. Another method that has been employed for oil extraction utilizes organic solvents to effectively dissolve the oil and separate it from the insoluble or inert solid; hence, the term solvent extraction.

In this study, various organic solvents such as hexane, acetone, and diethyl ether had been used to extract the oil from *J. curcas L.* seeds by soaking. Results showed that the optimum soaking time were 20 hours for hexane extraction (corresponding to 35.99 per cent oil yield), 24 hours for acetone extraction (28.8 per cent oil yield), and 16 hours for diethyl ether extraction (26.52 per cent oil yield). Moreover, the optimum kernel to solvent ratio (w:v) were found to be 1:8 for hexane extraction, and 1:10 for both acetone and diethyl ether extraction.

The utilization of another type of solvent, petroleum ether, was investigated for *J. curcas* oil extraction. The effect of soaking time and the effect of kernel to solvent ratio (w:v) on the oil yield were evaluated. The physico-chemical characteristics of the extracted oil were also determined, and compared with literature values.

To determine the effect of varying soaking times on the percent oil yield, the kernel to solvent ratio was held constant at 1:4. An increasing trend in per cent oil yield with time was observed until such point where further increase in the soaking time resulted to insignificant changes in the per cent oil yield. As soaking time is increased, the oil in the seeds is continuously extracted until equilibrium or near equilibrium is attained between the oil in the seeds and that in the solvent. Mass transfer occurs because of a concentration difference or gradient; that is, a species diffuses in the direction of decreasing concentration. Mass transfer stops when the concentration is uniform (Seader and Henley, 1998). The optimum soaking time was found to be 8 hours for petroleum ether extraction (corresponding to 22.76 per cent oil yield).

The effect of kernel-to-solvent ratio on the per cent oil yield was also evaluated at constant soaking time. The oil yield increased as the amount of solvent was also increased until equilibrium was reached where changes in oil yield were insignificant. At this point, equilibrium is established and no net mass transfer occurs between the extract (consisting of the solvent and the oil) and the seeds. The optimum ratio selected was 1:8 with a corresponding per cent oil yield of 27.58 per cent for petroleum ether extraction. The physico-chemical properties of the oil were also determined. Analysis of the petroleum ether-extracted oil showed that it had a specific gravity of  $0.9180 \pm 0.0037$  at  $25^{\circ}\text{C}$ , saponification value of  $186.72 \pm 1.01$  mg KOH/g oil, iodine value of 92.0 mg I/g oil, and an acid value of  $7.53 \pm 0.60$ .

#### **Further experiments to be conducted:**

The remaining part of the study involves extraction of oil using a two-step process: mechanical extraction of the oil and solvent extraction of the oil from the cake produced after mechanical extraction. The optimum soaking time and cake to solvent ratio will be determined and the oil yield will be compared to that for a one-step solvent extraction process.

#### **Study IV: Development of Treatment processes for Wastes Generated during the Production of Methyl Ester from *Jatropha curcas* Oil**

Determine the physico-chemical characteristics of wastes before and after treatment; apply Fenton's process in treating the wastewater generated during the production of methyl ester; and design other treatment processes for the different waste water generated. For this year, the study aimed to evaluate the efficiency of anaerobic digestion for the wastewater generated from the pre-treatment of *Jatropha curcas* oil, for transesterification.

Inoculum development is an important aspect of the application of anaerobic digestion on wastewater treatment. Hence, inoculum development for the anaerobic degradability of wash water from sodium hydroxide-methanol transesterification of *J. curcas* oil was performed. The original washwater was characterized as follows:

Chemical Oxygen Demand (COD)	38,168 mg/L
Biochemical Oxygen Demand (BOD)	24,783 mg/L
Total suspended solids (TSS)	4916.67 mg/L
pH	10.6
Oil and grease	3805 +/- 145 mg/L

In this study, the anaerobic digestion of the wash water was acclimatized to the strained ruminal fluid (SRF), with pH 7.6, soluble COD of 2658 mg/l, and VSS of 10666.67 mg/l at varying organic loading rates. The values of the following parameters were monitored: pH, TSS, VSS, biogas production, COD reduction at retention time of 20 days, for organic loading rates (OLR) of 0.01, 0.1, 0.5, and 1 g/L-day. Then there was a second phase, at a retention time of 15 days, and values of same parameters were monitored for OLR's of 0.025, 0.25, 1.25, 2.5 g/L-d.

