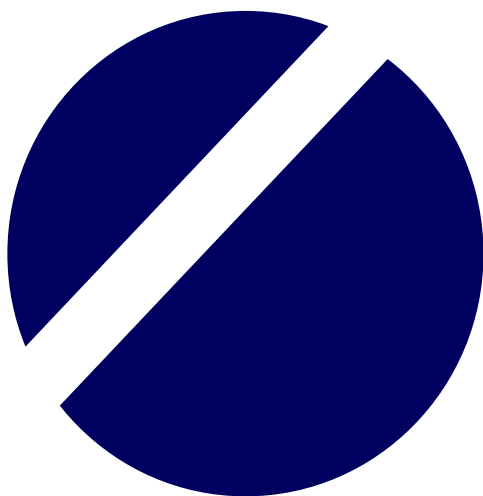


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## EFFECTIVENESS OF TWO BOTANICAL INSECTICIDE FORMULATIONS TO TWO MAJOR CABBAGE INSECT PESTS ON FIELD APPLICATION

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### ABSTRACT

A field application of two botanical insecticide formulations was conducted on cabbage crops in Bogor, West Java, Indonesia to assess the effectiveness of these formulations in reducing two major cabbage insect pest populations. The efficacy of two botanical insecticide formulations, mixtures of *Piper retrofractum* (Piperaceae) and *Annona squamosa* (Annonaceae) (RS) extracts and *Aglaia odorata* (Meliaceae) and *A. squamosa* (OS) extracts at 0.05% and 0.1% was compared to a synthetic pyrethroid, deltamethrin at 0.04% and a microbial insecticide, *Bacillus thuringiensis* at 0.15%. The application of both RS and OS formulations decreased the population of *Crociodolomia pavonana* (F.) (Lepidoptera: Pyralidae) and *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae) and the treatments of RS and OS at 0.1% was more effective than synthetic insecticide. The application of RS and OS did not affect the performance of insect pest natural enemies.

**Key words:** Botanical insecticide, *Crociodolomia pavonana*, *Plutella xylostella*, safety

### INTRODUCTION

The cabbage webworm, *Crociodolomia pavonana* (F.), (synonymous to *C. binotalis* Zeller) (Lepidoptera: Pyralidae) and the diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae) are two major insect pests on cabbage and other cruciferous crops. They often cause heavily damage on cabbage crops particularly in dry season. The common strategy adopted by farmers in overcoming the insect pest population in cabbage crops is by using synthetic insecticides. The use of synthetic insecticides in Indonesia to control insect pests on cabbage and other vegetable crops such as tomato, potato, string bean, as well as broccoli is still intensive due to its efficient, practical use, as well as effectiveness (Dadang *et al.*, 2003a; Dadang *et al.*, 2003b). Farmers spray synthetic insecticides 2-3 times/week and the total number of pesticide applications on cabbage cultivation in one season could reach 30-35 times (Rauf *et al.*, 2005). Moreover, about 70% of cabbage farmers spent money for pesticides about 25-30% out of the total production input cost.

The misuse and excessive use of synthetic insecticides may cause some undesirable effects not only to the agricultural ecosystem but also to human health due to insecticide residue in food. Insecticide residue in agricultural products particularly in vegetable and fruit products is a growing concern for producers, traders, and consumers in many parts of the world. Therefore, several efforts have been created to reduce the use of synthetic pesticides particularly the use of synthetic insecticides. One of the efforts is the development of botanical insecticides as a novel and safer alternative strategy. Botanical insecticides, which contain plant extracts as active components, are safer as well as environmentally friendlier than synthetic insecticides. Therefore, this research was conducted to assess the effectiveness of two botanical insecticide formulations in reducing the major cabbage insect pests and their impact to natural enemies and cabbage crops in field test.

## MATERIALS AND METHODS

### Plant Materials

Plant materials used in this experiment were seeds of *Annona squamosa* (Annonaceae), twigs of *Aglaia odorata* (Meliaceae), and inflorescences of *Piper retrofractum* (Piperaceae). All plant materials were air-dried for one week before extracted.

### Extraction

Plant materials were cut and then ground using a mill to yield uniform size of powder. The powder of each plant species was soaked in methanol (1:10; w/v) for 48 hours. Each plant extract solution was filtered with filter paper (Whatman No. 1) and methanol was evaporated using a rotary evaporator at 50°C under reduced pressure (400-450 mmHg) to produce crude extract. Crude extracts were kept under low temperature (-4°C) in the refrigerator until used.

### Preparation of Extract Formulation

An appropriate amount of each crude extract was mixed to prepare extract mixtures of *P. retrofractum* and *A. squamosa* (RS) and *A. odorata* and *A. squamosa* (OS). The extract mixture was diluted with methanol, and then stirred until getting good homogeneity of extract mixture. Each extract mixture solution was added with water containing Agristik 400 L (a.i. alkylaryl polyglycol ether) as emulsifier and sticker to produce the desired extract mixture concentration. The final concentrations of organic solvent (methanol) and emulsifier were 1% and 0.05%, respectively. Two extract concentrations of each formulation, 0.05% and 0.1% were applied. Water containing 1% organic solvent and 0.05% emulsifier served as a control. In order to compare the effectiveness of botanical insecticide formulations, synthetic insecticides, Decis 2.5 EC (pyrethroid, a.i. deltamethrin) and a microbial insecticide Agrisal WP (*Bacillus thuringiensis*) were used and applied at recommended concentrations of 0.04% and 0.15%, respectively. All insecticides were applied using a lever operated knapsack sprayer. Applications of insecticides were done five times during the experiment with one-week interval between applications.

### Cabbage Crop Management

Field application was conducted in 1500 m<sup>2</sup> area of a cabbage field in Bogor, West Java, Indonesia. Cabbage seedlings were transplanted to plots (8 m x 6 m). Each plot consisted of 12 rows of plants and each row consisted of 12 plants, so that each plot contained 144 cabbage plants. The plots were fertilized with chicken manure applied two weeks before transplanting at the rate of 10 ton/ha. Inorganic fertilizers (90 kg/ha urea, 30 kg/ha SP-36, and 30 kg/ha KCl) were applied twice, two and four weeks after transplanting. Weeds were removed mechanically when necessary.

### Field Observation

This experiment consisted of seven treatments and three replications. Ten cabbage plants in each plot were randomly selected as plant samples. Number of *C. pavonana* and *P. xylostella* larvae of each plant sample (larval density) was weekly monitored. The first and second observations were conducted before the first application of insecticides, while the third to seventh observations were conducted a week after each insecticide application.

In order to evaluate the effect of application of insecticides on natural enemies especially parasitoids, 10 larvae of *P. xylostella* and *C. pavonana* were collected from each plot separately. Larva were collected at 7, 8, 9, and 10 weeks after transplanting (WAT). All collected larva were

reared and fed with free insecticide cabbage leaves in the laboratory until adult emergence. The percentage of parasitization was calculated by the following formulae:

$$\text{Percentage of parasitization} = \frac{\text{Number of parasitized larvae}}{\text{Number of collected larvae}} \times 100 \%$$

Other supported data were collected such as cabbage production and phytotoxic effect on cabbage crops.

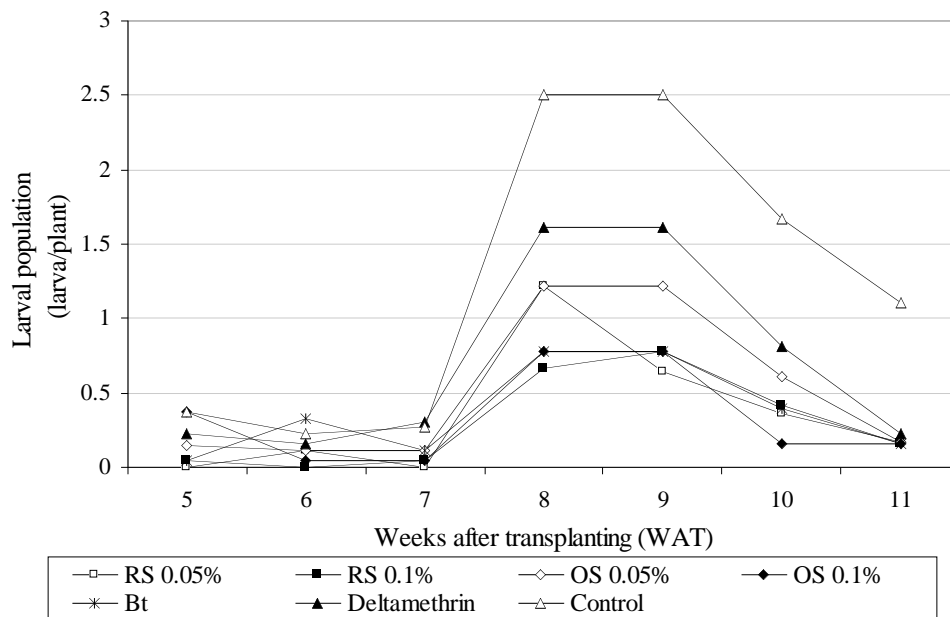
The experiment was arranged based on a complete randomized block design with seven treatments and three replications. The data obtained were analyzed by analysis of variance. The comparison of means were done using Duncan multiple random test at 0.05 level (Steel and Torrie, 1980).

## RESULTS AND DISCUSSION

### *Plutella xylostella* larval population

Before first application of insecticides, the population of *P. xylostella* larvae was weekly monitored since fifth weeks after transplanting (WAT). The average of *P. xylostella* larval populations was 0.06-0.37 and 0.06-0.33 larvae/plant at five and six WAT, respectively.

After first application of insecticides, the population of *P. xylostella* increased slightly on RS 0.1% (0 to 0.05 larvae/plant) but decreased on *B. thuringiensis* treatment (0.33 to 0.11 larvae/plant). Other treatments, OS 0.05% and 0.1%, were able to maintain the larval population on the same level before and after insecticide application. Treatment of deltamethrin showed highly increased larval population from 0.16 to 0.31 larvae/plant (Fig. 1).



**Fig. 1.** Development of *P. xylostella* larval population on cabbage crops treated with botanical, synthetic, and microbial insecticides.

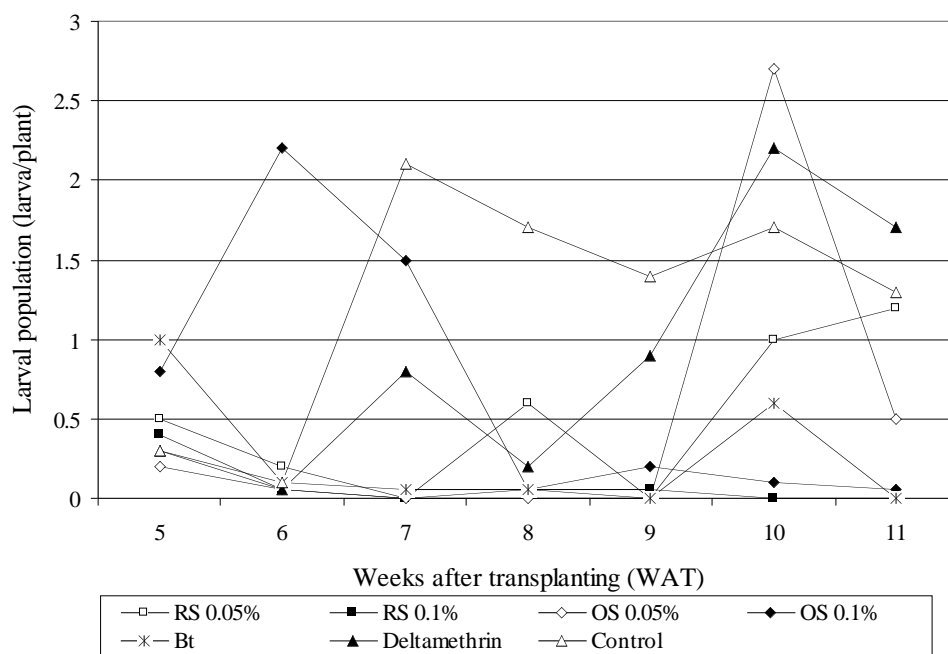
After the second application, the larval population on three treatments, RS 0.1%, OS 0.1%, and *Bacillus thuringiensis* slightly increased, but treatments of RS 0.05%, OS 0.05%, deltamethrin, and control highly increased (Fig. 1). The increase in larval population might be caused by new infestation of *P. xylostella* from neighboring cabbage crop areas. In addition, the peak population of *P. xylostella* occurred on the eighth week after transplanting. This phenomenon might be correlated with the increase in the larval population in all treatments.

The larval population decreased on all treatments since ninth week but two treatments, deltamethrin and control, showed higher population than other treatments. It indicates that treatments with botanical insecticides (RS and OS particularly at 0.1%) were more effective than synthetic insecticide. In addition, the formulation of RS showed more effective than OS formulation.

### *Crociodolomia pavonana* larval population

The average larval populations of *C. pavonana* at 5 and 6 WAT were 0.17-0.83 and 0.05-2.23 larvae/plant, respectively. After the first application, the larval population decreased in all treatments except for deltamethrin treatment and control. The larval population increased from 0.05 to 0.78 larvae/plant and from 0.11 to 2.06 on the treatments of deltamethrin and control, respectively (Fig. 2).