The pH of the system was maintained at 7.1-7.5 throughout the experiment. Good gas production was initially observed at increasing loading rates but inhibition was suspected upon increase of OLR from 1 to 2.5 g/L in the second phase of the experiment. COD reduction was observed in all reactors with concomitant detection of methane in the samples subjected to gas analysis.

Results showed that the wastewater generated may be utilized for anaerobic digestion to produce biogas. However, further studies should be done on the improvement of the acclimatization phase of anaerobic bacteria on the new environment. Assays for the presence of toxic and inhibitory materials should be conducted.

#### **Further experiments to be conducted:**

Wastewater generated from different systems (using different combinations of KOH, NaOH, methanol, ethanol) will be used for anaerobic digestion, and the different parameters will be monitored (biogas production, COD, pH).

#### *Design and Installation of a Micro-hydro Generator*

The general objective of the project is to design a localized micro hydro system as source of farm power. The project is consists of three different studies with the following specific objectives:

**Study I:** Testing and evaluation of a 200W capacity micro-hydro generator

- a. To maximize the working condition of an existing 200W capacity micro-hydro generator using different flow rates (Q) and head (H)
- b. To modify an existing micro hydro test rig
- c. To formulate standard specifications and methods of test for a micro-hydro generator
- d. To generate a performance curve for the 200W capacity micro-hydro system

**Study II.** Matching of alternative DC/AC generator for the 200W capacity turbine

- a. To gather data on locally available alternator as DC generator and AC generators with low head requirement
- b. To identify and match the DC/AC generator to the 200W capacity turbine
- c. To test the performance of the DC/AC generator- turbine set –up

**Study III.** Design of alternative system components for a 200W capacity turbine

- a. To design, match and test the performance of an induction motor as generator for the 200W capacity turbine
- b. To design, fabricate and test an AC and DC Load Controller
- c. To design a single wire transmission system for Micro Hydro Set-up

**Accomplishments:**

Procurement of materials for the test rig for the microhydro generator were undertaken. Test rig modification is on going. Further, secondary data gathering for the automotive alternator as DC generator and AC generator with low head requirement were also done. The bulk of the progress of this study is on research and conceptualization. Everything is still theoretical, because the materials are not yet available.

The basis for the design and process of conversion from a motor to a generator has already been acquired. Research regarding the Fisher and Paykel (F&P) and the principles behind the machine has already been accomplished.

In the design of the Electronic Load Controller (ELC) that would match the generator, two existing prototypes have been found to be most suitable namely; (1) the commercially available Hummingbird ELC and (2) the controller attached to the existing set-up. Research shows that for the target 200W Pico-hydro generator, an Induction Generator Controller (IGC) is more appropriate than ELC. This is mainly because such small systems are more concerned with voltage fluctuations than frequency inconsistencies. The latter being the primary concern of Electronic Load Controllers. The two prototypes can still serve as basis for the IGC design with few adjustments and modifications. The power electronic devices and protection systems to be used are still being researched before finalization of the design and fabrication of the controller.

With regards to the transmission system, research on the installation of Single Wire Earth Return (SWER) transmission has been done. Research shows that the configuration of the SWER system can/cannot have a transformer. This will depend on the voltage drop contributed by earth. The recreation of the moisture at the appropriate depth is significant. A soil moisture tester has been borrowed from the Soil Science Cluster, College of Agriculture. Furthermore, the existence of the soil bin in the College of Engineering and Agro-Industrial Technology (CEAT) shop is an advantage.

Electrification is important in the development of rural communities. In our era where there is a greater demand for energy, alternative sources can be beneficial for the development of the agricultural sector. Moreover, if the generator could produce sufficient electrical energy to power farm equipments, farmers would be able to utilize these to enhance food production.

#### Problems Encountered and Recommendations

One of the most pressing concerns is the lack of published references for a more comprehensive research and detailed data gathering. Majority of the sources are online, thus some of these are not reliable. The theoretical framework is not concrete as desired. If there are possible sources of published data regarding this study, knowledge on where to access these sources would be helpful in its completion.

For the IGC, available reliability testing after fabrication is insufficient because standards for such devices have not been implemented in the country. It will be more advantageous if materials can be obtained from the local market instead of procuring them abroad.