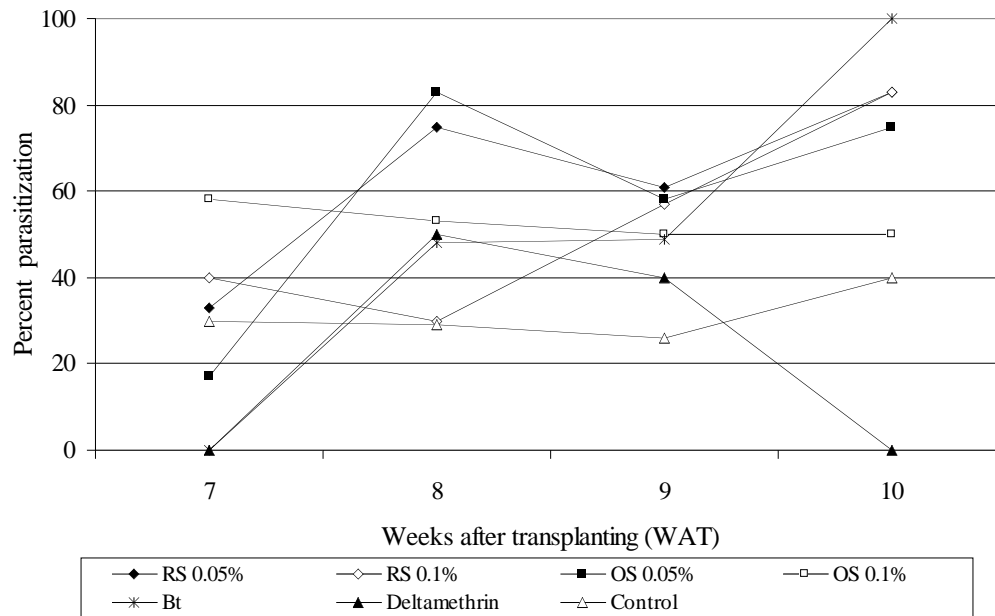
The larval populations treated with RS 0.1%, OS 0.1% and *B. thuringiensis* at 8 to 11 WAT were consistently low and the larval populations treated with deltamethrin and control were consistently high. It indicates that two botanical insecticides were more effective to *C. pavonana* than synthetic insecticide and was comparable to *B. thuringiensis*.



**Fig. 2.** Development of *C. pavonana* larval population on cabbage crops treated with botanical, synthetic, and microbial insecticides

### The effect of two botanical insecticide formulations to *P. xylostella* parasitoid

Treatments of two botanical insecticide formulations did not affect the performance of *Diadegma semiclausum* (Hymenoptera: Ichneumonidae), a parasitoid of *P. xylostella*. Parasitization level on two botanical insecticide formulation treatments were higher than control and deltamethrin (Fig. 3). The percentages of parasitization on RS 0.1% and OS 0.1% at 7, 8, 9, and 10 WAT were 40, 30, 57, and 83% and 58, 53, 50, and 50%, respectively. Meanwhile, the percentages of parasitization on deltamethrin were 0, 50, 40, and 0%, respectively. The application of RS and OS formulation are safe to *D. semiclausum* parasitoid.



**Fig. 3.** Development of percentages of parasitization of *D. semiclausum* on cabbage crops treated with botanical, synthetic, and microbial insecticides

### The effect of two botanical insecticide formulations on *C. pavonana* parasitoid

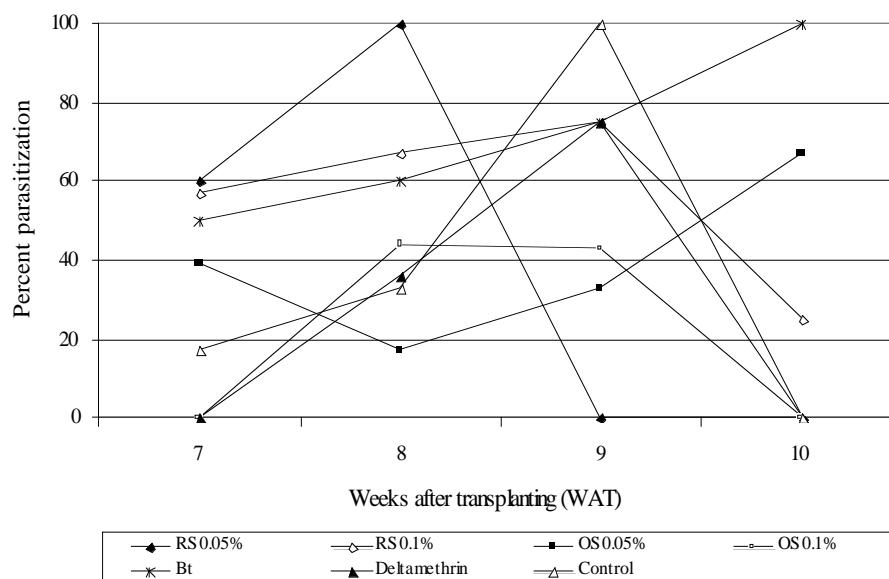
The RS 0.1% formulation showed higher percentage of parasitization than control and deltamethrin but the formulation of OS 0.1% showed lower percentage of parasitization (Fig. 4). The percentages of parasitization on RS 0.1% treatment at 7, 8, 9, and 10 WAT were 57, 67, 75, and 25%, respectively and percentages of parasitization of OS 0.1% treatment were 0, 44, 43, and 0%, respectively. Meanwhile, percent parasitization in deltamethrin treatments were 0, 36, 75, and 0%, respectively. These results indicate that the application of the RS formulation is safe for *Eriborus argentiopilosus* (Hymenoptera: Ichneumonidae), a parasitoid of *C. pavonana* but OS formulation affected slightly the performance of the parasitoid.

### Intensity of cabbage damage and yield

The intensity of cabbage damage on all insecticide treatments except OS 0.05% treatment was lower than untreated control (Table 1). The intensity of cabbage damage in control plots compared to RS 0.05%, OS 0.05% and deltamethrin treatments did not show any significant

difference while RS 0.1%, OS 0.1%, and *B. thuringiensis* treatments showed significant difference. RS 0.1%, OS 0.1%, and *B. thuringiensis* treatments reduced intensity of damage caused by *C. pavonana*. For the RS 0.1%, OS 0.1%, and *B. thuringiensis* treatments, intensity of cabbage damage in RS 0.1% and *B. thuringiensis* treatments was similar but was lower than OS 0.1% treatment.

RS 0.1% treatment produced the highest average yield followed by deltamethrin and *B. thuringiensis* treatments, while RS 0.05% treatment produced lowest yield (Table 1). There was an inconsistent correlation between intensity of cabbage damage and yield. Intensity of cabbage damage on RS 0.05 treatment was lower than deltamethrin treatment but the production of cabbage in deltamethrin treatment was higher than RS 0.05% treatment.



**Fig. 4.** Development of percentages of parasitization of *E. argentiopilosus* on cabbage crops treated with botanical, synthetic, and microbial insecticides.

**Table 1.** Yield and percent damage (average) of cabbage.

Treatment	Percent damage (%) $\pm$ sd	Yield (kg) $\pm$ sd <sup>1)</sup>
RS 0.05%	10.4 $\pm$ 1.2 <sup>ab</sup>	32.0 $\pm$ 6.9 <sup>b2)</sup>
RS 0.1%	6.3 $\pm$ 2.7 <sup>b</sup>	69.0 $\pm$ 4.8 <sup>a</sup>
OS 0.05%	12.5 $\pm$ 1.0 <sup>ab</sup>	55.5 $\pm$ 7.2 <sup>a</sup>
OS 0.1%	8.9 $\pm$ 3.2 <sup>b</sup>	43.2 $\pm$ 1.4 <sup>b</sup>
<i>B. thuringiensis</i>	6.3 $\pm$ 3.6 <sup>b</sup>	60.5 $\pm$ 2.9 <sup>a</sup>
Deltamethrin	11.0 $\pm$ 3.6 <sup>a</sup>	62.4 $\pm$ 5.2 <sup>a</sup>
Control	14.0 $\pm$ 2.0 <sup>a</sup>	48.0 $\pm$ 6.6 <sup>b</sup>

<sup>1)</sup> Standard deviation

<sup>2)</sup> Averages in the same column followed by the same letter are not significantly different by DMRT at  $\alpha=0.05$ .

## DISCUSSION

Two botanical insecticide formulations containing extract mixtures of *P. retrofractum* and *A. squamosa* (RS) and *A. odorata* and *A. squamosa* (OS) have been tested on cabbage crops in order to evaluate the effectiveness of formulations in reducing *P. xylostella* and *C. pavonana* larval population. Overall, these two formulations at 0.1% showed high effectiveness and gave more effective than deltamethrin, a synthetic pyrethroid insecticide. RS 0.1% was slightly more effective against *P. xylostella* than *C. pavonana*, while effectiveness of OS 0.1% was similar to both *P. xylostella* and *C. pavonana* larvae. These results indicate that these two botanical insecticide formulations have the potential to be developed as commercial products.

In single assays, the seed extract of *A. squamosa* exhibited high insecticidal activity against *C. pavonana* larva where  $LC_{50}$  was 0.208% (Basana and Prijono, 1994) and at the range of 0.063-0.1% concentration was effective against *P. xylostella* larvae (Istiaji, 1998). Acetogenin compounds such as annonin I and squamosin, isolated from seed of *A. squamosa*, were responsible for toxicity of *A. squamosa*. These compounds together with asimisin caused more toxicity against *P. xylostella* (Ohsawa and Dadang, 1998). Acetogenin will inhibit conversion of ADP to ATP in the ion transport system (Gu *et al.*, 1975).

The extract of *P. retrofractum* has been known to have insecticidal activity to *P. xylostella* and *C. pavonana* (Dadang, 1999; Dadang *et al.*, 2007). *P. retrofractum* extract at 0.5% gave 100% mortality against instar II of *C. pavonana* (Prijono *et al.*, 2006). This extract also showed high knock down effect on several test insects including *P. xylostella* and *C. pavonana*. Other insects that were affected by *P. retrofractum* extract were *Forficula auricularia* (Dermaptera: Forficulidae), *Culex quinquefasciatus* and *Aedes aegypti* (Diptera: Culicidae), and *Coptotermes gestroi* (Isoptera: Rhinotermitidae) (Assabgui *et al.*, 1995; Chansang *et al.*, 2005; Alfian, 2007). Piperamide compounds which have isobutylamide and methylenedioxyphenyl moieties have strong insecticidal activity by inhibiting the impulse current on the axon of the nerve system (Miyakado *et al.*, 1989).

*A. odorata* extract was noted to be effective to several agricultural insect pests including *P. xylostella* and *C. pavonana* larvae. The extract of *A. odorata* at 1.0% produced 92% larval mortality of *C. pavonana* (Dadang *et al.*, 2007). Treatment of ethanol twig extract of *A. odorata* caused 100% mortality to *Spodoptera litura* (Lepidoptera: Noctuidae) (Koul *et al.*, 1997). Nugroho (1999) isolated six rocaglamide derivate compounds from *A. odorata*, which were responsible for feeding inhibition, mortality, and growth regulatory activity against *Spodoptera littoralis*. Rocaglamide at 80 ppm caused 90% mortality of *C. pavonana* larva (Sudarmo, 2001). In addition, rocaglamide has high toxicity activity against *S. litura* as indicated by  $LC_{50}$  and  $LC_{90}$  values of 4.8 ppm and 8.76 ppm, respectively (Janprasert *et al.*, 1993).

Based on single assay of extract and mode of action, it seems that each extract works on different target site. The combination of each extract in formulation will produce a good botanical insecticide formulation. Dadang *et al.* (2007) reported the strong efficacy of a mixture of *P. retrofractum* with *A. squamosa* and *A. odorata* with *A. squamosa* which produced 100% and 94% mortality when *C. pavonana* larvae were treated with 0.05% extract mixture at 48 hours after treatment. The extract mixture of *A. odorata* and *A. squamosa* gave a synergistic combination with multiple actions, as feeding inhibition and insecticidal activity (Dadang *et al.*, 2007).

Generally, the two effective botanical insecticide formulations did not affect the performance of both parasitoids *D. semiclausum* and *E. argentiopilosus* on cabbage crops. Istiaji (1998) mentioned that the increasing of *A. squamosa* extract concentration increased the sensitivity of *D. semiclausum* but did not affect the development and parasitization level of *D. semiclausum*. In the field test, treatment of *A. squamosa* extract did not affect the parasitization level of *D. semiclausum*.



(Nurmayanti, 1998). *A. odorata* is highly toxic to *C. pavonana* and *P. xylostella* but not to *E. argentiopilosus*. The *A. odorata* extract works on insects as a stomach poison and not as a contact poison due to weak penetration ability of the active compound on the insect integument. Moreover, *A. odorata* has no repellent effect on the parasitoid, *E. argentiopilosus* adults, so application of this extract did not affect the parasitoid activity in terms of visiting cabbage crops (Sudarmo, 2001). It means that these botanical insecticide formulations are safe for field application and can be combined with the use of natural enemies in cabbage insect pest management program due to its selectivity in action. This result also proved that application of deltamethrin affected the parasitoid population. Deltamethrin is one of the pyrethroid insecticides that is categorized as a broad spectrum, unselective insecticide (Undiarto and Sastrosiswojo, 1997).

The treatment of RS 0.1% gave lowest percent damage and produced highest yield. Treatment of OS 0.1% also gave low percent damage but produced lower yield than deltamethrin treatment. The low cabbage yield may be caused by *A. odorata* extract. Sometimes, the application of *A. odorata* caused phytotoxicity to the crops and inhibited plant growth. This phenomenon should be evaluated. It gives experience to us to evaluate the overall effect before botanical insecticide formulations can be commercialized.

Based on the plant chemical nature, in terms of the concentration of active compounds that is strongly influenced by geographic and climate conditions, the availability of botanical insecticide formulation in the market is necessary. It will assure the quality of botanical insecticide formulation. Moreover, the formulations should contain two or more plant extracts to make the formulation more efficient in using plant materials, more economic in extract and formulation preparations, and more effective in toxicity and slow down the development of insect resistance (Dadang *et al.*, 2008). Another important matter in the application of botanical insecticide formulation should be its compatibility with other integrated pest management strategies.