### **Training, Extension and Information Dissemination Activities**

#### *Dissemination of AMDP Developed Agricultural Mechanization Technologies*

One of the major functions of AMDP along with research and development is extension. Among its activities are promotion of agricultural mechanization through exhibitions/demonstrations, loan-out of machines, provision of expert services and technical assistance, conduct of training on the operation, repair and maintenance and fabrication of agricultural machines, provision of technical drawings and production of print media for extension/popularization and information dissemination, and maintenance of agricultural mechanization display area. The display area is currently being used for instruction an exhibit purposes to demonstrate various technologies developed by the programme as well as the other locally and commercially available technologies to students, researchers, farmers'/fisherfolks' groups/organizations, cooperatives, agricultural manufacturers, GO/NGO agricultural planners and other walk-in visitors.

The general objective of the project is to extend and actively promote AMDP developed agricultural mechanization technologies to target clients. The project specifically aims to conduct technology demonstrations and participate in different agricultural machinery exhibitions/fairs/symposia; maintain the AMDP agricultural mechanization display area to showcase the technologies developed by the programme; conduct technical assistance and provision of technical drawings to interested clients; and conduct training on operation techniques and manufacturing of AMDP developed machines to interested clients.

#### *Maintenance of Machinery Display Area*

The AMDP display area houses different agricultural mechanization technologies designed and developed by its competent engineers and part-time CEAT faculty. Forty seven agricultural

machines used from production to post production operations for different agricultural crops are on display. These are being showcased to walk-in visitors and other clients of the programme.

- Re-arranged the tools, machines and equipment on display for better flow/ movement of visitors.
- Fabrication of UPLB Upland Hand Tractor, UPLB Mini Hand Tractor, UPLB Corn Mill, UPLB Single-row Organic Fertilizer Applicator and UPLB Two Drum Corn Sheller for display is on- going.
- Visitors were entertained and briefed about the different machines in the display area and the various activities of the programme.

#### *Participation in Exhibitions/ Fairs/Demonstrations*

AMDP participated in exhibits fairs and demonstration for the promotion of agricultural mechanization. It participated in the following exhibits:

- Participated in 8<sup>th</sup> Philippine Society of Agricultural Engineering(PSAE) Conference and Exhibition 2008, Electrical Engineering, CEAT UPLB, April 21-25, 2008
- Exhibit of UPLB technologies for Sen. ANGARA and Gov. Salceda of Albay during the 2008 UPLB Graduation Day, Umali Auditorium, UP Los Banos. . April 26, 2008.
- Conducted demonstration on the operation, repair and maintenance of the UPLB Two Drum Corn Sheller to corn farmers of Brgy. Kay-anlog, Hornalan, Makiling, Borol, and Laguerta Calamba, Laguna from February – May 2008 in cooperation with DA. Calamba City.
- Demo cum-training on post-harvest operation on corn mechanization technologies (corn shelling, drying and storage) to corn farmers of Brgy. Tranca Bay, Laguna post-harvest operation on corn mechanization technologies(demo cum training in corn shelling drying and storage) to corn farmers under the rice-maize collaborative project of DA. UPLB and IRRI on May 27-28, 2008.

#### *Dissemination of Machinery Designs/Blue Prints and Provision of Expert Services*

##### a. Dissemination of Machinery Design

One of the activities of the programme is to disseminate machinery designs and blue prints to interested manufacturers. The programme also assists the manufacturers in interpreting working drawings. Nine technical drawings were given to local agricultural machinery fabricators.

##### b. Production of Extension Materials

Two posters entitled “Development and Introduction of Appropriate Mechanization Technology for Local Vegetable Production” and “The UPLB Hot Water Treatment System for Carabao Mango” were made.

Machine drawings were given to local machinery fabricators. These included UPLB Mini Hand Tractor, Hand Jabber, Mini Corn Mill, Corn Injector Planter, Hydraulic Ram, Motorized Corn Sheller, UPLB Two Drum Corn Sheller, Two Row Cono Lowland Weeder, MDPS-3 Motorized Driven Peanut Sheller

### c. Expert Services

Expert services like conducting feasibility studies, procurement of machines and consultancy services were also extended to the different clients of the Programme. Visitors were given technical assistance on the different AMDP-developed machines such as agricultural machines, tools and implements. They were also briefed with the different on-going research and extension activities of the Programme.

About 500 visitors and ten institutions made inquiries through phone calls and letters or actual visit to AMDP were assisted and given technical assistance.

Technical expert services were provided to various AMDP clients. One of the technical assistance given was extended to Baras, Rizal organic vegetable farmers with regards to the mechanization needs of the area. Some of the needs identified were the installation of windmill for water pumping to irrigate their fields, land preparation machines like hand tractor, soil sterilizer for their nurseries, compost mixer as well as rain harvesting system to collect water for future irrigation needs. AMDP technical staff provide technical assistance, expert services, and briefing on agricultural mechanization technologies to visitors/clients

### *Collaborative RDE Project in Region 7*

- The collaborative research proposal with the Farmer scientist Training Programme (FSTP) was submitted to BAR for funding. Related to this, the FSTP has been declared a national programme through the signing of EO 107. This would mean that AMDP would also be part of the FSTP programmes since they had acknowledged that agricultural mechanization is a necessary ingredient for progressive farming.
- An official trip was conducted in June to determine machine utilization and status of the project in Cebu. Mr. MC Bueno who will coordinate all extension activities for corn was introduced to the key personnel in the area and was updated with regards to the pilot area activities in province.
- During the trip to Cebu, the province of Bohol was also visited since there was a pending request for a manufacturing training on AMDP planters. The AMDP team inspected the facilities and discussed with the proponents on the proposed training. Funding of the training will be shouldered by DA-RFU 7 and the Bohol Agricultural Promotion Center (BAPC). The training is tentatively scheduled in August 2008.

### *Publication of the Philippine Agricultural Mechanization Bulletin and the Philippine Journal of Agricultural and Biosystems Engineering*

The main objective of this activity is to extend and popularize different agricultural mechanization and related technologies produced by AMDP through the production of print and audio/video materials, which serve as materials for information dissemination and in the extension and popularization of the different agricultural mechanization technologies. The following are the specific objectives:

1. To publish the Philippine Journal of Agricultural and Biosystems Engineering, which is a referred journal that aims to serves as national venue for disseminating information about

recent completed researches and development in the field of Agricultural and Biosystems Engineering;

2. To publish the Philippine Agricultural Mechanization Journal, which is a semi-technical bulletin that serves as a venue for researches on agricultural mechanization and other related fields;
3. To produce the Mechanization Updates which promote RD&E activities of AMDP and other agricultural mechanization research institutions and serves as venue to disseminate significant and interesting information on mechanization; and
4. To publish other print media materials such as power point presentations, leaflets, brochures, fliers, operators' manuals, etc for information dissemination.

Five publications were completed by the programme

1. Philippine Journal of Agricultural and Biosystems Engineering (PJABE) 2007
2. Philippine Journal of Agricultural and Biosystems Engineering (PJABE) 2008
3. Philippine Agricultural Mechanization Journal (January to June 2007)
4. Philippine Agricultural Mechanization Journal (July to December 2007)
5. Proceedings of the National Corn Mechanization Conference

*Extension of Hand Tractor and Windmill for Corn and Vegetable Production in Region IVA (CALABARZON)*

The project aims to: demonstrate the UPLB-AMDP Upland and Mini Tractor within Region 4-A; promote the adaptation of the hand Tractor for land preparation and plant cultivation; determine the effect of introducing mechanize tillage practices on corn and vegetable production; demonstrate the windmill technology for irrigation purposes; and identify refinement in the design for further development and manufacturing purposes for both the upland and mini tractor, and of the windmill technology.

Demonstration of the AMDP-UPLB Hand Tractor was made to last 2<sup>nd</sup> quarter to members of the Calauag Municipal Cooperative Development Council for the intension of the group to produce corn within the municipality of Calauag, Quezon. A meeting with the cooperative council was made together with the Caluag town Mayor for the local government to fund the propose mechanization project with AMDP. Through the said fund, two cooperative group purchase one (1) unit each of Hand Tractor for corn production. Other proposed machines for funding were: corn sheller, grain dryer, hammer mill and feed mixer.

As for the status of the vegetable project, AMDP loan out the AMDP windmill unit to Majent Foundation producing lettuce vegetable at Bgy. Pulong Saging, silang, Cavote. The foundation will use the windmill for irrigating vegetables produced within their farm. The duration of the project is two years.

With regard to the extension of AMDP hand and mini tractor, during the 2<sup>nd</sup> quarter, both machines were demonstrated for land preparation to vegetable farmers of Calamba City. The area will be planted with tomatoes or eggplant.



### *Other Important Activities*

A proposal entitled, “Development and Piloting of a Mechanized Integrated Production, Processing and Marketing Center for Selected Corn Growing Areas” was made and submitted to BPRE as part of a bigger integrated project for funding. The general objective of the project is to develop and pilot a mechanized integrated production, processing and marketing center for corn in selected areas. An analysis of the energy expenditure for corn production has been initiated. The analysis seeks to determine the energy expenditure for the different farming operations involved in corn production from land preparation to storage.

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