## CONCLUSION

Two botanical insecticide formulations containing extract mixtures of *Piper retrofractum* and *Annona squamosa* (RS) and *Aglaia odorata* and *A. squamosa* (OS) showed high efficacy and were more effective than deltamethrin. Between the two formulations, RS 0.1% was more effective against *P. xylostella* than *C. pavonana*, while OS 0.1% gave the same effectiveness against *P. xylostella* and *C. pavonana* larvae. These formulations did not affect the performance of both parasitoids, *D. semiclausum* and *E. argentiopilosus*, on cabbage crops. Treatments with RS 0.1% and OS 0.1% resulted in significant reduction in cabbage damage compared to deltamethrin treatment. In addition, treatment with RS 0.1% produced highest cabbage yield.

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## **KEY ACTORS, PRICES AND VALUE SHARES IN THE PHILIPPINE COCONUT MARKET CHAINS: IMPLICATIONS FOR POVERTY REDUCTION**

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### **ABSTRACT**

The Philippine coconut market chains was examined for three products, namely, coconut oil (CNO), virgin coconut oil (VCO), and coco wine in terms of (1) the different market actors or participants that perform the various production and marketing services to ensure that products reach the end-users in the right form, time and place; (2) the price structure that reflects the value-addition through the various stages of the chain; and (3) the distribution of the final product value among the different market participants including the coconut farmer.

Socio-economic surveys were conducted in two municipalities in Quezon, the Philippines' largest coconut producing province. The farmers have limited participation in the coconut distribution chain since they remain in the lowest stage of the chain and sell only raw materials. There is considerable value-addition taking place as coconut products move through the chain as indicated by the extent of coconut processing into high value products. The shares of the different market actors in the final value of the coconut product vary. Although the farmer's share is relatively high for some coconut products, their income remains low compared to the other market participants such as the processors and traders. Thus, coconut farmers are among the poorest in Philippine agriculture. Government support is necessary to address the market development needs of coconut farmers in order to reduce poverty in coconut farming communities. These needs relate to inadequacy of capital, technical and entrepreneurial skills, equipment and tools, and market access and information. Specific measures may involve making institutional credit accessible to farmers, providing them training on product processing and quality improvement, and linking them to favorable markets. Additionally, there is a need to raise overall farm productivity through improved farm management practices. Efficient delivery of support services to farmers and initiatives for farm and marketing improvements will necessitate having strong farm organizations.

**Key words:** market actors, value-addition, poverty

### **INTRODUCTION**

The coconut industry provides significant income, employment and foreign exchange to the Philippine economy. According to the Bureau of Agricultural Statistics (BAS), the coconut area is 3.36 million hectares comprising 27% of the country's total cultivated area in 2007. Nut production is 14.85 million metric tons with a value of PhP59.71 billion at current prices. Coconut is the country's top agricultural export with foreign exchange earnings of US\$965 million in 2006. The Philippine Coconut Authority (PCA) reports that the industry provides employment to more than 3 million

coconut farmers and workers and to 25 million more Filipinos working in various coconut-based enterprises throughout the country.

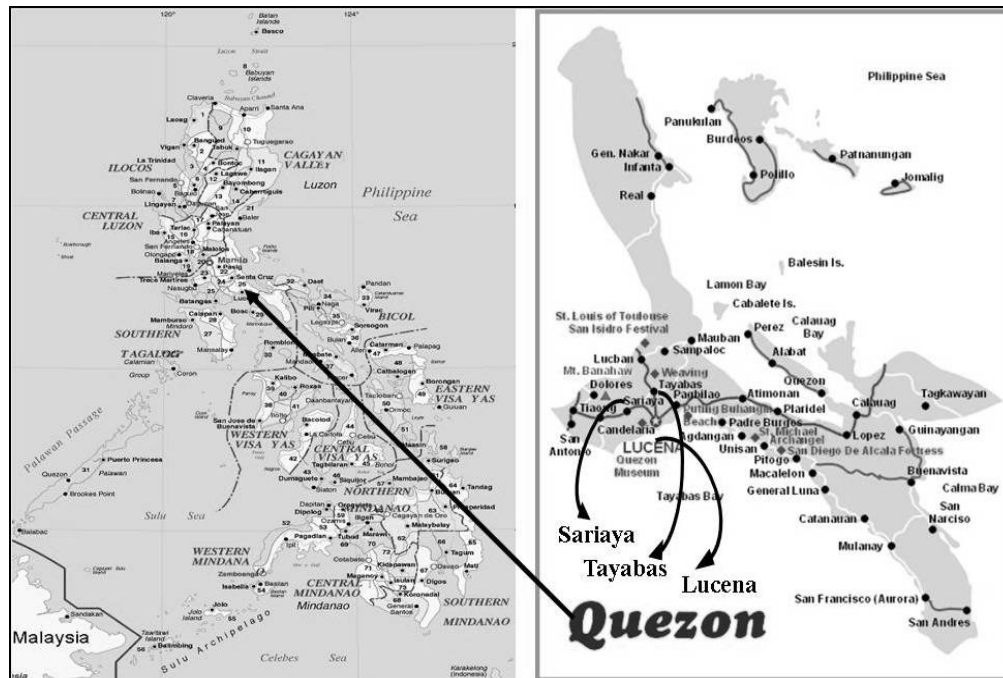
Despite this important contribution, the coconut farmers are considered among the poorest of the poor in agricultural communities (Balisacan, 1992). Aside from problems of low productivity and small farm sizes, coconut farmers are confronted with marketing-related difficulties such as the low and highly fluctuating prices and inability to find favorable market outlets for their products. In order to provide specific recommendations on how to improve the marketing system for coconut farmers, there is a need to have an in-depth understanding of the coconut market chains. By examining the market chain (or alternatively the production-to-consumption system), it is possible to determine how value-adding and marketing activities take place, who performs and benefits from these, and what are the constraints that need to be overcome by those who desire to benefit from value-addition. Market chain analysis can identify the principal constraints and possible solutions to improve the performance of the chain; and analyze the feasibility of opportunities for development through the adoption of innovations (production, packaging, adding value, transportation) or exploring of new markets. Pabuayon and Medina (2007) argued that linking farmers to markets and supporting value-adding activities can raise their income and thus provide incentives for improving their management practices toward greater farm productivity.

This paper (1) analyzes the market chains for the main coconut products produced in the municipalities of Sariaya and Tayabas, Quezon province; (2) identifies the constraints faced by farmers in seeking higher level markets and getting a better value for their products; and (3) discusses the implications for reducing poverty among the coconut farmers in the study area.

## **METHODOLOGY**

Socio-economic surveys were conducted in 2006 to obtain production and marketing-related information from coconut farmers, traders and processors. Thirty-five farmers were randomly selected while 23 traders and 25 processors were selected purposively based on their availability and willingness to provide information. The respondents were personally interviewed using questionnaires. The study area is Quezon province which is located some 150 kilometers southeast of Metro Manila (Fig. 1). Quezon is the largest coconut producing province in the Philippines and although primarily agricultural, has considerable potential for economic and business growth. Although most primary data came from the two municipalities of Sariaya and Tayabas, other pertinent information for the province as a whole was considered. Key informant interviews with the personnel of PCA and farmer leaders in the villages were also undertaken to obtain additional insights on the marketing constraints faced by farmers in the area.

The market chains for coconut products were drawn to indicate the flow of the commodity from the farmer through the different market intermediaries to the consumer. Prices were compared at the different stages or levels of the market chain to reflect the value-addition taking place and determine the marketing margins of the market intermediaries. The value shares of the different market participants were estimated by taking the farm price in the case of the farmer and the marketing margin in the case of the market intermediary (trader or processor) as a percent of the final value of the product at the consumer level (retail price). The marketing margin of an intermediary is the difference between his selling price and his buying price. This margin represents his contribution in the whole process of delivering the product from its source to its final destination in terms of the marketing services he provides. It is equal to the costs he incurs and the payment he receives for his capital, labor and management in providing the marketing services.



**Fig. 1.** Map of the Philippines showing Quezon province as the study area

## RESULTS AND DISCUSSION

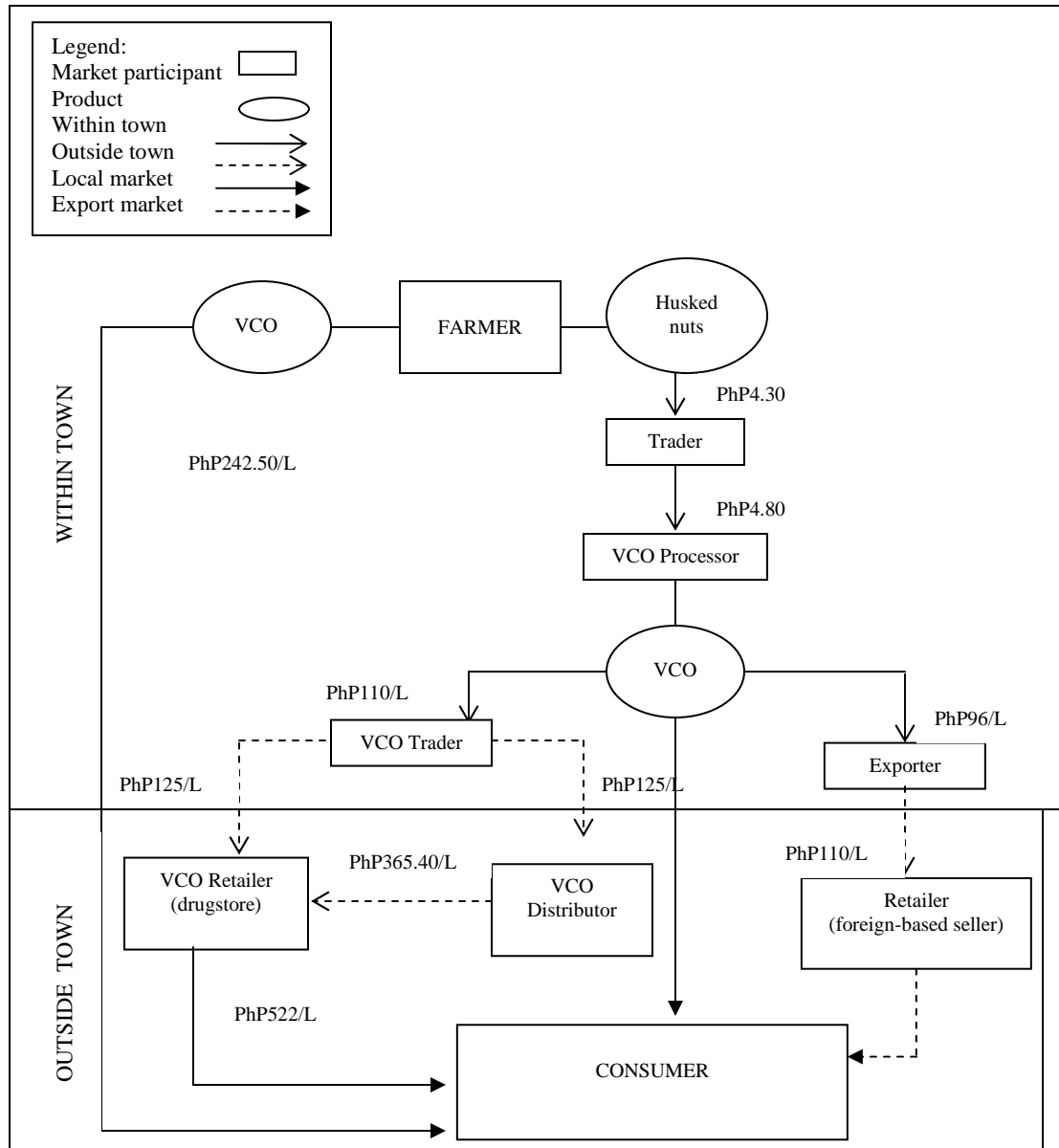
### Key Actors and Prices in the Coconut Market Chains

For major coconut products in Quezon, the market chains indicating the flow of the product through the various intermediaries are shown in Figures 2, 3 and 4. They reveal: (a) the movement of the coconut from the source (towns of Sariaya and Tayabas) to outside town outlets; (b) the transformation of the raw material (husked nuts) into other products such as coconut oil (CNO), desiccated coconut (DCN), coconut milk, and virgin coconut oil (VCO); and (c) the prices or values of the products at the various stages of the market chains. The flow of coco wine (produced from coconut toddy) is also shown. Called the “tree of life”, coconut yields many other products but these are not shown here.

There are different market channels for husked nuts or copra produced by the farmer (Fig. 2). He sells the husked nuts to the village agent at 3.60 Philippine pesos (PhP3.60) per kilogram (kg) who then sells them to the town trader at PhP3.75 per kg. The trader may sell the nuts to the retailer in the public market, wholesaler, coco milk processor, or desiccating processing plant at PhP5.00 per kg. The coco milk is sold to the consumer at PhP8 per kg in the town public market or PhP15 per kg at the supermarket outside town. The desiccated coconut is sold to the local or foreign-based food processors before reaching the final consumers. The farmer may also process the nuts into copra (i.e., dried coconut meat from which oil is extracted) which he sells to the town trader at PhP12.83 per kg. The trader then delivers the copra to the oil miller at PhP16.01 per kg. The oil miller produces the crude coconut oil and passes it on to the oil refiner at PhP26 per kg. The final product (cooking oil) is then sold to the consumer at PhP40 and PhP65 per liter for the unbranded and branded CNO, respectively. The town trader may also process the nuts he buys from the farmer into copra which is also sold to the oil miller.



The farmer may process the husked nuts into VCO or sell them to processors (Fig. 3). VCO could be sold to some traders including an exporter located in the town at PhP96 to PhP110 per liter. This is then sold to distributors and retailers based outside the town before getting into the hands of the final consumers. Some small volumes are sold directly by the processor to consumers. At this stage, the VCO could be in various forms, unflavored or flavored packed in different sizes, and may or may not be labeled and branded. Due to varying extent of value-addition, prices could range from PhP243 to PhP522 per liter. It is noted though that consumer packages are usually in smaller sizes of 500 ml or less. Considering that 12 nuts are required to produce 1 liter of VCO, the corresponding value of the raw material at PhP4.80 per nut is PhP57.60 at the farm level, excluding other intermediate inputs.

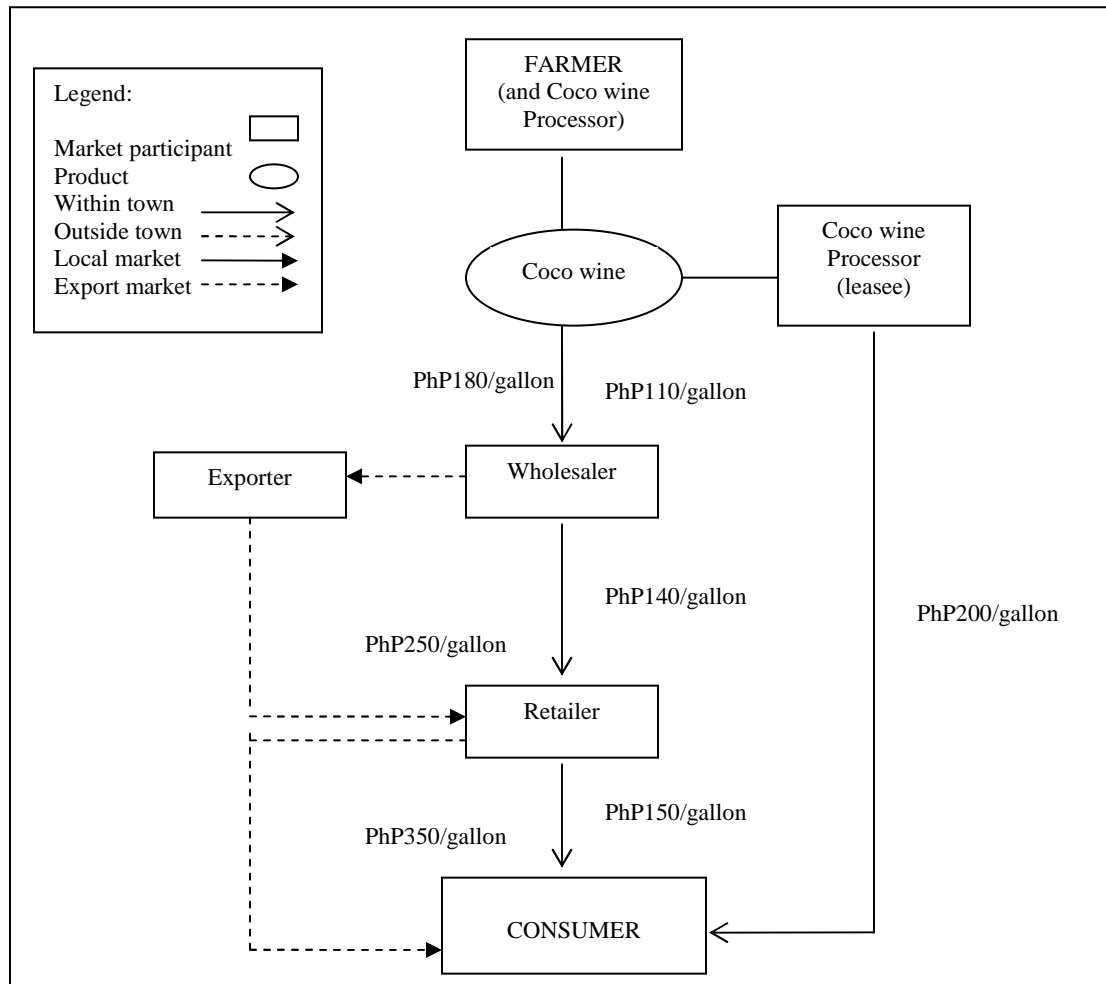


**Fig. 3.** Market chains for virgin coconut oil, Sariaya, Quezon, March 2006.



The bulk of coco wine produced by the farmer and any individual processor is sold to consumers in the local market through the wholesaler and retailer (Fig. 4). A limited volume of high quality coco wine, properly labeled, with improved packaging reaches the overseas markets. The farmer/processor sells at PhP110 per gallon to the wholesaler who passes it on to the retailer at PhP140, who finally sells to the consumer at PhP150. The prices at the various stages are higher when the wine is delivered to outside town buyers.

The activities performed in the chain are the exchange functions (buying, selling, wholesaling and retailing), physical functions (transportation, storage, processing, packaging), and facilitating functions (sorting and grading, financing, market intelligence, and various forms of market promotion). These activities add value to the product as indicated by the increasing prices when products move from lower to higher stages of the market chain. These marketing functions create place, time, form and possession utilities that provide satisfaction to consumers. Performance of these activities involves costs for the use of intermediate inputs and investment goods and payment of return to those who perform those activities.



**Fig. 4.** Market chains for coco wine, Sariaya, Quezon, March 2006.

### Distribution of Product Value Shares

For selected market channels, the market shares of the different market participants are shown in Table 1. For branded CNO sold at a supermarket outside the town, the equivalent values or prices at the different market levels are based on the following conversion factor: 1 kg (approximately 1 liter) of refined CNO = 1.081 kg crude CNO = 1.716 kg copra = 7.192 kg husked nuts. Here, the specific products are as follows: nuts at the farmer and agent's levels, copra at the trader's level, crude oil at the oil miller's level, and refined cooking oil starting at the oil refiner's level. Given their respective prices as shown above, the farmer's share of the final product value is close to 40%. The distributor and retailer combined get 53%, while the other intermediaries have much smaller shares.

For branded and flavored VCO which is processed from the nuts sold by the farmer and finally sold at an urban-based supermarket *cum* drugstore, the assumptions are as follows: 12 nuts are needed for 1 liter of VCO, price of nuts is PhP4.80 per kg, and price of VCO is PhP261 per 500 ml plastic bottle. The largest shares are for the distributor and retailer who provide additional services of bringing the product to an urban center; flavoring, branding and advertising of the product; and selling it through the supermarket. The farmer and processor get relatively smaller shares of 11% and 10%, respectively. The farmer produces the raw material (nuts) while the processor is engaged only in primary processing without much value-added while at the same time selling on picked-up and wholesale basis. The trader's contribution and therefore share is the least since his role is only to bring the product from the village-based processor to the distributor for further processing, packaging, labeling, market promotion, and distribution to retailers.

**Table 1.** Product value shares of the different market participants per unit of the product sold, Quezon, 2006.

Market Participant	Selling Price <sup>a</sup>	Buying Price <sup>a</sup>	Marketing Margin <sup>a</sup>	Percent Share (%)
<u>Branded CNO</u>				
Farmer	25.89	-	-	39.83
Agent	26.97	25.89	1.08	1.66
Town trader	27.47	26.97	0.50	0.77
Oil miller	28.11	27.47	0.64	0.98
Oil refiner	30.50	28.11	2.39	3.68
Distributor/retailer	65.00	30.50	34.50	53.08
Consumer	-	65.00	-	100.00
<u>Branded VCO</u>				
Farmer	57.60	-	-	11.04
Processor	110.00	57.60	52.40	10.04
Trader/wholesaler	125.00	110.00	15.00	2.87
Distributor	365.40	125.00	240.40	46.05
Retailer	522.00	365.40	156.60	30.00
Consumer	-	522.00	-	100.00
<u>Coco wine</u>				
Farmer/processor	110.00	-	-	73.33
Wholesaler	140.00	110.00	30.00	20.00
Retailer	150.00	140.00	10.00	6.67
Consumer	-	150.00	-	100.00

<sup>a</sup> Selling and buying prices are in PhP per liter for CNO and VCO and PhP per gallon for coco wine. During the time of survey (February to April 2006), the exchange rate is about 51.50 Philippine pesos per US dollar.

The simple channel for coco wine sold within the town involving only the wholesaler and retailer as intermediaries provides a considerable share of 73% to the farmer/processor. This is because of the relatively low final product value since no transportation and other value-adding costs are incurred. In the extreme case of the farmer selling directly to town consumers, the farmer will get 100% of the entire product value.

The above analysis shows that there is considerable value addition taking place in the market chains as indicated by the increasing prices of the coconut products as they move from the lower to higher stages of the chain. However, the farmer's participation in the marketing activities is quite limited as they remain in the lowest stage of the chain, the farm market level. Commonly, they sell only the raw materials (husked nuts or copra) and therefore receive the lowest price among the various market participants. Although it appears that the farmer's share is quite high especially in the case of coconut oil and coco wine, this does not necessarily translate into high farm income. The shares are based on per unit product value and since farmers have small farm sizes, low farm productivity and therefore have low marketable surplus, their incomes are generally low (Pabuayon and Medina, 2007). In fact, among the key market actors, the farmer has the lowest income (Table 2). While the trader and oil miller have much smaller shares of the final product value, their incomes are considerably higher because of their large scale operations. Incidentally, they have considerable advantage over the farmers as they have the required capital, managerial skills, and access to market and information. On the other hand, the farmers are in a disadvantaged position. Although VCO is a high-value product, farmer-processors do not get high income due to small-scale operation and inability to undertake other value-adding activities like improved packaging, labeling, advertising, and selling in high-end markets. Pabuayon (2008) reported that the coconut farming communities in the Philippines have higher poverty incidence compared to the country as a whole.

**Table 2.** Estimated average income (before tax) of key participants in the coconut market chains, Quezon, 2006

<b>Market Participant</b>	<b>Products Produced/Sold</b>	<b>PhP per Month</b>
Farmer	Husked nuts	892 – 1,138
Farmer/processor	VCO	6,762
Trader	Husked nuts, copra, charcoal	84,960
Oil miller	Crude CNO, copra cake	0.80 – 2.55 million

### **Constraints Faced by Farmers**

The existing marketing system wherein farmers usually just sell raw materials and often to village-based traders indicates their inability to provide greater value for their products and seek higher-level markets. There are various reasons why the current marketing practices persist. These are:

- (1) no minimum or maximum volume required by the local trader; farmer can sell any volume without any purchase order or written contract governing sale
- (2) product can be delivered to or picked up by the trader anytime
- (3) buyer could be easily contacted whenever there is some product for sale
- (4) all sizes and qualities are accepted although some buyers may reject over-mature and cracked nuts and impose price discounts for copra not meeting the moisture and quality requirements
- (5) farmers are immediately paid in cash upon sale and can request for cash advances or loans charged against future sales although this arrangement provides very little market power for farmers during actual sale

- (6) long-time relationship between farmer and trader
- (7) no transport and delivery problem to higher-level markets
- (8) belief that there is no significant price advantage for products sold to town or provincial buyers

Farmers are constrained from engaging in value-adding activities and exploring alternative marketing options (Table 3). The primary reasons relate to lack of technical knowledge and inability to finance the business. Technical seminars have not been conducted yet in their area according to the farmers while others stated that although they have already attended seminars on VCO processing they still could not get the right quality required by the market. They do not have start-up capital for processing equipment and operations. Others contend that their harvest is small to support processing while some are not certain how and to whom they could sell their products.

**Table 3.** Constraints in engaging in coconut-based enterprises and in linking with markets

Constraints in Enterprise Development <sup>a</sup> %		Constraints in Linking With Markets %	
Lack of technical knowledge	55	Poor roads, high transport cost	13
Lack of capital	52	No assistance, no information	18
Lack of equipment for processing	18	Limited coconut production	15
Limited coconut production	16	Lack of capital	11
No sure market	11	Cannot compete with other sellers	16
Time management problem	5	No response	27
<sup>a</sup> Multiple response		All	100

Poor roads and high transport cost, lack of market information, limited volume for sale, lack of capital, and inability to compete with those who have large surplus to sell make it difficult for farmers to link with favorable markets. Table 4 presents the problems and constraints reported for specific coconut products.

**Table 4.** Product-specific problems reported by coconut producers and sellers

Coconut Products	Problems/Constraints
Husked nuts and copra	<ul style="list-style-type: none"> <li>• Infestation of pests and diseases and adverse weather conditions</li> <li>• Poor post harvest handling resulting to poor quality products</li> <li>• Poor farm-to-market roads</li> <li>• Limited access to markets and buyers</li> </ul>
Virgin coconut oil	<ul style="list-style-type: none"> <li>• Lack of big buyers</li> <li>• Lack of capital</li> <li>• Lack of technical and entrepreneurial skills</li> <li>• Limited quality control</li> </ul>
Coco wine	<ul style="list-style-type: none"> <li>• Absence of product standards</li> <li>• Inadequate quality control among small scale producers</li> <li>• Poor linkage with higher-level markets</li> <li>• Limited product development</li> <li>• Rising cost of production</li> </ul>

## **CONCLUSIONS AND POLICY IMPLICATIONS**

Due to lack of adequate resources, farmers are constrained from adopting various marketing and value-adding activities that will improve farm income. Primarily, farmers are unable to add value to their products and to reach higher level markets. As a result, they receive low prices for their products causing limited incentives for improving farm productivity. Although village-level processing of VCO and coco wine is possible, these are limited to a few farmers with adequate resources. Comparatively, farmers realize much lower income than the other players in the market such as traders and processors. This partly explains the relatively higher poverty incidence in coconut farming communities compared to the rest of the country.

In order to alleviate poverty in coconut farming communities, the policy initiatives should focus on providing assistance to farmers towards addressing their market development needs and improvement of the current marketing system. The critical needs are capital, technical assistance and training, equipment and tools, and market information to enable farmers to undertake processing and put up village-level enterprises for producing higher-value products, improve product quality, and forge linkages with favorable markets. They also need to increase their harvest through higher farm productivity to support the raw material needs of the new enterprises.

Higher productivity could be achieved through improved farm management practices including multiple cropping and replacement of senile trees with new ones. They need reliable information on prices and favorable market outlets for their products. Toward meeting these needs, the Philippine Coconut Authority must re-focus its extension program to provide a holistic package of services on technology, information, credit, markets, and entrepreneurship. On the part of the farmers, they must strengthen their organizations to enable them to undertake collective action for efficient marketing of their products, improved bargaining for better prices with their buyers, and better coordination in obtaining available services and resources from the government and NGOs. Better organization of farmers is possible through continuous training and capacity-building, sustained support from the government, and improved business linkages with the private sector.

## **ACKNOWLEDGEMENT**

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## **MICROBIAL ORGANIC FERTILIZER APPLICATION FOR SAFE COFFEE PRODUCTION AT DAKLAK, VIETNAM**

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### **ABSTRACT**

A replacement for chemical fertilizers using microbial organic fertilizer was investigated for 2 years to decrease production cost for safe coffee production in DakLak province, Vietnam. Through experimental research and during the course of the establishment of production models, the yield and quality were maintained. In addition, the production cost was reduced, when 4 tons of microbial organic fertilizer replaced the combination of 70% of chemical fertilizers with 5 tons of normal manure. It is an easy method and has the advantage of producing microbial organic fertilizer in local production sites. The economic effectiveness of this replacement technology was higher than that of currently practiced coffee production methods by about 5 million VND per hectare. This increases the capability of stable coffee production in DakLak, Vietnam.

**Key words:** Chemical fertilizer, normal manure, coffee yield

### **INTRODUCTION**

DakLak Province has suitable ecological conditions of soil and climate for coffee production. In the last few decades, the average yield of coffee has increased continuously: from 0.7 to 0.8 tons in 1980, to 3 to 4 tons coffee seeds per hectare at present. In order to attain such high coffee yield, however the producers have to invest heavily in inputs, especially in chemical fertilizers. By our survey most of the coffee producers in Daklak applied 270 kg N, 90 kg P<sub>2</sub>O<sub>5</sub>, 270 kg K<sub>2</sub>O, and 5 tons of manure in order to meet the target of 3 tons *Robusta* seeds as well as 2.5 tons *Arabica* seeds per hectare. In Vietnam, coffee hectareage increased continuously from 1980 - 22,000 ha; 1990 - 119,000 ha; 2000 - 397,000 ha; 2003 - 470,000 ha and slowly increased in 2004 - 500,000 ha (General Statistical Office, 2000 and 2005). At present, the price of coffee is going down continuously, while the price of fertilizer is increasing dramatically. Coffee producers suffered from huge losses making coffee production unstable. In order to solve this problem, it would be necessary to look for new cultivation solutions to reduce cost and increase quality of coffee product.

One of the solutions may involve the use of microbial organic fertilizer. The companies, Noble Hilter (1896) and Pham Van Toan (2004) were successful in producing Nitragin for soybean and a special microbial fertilizer for some kinds of crops, respectively. It increased tomato yield by 20.5%, potato yield from 30.9 to 72.9%, peanut yield from 13.3 to 19.1%, and coffee yield by 16.2%. Nguyen Xuan Thanh (2003) showed that multiple functions of microbial organic fertilizer increased useful soil microbial density which led to increases in soybean bud ratio, 17.3%; plant height; 35.8%, living mass weight, 35.1%; effective nodules, 76.1%, and soybean yield, 33.8%. In the last decade, the Korean Natural Farming Association (KNFA) received a lot of attention because of its remarkable success in productivity and profitability with minimum labor requirement through full use of local natural microbe potential (Han and Koyama 1997). In Vietnam, the Vietnam Productivity Center (VPC) of Hanoi Agricultural University (HAU) transferred this technology successfully from Korea on rice and some kinds of vegetable, and showed that using microbial organic fertilizer could replace 50% of chemical

fertilizer while crop yield remained with improved safety. The  $\text{NO}_3^-$  content in the treated products is lower than that of untreated control and lower than the  $\text{NO}_3^-$  content threshold,  $\leq 500 \text{ mg/1 kg}$  fresh vegetable set by FAO and WHO as cited in Decree number 867/1998/QĐ-BYT of the Ministry of Public Health, Vietnam.

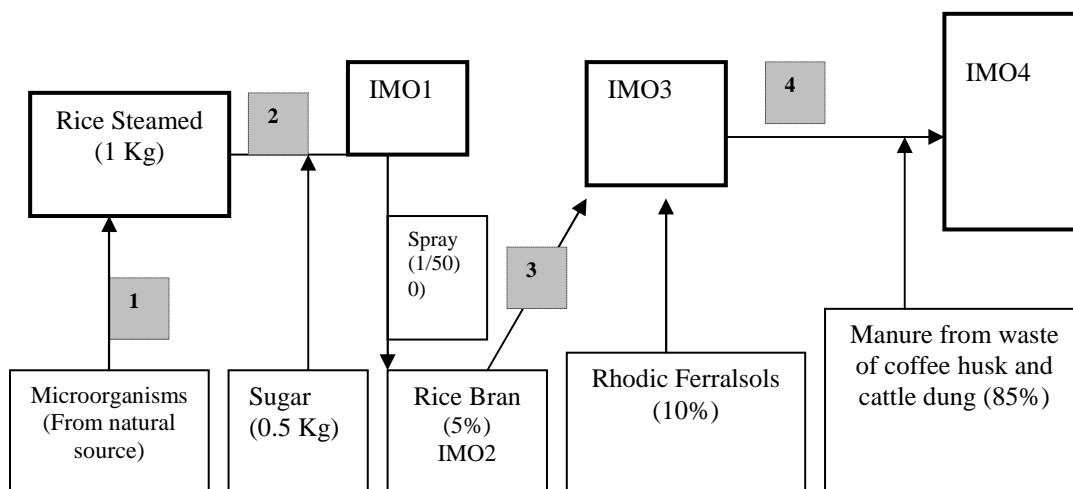
The research was conducted to demonstrate the utilization of local nutrient sources by using local microorganisms for coffee production in DakLak to increase productivity.

## MATERIALS AND METHODS

The Ea Tul Coffee Company is located in the Ea Tul Commue, Cu M'gar district, DakLak Province. It is about 30 kilometers in the north east direction from the center of Buon Ma Thuot City and about 12 kilometers from the town of Cu M'gar.

The average altitude of the study site is from 500 to 620 meters above sea level and was in the past a center of volcanic activities. Weathering of basalt rock of the site created Rhodic Ferralsols soil layers which are very fertile with a diversity of microorganisms and suitable for industrial crops like coffee. It has two distinct seasons: wet season and dry season. The dry season begins in November to April and wet season is from May to October. The average annual rainfall is 1,916 mm. and annual evaporation is 90 mm. The average air temperature is  $23.4^\circ\text{C}$  and air humidity average is 83%. The experiment soil physical characteristics were: bulk density,  $1.03 \text{ gram/cm}^3$ ; particle density,  $2.66 \text{ gram/cm}^3$ ; porosity, 61.28 % and clay ratio: 60.58%

IMO is collected from the local forest or rice field after harvest by placing a box of steamed rice in the field and covering it with decayed leaves or straw for three to five days.



**Fig. 1.** Package technique to produce IMO4 that will replace manure in the experiment.

Notes: (1) = 3-5 days; (2) = 2-3 days; (3) = 5-7 days; (4) = 15-30 days

Both the experiment and household models were carried out on 5 year old *Coffea canephora* var. *Robusta* for two years. The main materials used included urea nitrogen: 1450 kg; Tecmophosphorus: 1235 kg; Kali Clorua: 1502 kg; manure: 15220 kg; rice bran: 860 kg, Rhodic Ferralsols soil and some sugar.



The field experiment included the following treatments:

- Treatment 1(Control): NPK (270N – 90P<sub>2</sub>O<sub>5</sub> – 270 K<sub>2</sub>O) + 5 tons of manure.
- Treatment 2: 100% NPK + 1 ton IMO<sub>4</sub>
- Treatment 3: 25% NPK + 4 tons IMO<sub>4</sub>
- Treatment 4: 0% NPK + 5 tons IMO<sub>4</sub>

The application of fertilizer in Treatment 1 is according to farmer practice. The experiment was arranged based on a complete randomized block design, with plot size of 400 square meters with 3 replications (Gomez and Gomez, 1984).

The household model treatments included the following:

- Treatment 1: NPK (270N - 90 P<sub>2</sub>O<sub>5</sub> - 270 K<sub>2</sub>O) + 5 tons of manure
- Treatment 2: 30% NPK (81N - 27 P<sub>2</sub>O<sub>5</sub> - 81 K<sub>2</sub>O) + 4 tons IMO<sub>4</sub>

There were 5 household models, each of them with an area of 1 hectare, of which the area for treatment 1 and 2 are 0.2 and 0.8 hectare, respectively. *Coffea canephora* var. *Robusta* trees were planted in 1996 with a plant density of 1,100 plants per hectare, and shadow trees fixed with a density of 80 plants per hectare. The five models in five farm households were: H'Mrao; H'Blonh; H'Ngong; H'Blon; H'Mon. Fertilizer application was dressed following the same common package technique for both experiment and models according to the time table:

**Table 1.** Time table of fertilizer dressing

Items	Percentage in each time of top dressing				
	March - April	May	June - July	September - October	November-December
Manure/IMO <sub>4</sub>					100
Nitrogen	15	25	30	30	0
Phosphorus	0	30	35	35	0
Potassium	0	50	0	50	0

#### Indicators studied

Several soil chemical characteristics before and after the experiment were analyzed to include: pH<sub>KCL</sub>, organic matter, total of N, P, K available P, K, exchanged Ca, Mg, and CEC. Soil microorganisms before and after the experiment, were also evaluated including: nitrogen fixing bacterium, cellulose decomposing microbe, aerobic total microorganism, fungi. Coffee growth was also evaluated through length of branches, number of leaf pairs per branch, branch diameter, ratio of shed fruit, and nutrient concentration in coffee leaves. Weight and fruit size, weight and seed size, ratio of fresh fruits/seed were likewise monitored while productivity and economic effects were analyzed.

All the observed indicators on the growth and fruits, seed of coffee were sampled randomly following tree's canopy, medium growth situations. Except for indicators on fruits, seeds were observed right after harvest and randomly on stacks of coffee fruits. Methods for soil physical and chemical characteristics determination included:

1. bulk density was determined by Core method (Grossman et al., 2002)
2. particle density was determined by pycnometer method (Alan et al., 2002)
3. clay content was determined by pipette method (Glendon et al., 2002)
4. organic matter (OM) was determined by Walkley-Black method (Nelson et al., 1996)
5. total nitrogen was determined by Kjeldahl method (Bremner, 1996)
6. total phosphorus: Digestion with perchloric acid to determine the P concentration by Ascorbic Acid method (Kuo, 1996)

7. available P is determined by Olsen method ( $\text{NaHCO}_3$  extraction) (Schoenau and Karamanos, 1993)
  8. total K: digestion by Smith, determine the K Concentration by flame photometric method (Vadzenin, 1975)
  9. Available K: ammonium acetate method (Helmke 1996)
  10. Available N is determined by Tiurin and Kononova method (Vadzenin, 1975)
  11.  $\text{Ca}^{++}$  and  $\text{Mg}^{++}$ : ammonium acetate method (Suarez 1996)
  12. soil microbial count by Agamedium method (Nguyen xuan Thanh, 2007).
- All soil samples were sampled by mixed random method right after the last coffee harvest.

### Data analysis

Basal statistical parameters are calculated by Excel Software and Analysis of Variance (ANOVA) for experimental data is done by IRRISTAT 4.0. Economic effect of applying microbial organic fertilizer to coffee was calculated based on price table of materials in the Appendix

## RESULTS AND DISCUSSION

### Field trials

Soil chemical characteristics, before and after the experiment, were analyzed and the results are presented in Table 2. There are no differences in the soil chemical indicators among treatments before or after the experiment. This proves that there were no significant changes in the soil chemical characteristics due to the treatments.

**Table 2.** Soil chemical characteristics before and after the experiment ( 0 - 30 cm soil layer).

Items	Before	After			
		Trt 1	Trt 2	Trt 3	Trt 4
$\text{pH}_{\text{Kcl}}$	4.00	4.22	3.91	4.05	3.85
OM (%)	3.28	3.28	3.38	3.35	3.50
N (%)	0.16	0.16	0.15	0.16	0.16
$\text{K}_2\text{O}$ (%)	0.06	0.06	0.07	0.06	0.06
$\text{P}_2\text{O}_5$ (%)	0.20	0.19	0.19	0.19	0.19
$\text{K}_2\text{O}$ (mg/100g soil)	13.13	13.9	14.10	12.30	12.90
$\text{P}_2\text{O}_5$ (mg/100g soil)	5.50	6.60	6.10	5.70	5.10
$\text{Ca}^{2+}$ (me/100g soil)	3.20	2.50	3.10	3.00	3.10
$\text{Mg}^{2+}$ (me/100g soil)	1.70	1.90	1.70	2.00	1.80

Regarding the soil microbial components, all treatments where microbial organic fertilizer had been applied at different levels, the soil microbial component increased much more than the soil microbial component in untreated controls (Table 3). The more microbial organic fertilizer applied, the more the microbial density increased. This is a good opportunity for transferring organic matter in the soil and converting unavailable matter into available matter to increase crop productivity.

In addition, with the high density of nitrogen fixing bacteria, the nitrogenous content in the soil would be enriched. This can be an advantage for improving soil fertility and increasing crop productivity.

**Table 3.** Soil microbial component after the experiment.

Items	Trt 1	Trt 2	Trt 3	Trt 4
Humidity (%)	31	32	32	32
Total aerobic microorganism ( $10^6$ )	9.10	19.10	40.30	35.50
Total anaerobic bacterium ( $10^3$ )	0.48	3.38	12.10	12.00
Total fungi CFU ( $10^3$ )	11.45	13.86	17.60	15.78
Total untinomycete CFU ( $10^3$ )	6.70	8.90	14.98	14.37
Ammonificator CFU ( $10^3$ )	0.36	4.40	5.33	5.21
Phosphorus lysogenic bacterium CFU ( $10^3$ )	32.40	39.20	52.40	55.90
Cellulose lysogenic bacterium CFU ( $10^3$ )	0.92	1.32	1.95	1.86
<i>Azotobacter</i> CFU ( $10^3$ )	12.65	26.53	43.89	42.68
<i>Rhizobium</i> CFU ( $10^3$ )	6.30	7.,80	30.78	31.45
<i>Clostridium</i> CFU ( $10^2$ )	0.13	0.48	1.07	0.98

In order to determine the role of the microbial organic fertilizer to coffee, the nutrient profile in the coffee leaves of the various treatments were monitored (Table 4). There is no clear difference in coffee leaf nutrient indicators of the different treatments. It is the same situation for treatments with IMO<sub>4</sub> at different rates.

**Table 4.** The effect of microbial organic fertilizer (IMO<sub>4</sub>) on nutrient concentration in experimental coffee leaves.

Treatment	Nutrient content (%)				
	N	P	K	Ca	Mg
100%NPK + 5 tons manure	3.09	0.13	2.35	1.63	0.51
100%NPK + 1 ton IMO <sub>4</sub>	3.10	0.12	2.28	1.55	0.53
25%NPK + 4 tons IMO <sub>4</sub>	2.95	0.13	2.31	1.53	0.50
5 tons IMO <sub>4</sub>	2.98	0.13	2.28	1.59	0.48

The effect of different fertilizer treatments on the growth of branches and leaves of coffee were also monitored (Table 5). The growth of main branch and leaf pairs per branch of coffee is different between treatments. The lowest growth occurred in Treatment 2 (100% NPK + 1ton IMO<sub>4</sub>) and the differences among other treatments are not statistically significant. Nevertheless, branch and leaf growth in Treatment 3 (25% NPK + 4 tons IMO<sub>4</sub>) represents a better trend. In this case, the role of manure fertilizer, especially IMO<sub>4</sub>, is very important for the growth of branches and leaves of coffee because in IMO<sub>4</sub> there are microorganisms that can break down organic matter into accessible type, and it can also fix nitrogen from the air to provide to coffee.

**Table 5.** The effect of microbial organic fertilizer on growth of main branch and leaf pair per branch.

Treatment	Main branch		Leaf pair/branch	
	cm <sup>*</sup>	(%)	No. of pairs <sup>*</sup>	%
100% NPK + 5 tons manure	26.8 <sup>a</sup>	100.00	2.5 <sup>a</sup>	100.00
100% NPK + 1 ton IMO <sub>4</sub>	23.0 <sup>b</sup>	86.01	2.3	92.13
25% NPK + 4 tons IMO <sub>4</sub>	27.4 <sup>a</sup>	102.45	2.5 <sup>a</sup>	99.84
5 tons IMO <sub>4</sub>	27.3 <sup>a</sup>	102.03	2.4 <sup>b</sup>	99.07
LSD <sub>0.05</sub>	<b>3.38</b>		<b>0.43</b>	

\* The numbers in one column having the same letter in superscript are not significantly different.

Growth of coffee branch diameter and ratio of shed fruit for the various treatments are shown in Table 6. There was no difference in the growth of branch diameter among treatments. The difference is clear for the ratio of shed fruit between Treatment 2 (100% NPK + 1 ton IMO<sub>4</sub>) compared to the other treatments. The ratio of shed fruit in Treatments 3 and 4 are the lowest. Thus, in this case IMO<sub>4</sub> affects the growth of branch diameter and it can limit the ratio of shed fruit.

**Table 6.** The effect of microbial organic fertilizer on coffee growth of branch diameter and ratio of shed fruit.

Treatment	Branch diameter		Ratio of shed fruit (%)
	mm <sup>*</sup>	%	
100%NPK + 5 tons manure	3.26 <sup>ab</sup>	100.00	3.9
100%NPK + 1 ton IMO <sub>4</sub>	3.17 <sup>b</sup>	97.14	4.6
25%NPK + 4 tons IMO <sub>4</sub>	3.47 <sup>a</sup>	106.46	3.2
5 tons IMO <sub>4</sub>	3.38 <sup>ab</sup>	103.55	3.2
LSD <sub>0.05</sub>	<b>0.22</b>		

\* The numbers in one column having the same letter in superscript are not significantly different.

There is no statistically significant difference between treatments on all of the recorded indicators of plant growth (Table 7).

**Table 7:** The effect of microbial organic fertilizer on fresh fruit ratio/seed and fruit weight of coffee.

Treatment	Fresh fruit ratio /seed <sup>*</sup>	Weight of 100 fruits (g) <sup>*</sup>	Volume of 100 fruits (cm <sup>3</sup> ) <sup>*</sup>
100%NPK + 5 tons manure	6.94 <sup>ab</sup>	137.8 <sup>a</sup>	134.2 <sup>a</sup>
100%NPK + 1 ton IMO <sub>4</sub>	6.84 <sup>b</sup>	134.8 <sup>a</sup>	131.2 <sup>a</sup>
25%NPK + 4 tons IMO <sub>4</sub>	7.00 <sup>a</sup>	138.3 <sup>a</sup>	133.9 <sup>a</sup>
5 tons IMO <sub>4</sub>	7.01 <sup>a</sup>	136.9 <sup>a</sup>	132.4 <sup>a</sup>
LSD <sub>0.05</sub>	<b>0.29</b>	<b>8.52</b>	<b>5.78</b>

\* The numbers in one column having the same letter in superscript are not significantly different.

Data on coffee yield of fresh fruit and seed of the different fertilizer treatments are presented in Table 8. There is no statistical difference which means that the use of organic fertilizer is not inferior to that of chemical ones.

**Table 8:** The effect of microbial organic fertilizer on the yield of coffee fresh fruit and seeds.

<b>Treatment</b>	<b>Yield of fresh fruit<sup>*</sup> (tons per hectare)</b>	<b>Yield of seeds<sup>*</sup> (tons per hectare)</b>
100%NPK + 5 tons manure	16.450 <sup>a</sup>	2.380 <sup>a</sup>
100%NPK + 1ton IMO <sub>4</sub>	15.110 <sup>a</sup>	2.190 <sup>a</sup>
25%NPK + 4 tons IMO <sub>4</sub>	16.592 <sup>a</sup>	2.380 <sup>a</sup>
5 tons IMO <sub>4</sub>	15.520 <sup>a</sup>	2.210 <sup>a</sup>
<b>LSD<sub>0.05</sub></b>	<b>3.661</b>	<b>0.509</b>

\* The numbers in one column having the same letter in superscript are not significantly different.

The recorded quality of coffee seeds are presented in Table 9. The results demonstrated no statistically significant difference on the weight of 100 seeds between treatments. It has been demonstrated that coffee seeds that are bigger in size have better quality (Nguyen Sy Nghi, 1982). In this study two treatments (1. applying enough 100% NPK + 1 ton IMO<sub>4</sub> and 2. Only 5 tons IMO<sub>4</sub>) having significantly lower ratio of seed with large seed size (>6.3mm). Thus, replacing 5 tons manure with 4 tons IMO<sub>4</sub> reduced 70 percent of chemical fertilizer amount than the usual but the quality of coffee seeds was still maintained. In addition, the production cost is reduced and the safety of the products was also improved.

**Table 9.** The effect of microbial organic fertilizer on quality of coffee seeds.

<b>Treatment</b>	<b>weight of 100 seeds<sup>*</sup> (g)</b>	<b>Ratio of seed size (%)</b>		
		<b>&gt; 5.1 mm<sup>*</sup></b>	<b>5.1 – 6.3 mm<sup>*</sup></b>	<b>&gt; 6.3 mm<sup>*</sup></b>
100%NPK + 5 tons manure	11.8 <sup>a</sup>	3.56 <sup>b</sup>	85.58 <sup>ab</sup>	10.87 <sup>a</sup>
100%NPK + 1 tons IMO <sub>4</sub>	11.5 <sup>a</sup>	4.40 <sup>ab</sup>	86.62 <sup>a</sup>	8.98 <sup>c</sup>
25%NPK + 4 tons IMO <sub>4</sub>	11.4 <sup>a</sup>	4.42 <sup>ab</sup>	85.11 <sup>b</sup>	10.47 <sup>ab</sup>
5 tons IMO <sub>4</sub>	11.5 <sup>a</sup>	4.89 <sup>a</sup>	85.42 <sup>ab</sup>	9.69 <sup>bc</sup>
<b>LSD<sub>0.05</sub></b>	<b>0.8</b>	<b>1.11</b>	<b>1.21</b>	<b>1.13</b>

\* The numbers in one column having the same letter in superscript are not significantly different.

The account of economic effect of this technique should be checked whether it can increase economic effect (Table 10). We determined that it is the same gross income in both treatments, where 100% NPK + 5 tons manure and 25% NPK + 4 tons IMO<sub>4</sub> were applied. In the second case, the price of coffee was higher because it is a safer product, thus its gross income would be higher. Because this involved reducing 70 percent of the chemical fertilizer from the usual, the production cost was greatly reduced by about 4,000 VND per hectare resulting in an increase in net income for the second case.

**Table 10.** Economic effect of applying microbial organic fertilizer to coffee.

Treatment	Fertilizer	Cost* Other Costs	Total	Gross income*	Net income*
100%PK + 5 tons manure	7,348	12,000	19,348	38,080	18,732
100%PK + 1 tons IMO <sub>4</sub>	5,298	12,000	17,298	35,040	17,742
25%PK + 4 tons IMO <sub>4</sub>	3,012	12,000	15,012	38,080	23,068
5 tons IMO <sub>4</sub>	2,250	12,000	14,250	35,360	21,110

\* Thousand VND per hectare

### Model farm trials

Five models were established in 5 farm households with two treatments in each model. Treatment 1 was the traditional one: 100 % chemical NPK and 5 tons manure while Treatment 2 was an improved one: 25% chemical NPK and 4 tons IMO<sub>4</sub>. In all of the model farms, the production cost for Treatment 2 is always lower than that of treatment 1, by about 2 million VND per hectare, but the yield was higher than that of Treatment 1 (Table 11). Thus, gross income from Treatment 2 in all 5 models is higher than gross income of Treatment 1. This creates a net income of all Treatment 2 in 5 models that are higher than that of Treatment 1. The higher numbers range from about 4.3 to 7.3 million VND per hectare and the increased income average is 5.245 million VND per hectare.

**Table 11:** Economical effect of coffee models in 2005 (Thousand VND per hectare).

Household Models	Treatment	Total Cost	Gross income	Net income	Difference in net income (Trt 2-Trt 1)
H'Mrao	1	17,680	41,745	24,065	
	2	15,504	45,045	29,541	5,476
H'Mon	1	17,680	36,630	18,950	
	2	15,504	39,270	23,766	4,816
H'Blon	1	17,680	36,960	19,280	
	2	15,504	42,075	26,571	7,291
H'Ngong	1	17,680	39,105	21,425	
	2	15,504	41,250	25,746	4,321
H'Blonh	1	17,680	34,815	17,135	
	2	15,504	36,960	21,456	4,321
<b>Average</b>	1	<b>17,680</b>	<b>37,851</b>	<b>20,171</b>	
	2	<b>15,504</b>	<b>40,920</b>	<b>25,416</b>	<b>5,245</b>

## **CONCLUSION**

The use of microbial fertilizers can replace to some extent the use of chemical fertilizers in coffee production in DakLak, Vietnam. The technology resulted in reduced production cost and increased gross income such that net income increased. One hectare of coffee produced by using microbial organic fertilizer can give the benefit of 5.2 million VND (equal 26%) higher than the traditional way. This will open a new direction for safe coffee production at DakLak by utilization of local manure source together with local micro-organisms to make microbial organic fertilizer for coffee production. This will contribute to a stable and safe coffee production in the region.

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#### **APPENDIX TABLE**

The price of some material items and man power

<b>Items</b>	<b>Unit</b>	<b>Amount</b>	<b>Price (VND)</b>
Urea	Kg	1	5,000
Termophosphorus	Kg	1	1,200
Potassium	Kg	1	4,500
IMO4	Kg	1	450
Coffee seed	Kg	1	16,500
Man power and Irrigation fee	Ha	1	12,000,000
USD		1	15,500



**EFFECTS OF NaCl SALINITY ON THE SUGAR METABOLISM OF COMMON BEAN (*PHASEOLUS VULGARIS* L.) CV. 'TSURUNASHI MARUSAYA KURO SANDO' FRUIT GROWN IN SOLUTION CULTURE**

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**ABSTRACT**

Common bean is an important source of amino acid in Southeast Asia, where salinity as well as other abiotic stresses is an important growth limiting factor. In order to examine the effect of salinity on the edible part of common bean, effects of 60 mM NaCl addition to Hoagland No. 2 nutrient solution on the sugar metabolism of developing pericarps and seeds of common bean (*Phaseolus vulgaris* L.) cv. 'Tsurunashi Marusaya Kurosando' were studied. In pericarps, the hexose (glucose and fructose) concentration was slightly affected, but that of sucrose and starch was increased markedly by salinity. The activity of acid invertase (EC 3.2.1.26) was suppressed, and that of sucrose phosphate synthase (EC 2.4.1.14) was enhanced by salinity, suggesting the role of these enzymes in the accumulation of sucrose in the pericarp. The activity of sucrose synthase (EC 2.4.1.13) was not much affected by salinity. Salinity had little effect on the composition and the activities of sucrose metabolizing enzymes of seeds. This experiment showed the severity of the effects of salinity was different among whole plant, pods and seeds. The results show the potential for the production of common bean for seeds in Southeast Asia especially with respect to salinity tolerance.

**Key words:** invertase, seed, sucrose phosphate synthase, sucrose synthase

**INTRODUCTION**

In some Southeast Asian countries where cereals are the main dietary supply, deficiency of essential amino acids, e.g. lysine, is a problem (Pellet, 1996). In such countries, beans including common bean are important supplements because they have high lysine content (van der Maesen and Somaatmadja, 1989). Salinity is a serious problem in some places of Southeast Asia, such as Thailand (Dobermann and Fairhurst, 2000; Sinanuwong and Takaya, 1974). In addition, the tsunami in 2004 caused flooding of sea water in farming areas (Slavich et al., 2008).

Common bean is a relatively salt sensitive crop (Greenway and Munns, 1980). So, it is not recommended to intentionally plant common bean in saline soil. However, gradual salinization can occur in common bean farms. The effect of salinity on its growth has been reported (Valdez et al., 2002; Yamauchi et al, 1997). The edible part of common bean is usually the mature seeds, while the whole fruit, consisting of immature pericarp and immature seeds, is sometimes used as vegetable. Even in the case of seed production, however, the metabolism of the pericarp may affect seed growth during development. Thus, the effects of salinity on the growth and composition of common bean fruit should be assessed for pericarp and seeds separately, but there seems to be few reports addressing this problem: most reports are concerned with whole plant growth (Valdez et al., 2002; Yamauchi et al, 1997). In soybean, growth and glucose, sucrose and starch concentrations were studied in seeds and pericarps under varying source condition (Fader and Koller, 1985). In common bean, the translocated sugar is sucrose (Thorne, 1985). Enzymes that metabolize sucrose (acid and neutral invertase (EC

3.2.1.26), sucrose synthase (EC 2.4.1.13) and sucrose phosphate synthase (SPS) (EC 2.4.1.14)) may be involved in the accumulation and usage of the translocated sugar and sink activity in pericarps and seeds.

Here we studied the effects of salinity on the sugar composition and the activities of sucrose metabolizing enzymes of pericarps and seeds of common bean grown in solution culture.

## **MATERIALS AND METHODS**

### **Cultivation**

Common bean (*Phaseolus vulgaris* L.) cv. 'Tsurunashi Marusaya Kurosando' was grown in solution culture in a glasshouse in Osaka, Japan, in the spring of 1991. During the experimental period, the temperature in the glasshouse during the day was about 30°C, night temperature was about 25°C and day length was about 14 h. Seeds were sown on river sand, and after 10 days when the primary leaves have already expanded, four seedlings were transferred to a plastic container (circular holder) holding 14 L Hoagland No. 2 solution. De-ionized water with electric conductivity less than  $10^{-8}$  Sm<sup>-1</sup> was used to prepare the solution which was aerated at a rate 0.5 L min<sup>-1</sup>. The pH of the solution was adjusted to 6.0 every two days and replenished every two weeks.

Sodium chloride (NaCl) was added to the nutrient solution to reach the NaCl concentration of 0 or 60 mM on 7 days after the start of solution culture in the experiment of the analysis of sugar metabolism, and on 10 days after the start of solution culture in the experiment of plant growth analysis. In preliminary experiments, 100 mM NaCl killed the plants and 80 mM NaCl caused marked plant damage, whereas effects of 20 or 40 mM NaCl on the sugar content of fruits were less marked than those of 60 mM NaCl. Thus, 60 mM, which has marked effect on sugar content of fruits but does not cause severe plant damage, was chosen as the NaCl concentration in this experiment. In the experiment of sugar metabolism, 3 fruits at each NaCl concentration were harvested 10, 12, 14 and 16 days after anthesis (DAA). For the harvest, the most basal fruit on the apical truss of the main stem was used. The seeds and pericarps were separated, weighed and frozen with liquid nitrogen and stored at -80°C until analysis. In the experiment of plant growth analysis, 3 plants in each treatment were harvested 0, 10, 20, 30 and 40 days after the start of solution culture. Each harvested plant was weighed, dried at 70°C for a week and weighed.

### **Sugar Analysis**

Pericarp samples of about 2 g in fresh weight was freeze-dried for 4 days, weighed, powdered with mortar and pestle and extracted with 20 ml 80% ethanol at 80°C for an hour. Portion of seed samples were weighed, oven dried at 70°C for a week and weighed. Frozen seed samples were directly extracted with 20 ml 80% ethanol at 80°C for an hour. After cooling, seed samples were homogenized with mortar and pestle. The extract solution was filtered with a glass filter (Whatman GF/F), and made up to 100 ml with 80% ethanol. The filtrate was used for sugar analysis. The residue (alcohol insoluble solids, AIS) was rinsed with diethyl ether and dried at 35°C, weighed and used for the analysis of starch.

Twenty ml ethanol extract was dried with a rotary evaporator (Model N-1 EYELA, Tokyo Rikakikai Co., Ltd.) at 40°C and re-dissolved with 2 ml de-ionized water. The concentrations of glucose, fructose and sucrose was measured by HPLC (Shimazu Shimpack CLC-NH<sub>2</sub> (M) column) using a refractometer detector (JASCO RID-300S) with 75% acetonitril solvent system at a flowrate of 1 ml/min for pericarps and enzymatically (Boehringer Mannheim F kit) for seeds. Five ml of 0.5 N NaOH was added to AIS and homogenized to extract starch. After 30 min, 5 ml of 0.5N acetic acid was added to neutralize the solution. Ten ml of amylase solution {120 mg of glucoamylase (Sigma,

11600 U $g^{-1}$ ) dissolved in 100 mM acetate buffer (pH 4.5)} was added to the extract solution, incubated at 37°C for 3 hours to hydrolyze the starch and centrifuged at 3000 g for 15 minutes. The glucose concentration of the supernatant was analyzed enzymatically (Boehringer Mannheim F kit).

### Enzyme assay

The methods for the extraction of crude enzyme extract and the assay of enzyme activity for soluble acid invertase, neutral invertase and sucrose synthase were similar to those reported earlier (Tazuke and Wada, 2002). The assay method of insoluble invertase activity followed that of Schaffer et al. (1987). The extraction of SPS followed Hubbard et al. (1989). The frozen sample was ground in a chilled mortar using a 1:5 tissue-to-buffer ratio. The extraction buffer contained 50 mM HEPES (pH 7.5), 5 mM MgCl<sub>2</sub>, 1 mM EDTA, 2.5 mM DTT, 0.5mg ml<sup>-1</sup> BSA and 0.05% Triton X-100. Homogenates were centrifuged at 20,000g for 3 min with a refrigerated centrifuge (TOMY MRX-150). Supernatants were desalted immediately by centrifugal filtration. 1.7 ml of the supernatant was loaded on a Sephadex G-25 column equilibrated with the extraction buffer minus EDTA and Triton X-100 and centrifuged at 1800 rpm for 2 min. The filtrate was immediately used for the measurement of SPS activity. The reaction mixture for SPS (final volume 0.5 ml) consisted of 50 mM HEPES (pH 7.5), 15 mM MgCl<sub>2</sub>, 25 mM UDP-glucose, 10 mM fructose-6-phosphate and 25 mM glucose-6-phosphate and 50 $\mu$ l crude extract. The reaction mixture was incubated for 30 min at 30°C. The reaction was stopped by the addition of 0.5 ml 30% KOH. The amount of sucrose generated was measured by anthrone method following the methods of Hubbard et al. (1989)

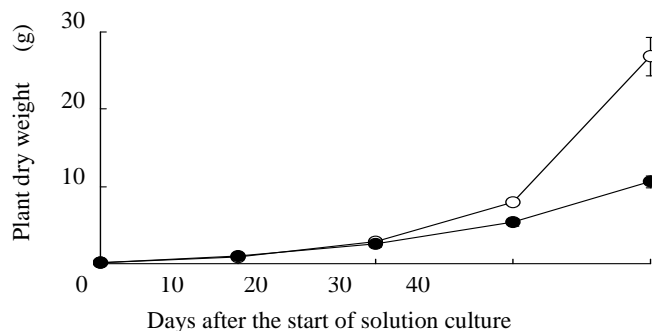
### Experimental Design and Statistical Analysis

In both experiments for plant growth analysis and sugar metabolism, experimental design was completely randomized design with 3 replications. Comparison between treatments was based on SE of means.

## RESULTS

### Plant Growth

Sixty mM NaCl markedly suppressed the plant growth. At 40 days after the start of solution culture (i.e. 33 days after the start of treatment), the plant dry weight was about 50% of the control (Fig. 1). The growth reduction was due mainly to the marked reduction in branching which led to the reduction of total leaf area, although expansion of individual leaves was also reduced about 20% at 60 mM NaCl (data not shown).

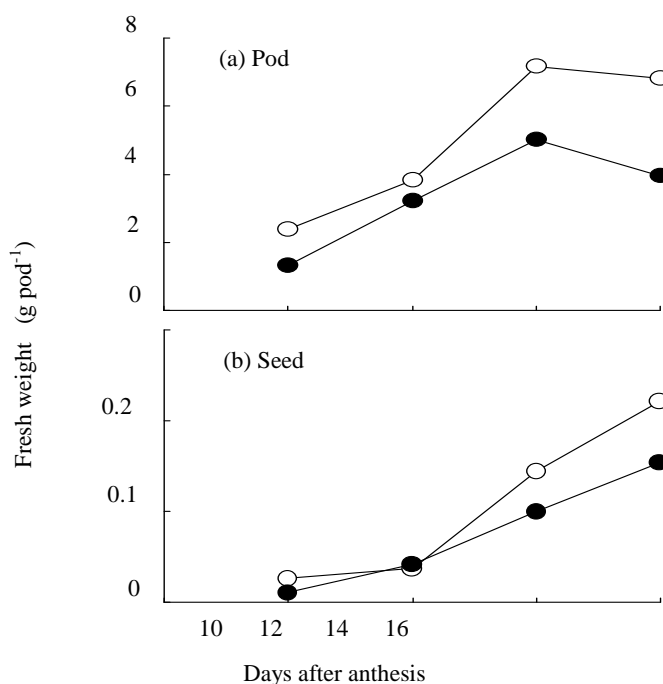


**Fig. 1.** Effects of NaCl addition to the nutrient solution on the growth in dry weight of common bean plant. NaCl was added 10 days after the start of solution culture. Open circles: 0 mM NaCl, closed circles: 60 mM NaCl. Vertical bars are SE of means.

## **Fruit Growth**

The fresh weight of a pericarp increased linearly in both untreated control and 60 mM NaCl until 14 DAA, after which growth stopped. At 60 mM NaCl, the growth in fresh weight was markedly suppressed (Fig 2a). The percent dry matter of a pericarp was fairly constant during the harvest period. It was about 8% without NaCl and about 10% at 60 mM NaCl. The concentration of AIS of a pericarp was fairly constant during the harvest period and tended to be higher at 60 mM NaCl (data not shown).

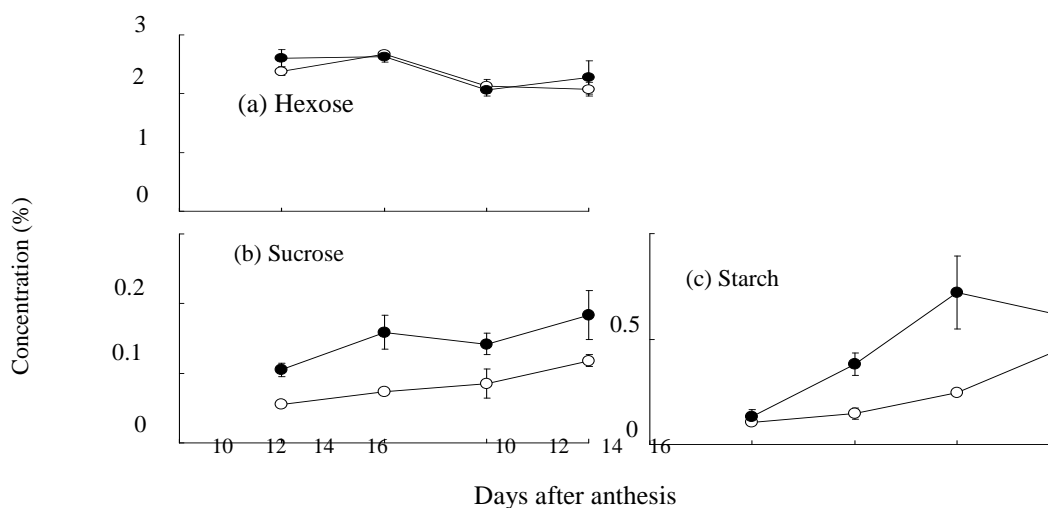
A pericarp contained about 6 seeds. At 60 mM NaCl, the growth of as many as 2 seeds stopped growth at an early stage. However, for well-developing seeds, fresh weight of seeds increased linearly during the harvest period, but no difference was observed between the untreated control and at 60 mM NaCl. Thus, when seed weight was expressed as the total fresh weight of seeds per fruit, it tended to be lower at 60 mM NaCl (Fig 2b). The percent dry matter of seeds was fairly constant during the harvest period, being about 15% irrespective of the treatment. The AIS concentration of seeds was fairly constant during the harvest period, being about 8% irrespective of the treatment (data not shown).



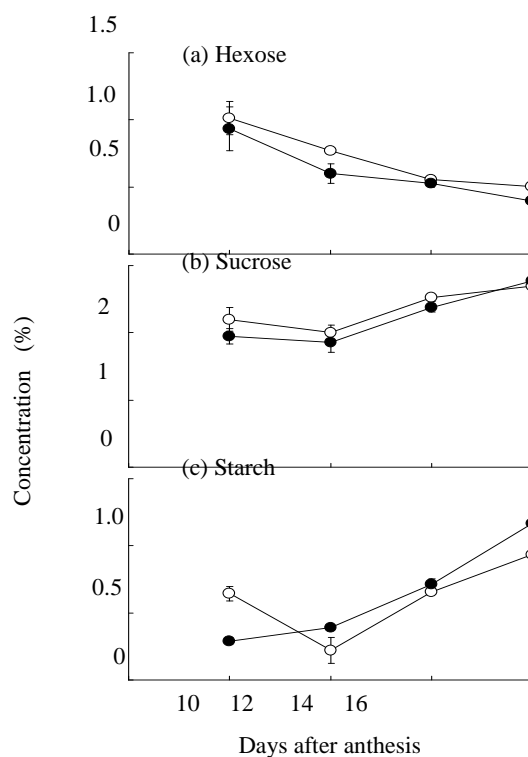
**Fig. 2.** Effects of NaCl addition to nutrient solution on the growth of pod and seed of common bean. Open circles: 0 mM NaCl, closed circles: 60 mM NaCl.

## **Sugar Concentration**

Hexose (glucose + fructose) concentration of the pericarp was fairly constant (about 2.5%) during the harvest period (Fig 3a). Sucrose concentration in the pericarp was about 1/10 of hexose concentration. It tended to increase as the fruit grew, and was markedly higher at 60 mM NaCl (Fig 3b). Starch concentration of a pericarp began to increase from 10 DAA. It continued to increase until 16 DAA at 0 mM NaCl. At 60 mM NaCl, starch increased more rapidly than at 0 mM NaCl until 14 DAA and then stopped to accumulate (Fig 3c).



**Fig. 3.** Effects of NaCl addition to the nutrient solution on the concentration of hexose (glucose + fructose), sucrose and starch of common bean pericarp. Open circles: 0 mM NaCl, closed circles: 60 mM NaCl. Vertical bars are SE of means. The concentrations are expressed as percentages on the basis of fresh weight.



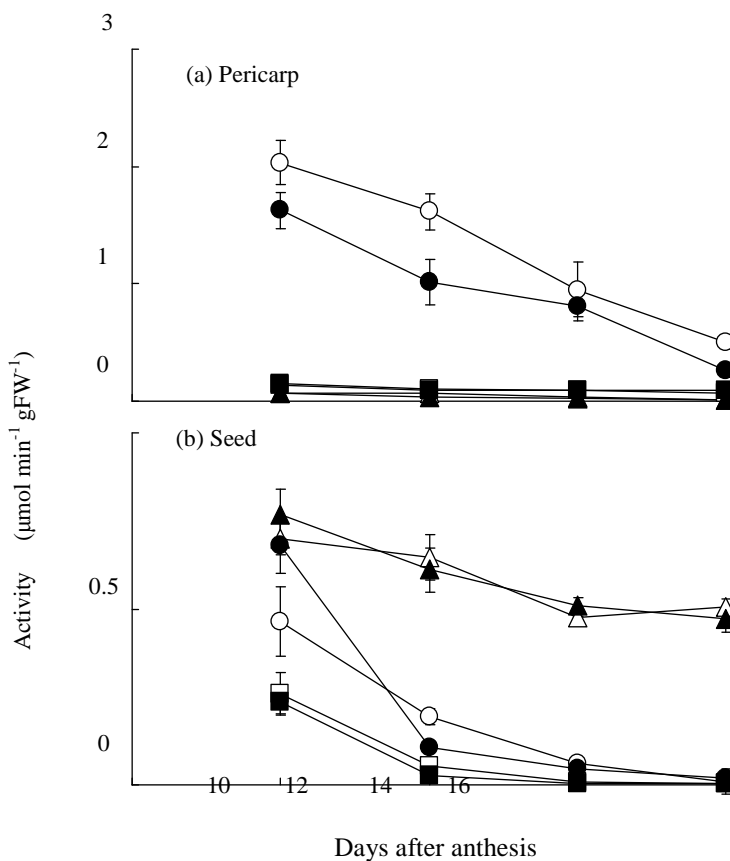
**Fig. 4.** Effects of NaCl addition to the nutrient solution on the concentration of hexose (glucose + fructose), sucrose and starch of common bean seed. Open circles: 0 mM NaCl, closed circles: 60 mM NaCl. Vertical bars are SE of means. The concentrations are expressed as percentages on the basis of fresh weight.

Hexose concentration of seeds declined during the harvest period. It was slightly lower at 60 mM NaCl than in untreated controls (Fig 4a). Sucrose concentration of seeds was apparently higher than that of pericarps, and increased slightly during the harvest period. There was no significant difference between the treatments (Fig 4b). Starch concentration of seeds tended to increase as fruits grew, and it was slightly higher at 60 mM NaCl at 12 DAA and onwards (Fig 4c).

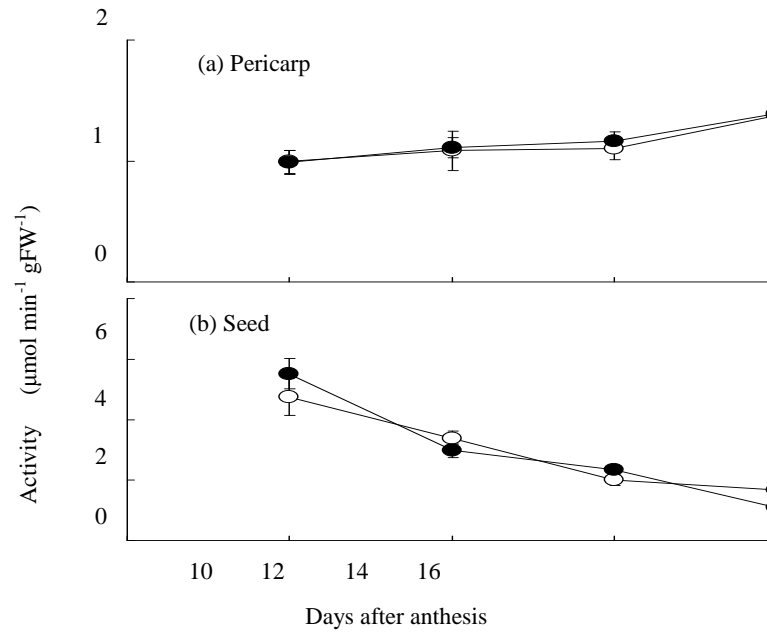
### Enzyme Activity

In pericarps, soluble acid invertase activity decreased as fruits grew, and it was lower at 60 mM NaCl as compared with the control. The activities of neutral invertase and insoluble invertase were negligible in both treatments (Fig 5a). In seeds, both soluble acid invertase and neutral invertase activities decreased as fruits grew, but there was not much difference between the treatments. The activity of insoluble invertase was fairly high and constant, but, again, there was no difference between treatments (Fig 5b).

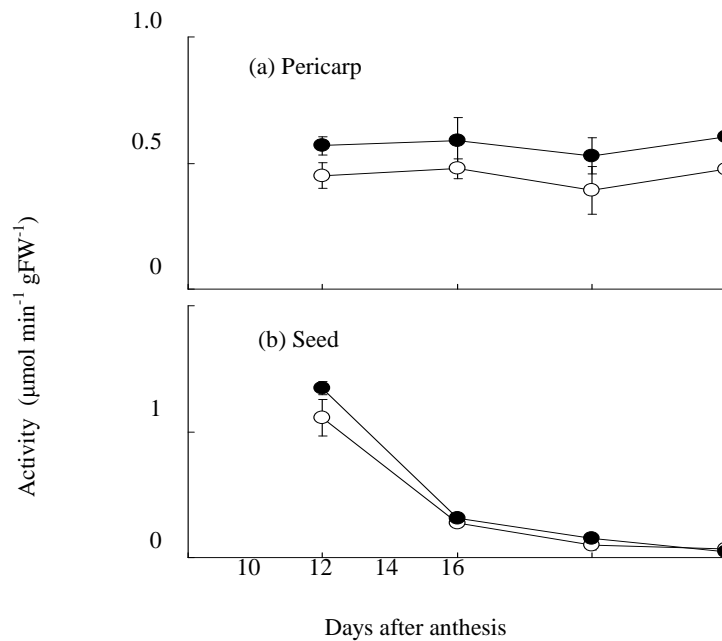
Sucrose synthase activity was fairly constant in pericarps but decreased as fruits grew in seeds. In both pericarps and seeds, no difference in sucrose synthase activity between the treatments had been observed (Fig 6). In pericarps, sucrose phosphate synthase activity was fairly constant and tended to be higher at 60 mM NaCl (Fig 7a). In seeds, sucrose phosphate synthase activity decreased as fruits grew, but there was no difference between the treatments (Fig 7b).



**Fig. 5.** Effects of NaCl addition to the nutrient solution on the activities of soluble acid invertase (circles), neutral invertase (squares) and insoluble invertase (triangles). Open symbols: 0 mM NaCl, closed symbols: 60 mM NaCl. Vertical bars are SE of means.



**Fig. 6.** Effects of NaCl addition to the nutrient solution on the activity of sucrose synthase of (a) pericarp and (b) seed. Open circles: 0 mM NaCl, closed circles: 60 mM NaCl. Vertical bars are SE of means.



**Fig. 7.** Effects of NaCl addition to the nutrient solution on the activity of sucrose phosphate synthase of (a) pericarp and (b) seed. Open circles: 0 mM NaCl, closed circles: 60 mM NaCl. Vertical bars are SE of means.

## DISCUSSION

The extent of growth suppression under salinity was different among whole plant, pericarps and seeds. It is interesting that pericarps and seeds showed different response to salinity. The reduction of pericarp growth is similar to the reduction of fruit growth in tomato (Adams, 1991). At 60 mM NaCl, some seeds in a pericarp stopped to grow, but other seeds grew at the same rate as those at 0 mM NaCl. In pea, soybean and lupin (Munier-Jolain et al., 1998), seed abortion was affected by treatments that affect source-sink relationship, i.e., depodding, defoliation, shading or changes in air CO<sub>2</sub> concentration. However, these treatments did not affect the growth rate of filling seeds. In soybean, water deficit causes the decrease in seed size, but this is due to the shortened growth period, and seed growth rate is unaffected (Westgate et al., 1989). These results suggest that in rapidly growing seeds, high sink activity is maintained. Our results conformed with this view and also showed the homeostasis of seeds at the sugar metabolism level.

In pericarps, concentrations of sucrose and starch markedly increased at 60 mM NaCl (Fig 3b, c). The increase of sucrose concentration of fruit under salinity is also reported for tomato (Saito et al., 2008) and cucumber (Tazuke, 2001). The decrease in the activity of soluble acid invertase (Fig 5a) and the increase in the activity of sucrose phosphate synthase (Fig 7a) in pericarps are consistent with the metabolic control of sucrose concentration as suggested for melon fruit (Hubbard et al., 1989). However, it is also possible that the increase in sucrose concentration is the result of negative correlation between sink activity and sucrose concentration in the sink (Walker and Ho, 1977). In tomato, starch concentration of a fruit increases temporally before maturation (Ehret and Ho, 1986; Gao, et al., 1998; Robinson et al., 1988), and it is suggested that the increase in hexose concentration of mature fruit is due to the increase in the temporal accumulation of starch (Gao et al., 1998). The temporal starch accumulation in tomato fruit is enhanced by salinity (Ehret and Ho, 1986; Gao et al., 1998). Hexose concentration was not much affected by salinity. Hexose concentration was not much affected (Saito et al., 2008) or rather reduced (Ehret and Ho, 1986) in immature tomato fruit under salinity. The mechanism of the increase of sugar concentration under salinity has been studied by many workers (Adams, 1991; Ehret and Ho, 1986; Gao et al., 1998; Saito et al., 2008), but it is still not elucidated. One simple interpretation may be the condensation effect: the decline in fruit growth under salinity condenses sugars. However, in our experiment, hexose concentration did not increase under salinity, which contradicts the simple condensation interpretation.

In seeds, neither sugar concentration (Fig 4) nor the activities of sucrose metabolizing enzymes (Fig 5b, Fig 6b, Fig 7b) was much affected by salinity. This indicates that the maintenance of sink activity of seeds under salinity also accompanies the homeostasis at the level of sugar metabolism. In legume seeds, the seeds have no symplastic connection to the maternal tissue, and seeds are nourished by the exudate from the seed coat (maternal tissue symplastically connected to pericarp) (Thorne, 1985). It is possible that the change in the sucrose metabolism in pericarp, the immediate source to the developing seeds, is involved in the homeostasis of sugar metabolism in seeds by compensating the perturbation caused by salinity. In cowpea, recovery from the water stress increases the water potential of pericarp, but the turgor pressure of the cells of seed coat is relatively low and essentially unchanged (Shackel and Turner, 2000). This suggests that the homeostasis is working at the level of seed coat. Geromel et al. (2006) measured the activities of acid invertase, sucrose phosphate synthase and sucrose synthase in pericarp, persperm and endosperm of coffee fruit, and found the activities are different between persperm and endosperm. In our experiment, seed coat (maternal tissue) and embryo (offspring tissue) were not separated. Such a separation can yield further useful information about the sink control of the embryo.

Because common bean is a relatively salt sensitive crop (Greenway and Munns, 1980), it is not realistic to intentionally plant it to saline soil. However, gradual salinization can occur in coastal area and tsunamis (Slavich et al, 2008) can cause sea water flooding. The result of this experiment



suggests that common bean might be cultivated for seed production, not pod production, in these salinized soil.

## CONCLUSION

The growth suppression by salinity was seen in whole plant and pericarps, but not in seeds. Also, the concentration of sugars and the activity of sucrose catalyzing enzymes were affected in pericarps, but not in seeds. The cause of these differences among plant parts in the response to salinity needs further study.

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## **THE FUNCTION OF SOCIAL NETWORKS TO CREDIT ACCESS AND OFF-FARM WORK: A CASE OF COCONUT FARMERS IN RURAL AREAS OF RIAU PROVINCE, INDONESIA**

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### **ABSTRACT**

Social networks in agricultural marketing are important for both farmers and traders, since they face high risks caused by price and production fluctuation without any formal insurance. Moreover, in remote areas, the risks are even higher because of high transportation costs. This paper presents an analysis of farmer networks to support coconut marketing and off-farm work. The analysis was based on a survey of data of coconut farmers in Riau province, a coastal remote area in Sumatera island, Indonesia. We conclude: (1) that the coconut market structure is oligopolistic, with radiate vertical networks between farmers and traders; (2) that the coconut transactions was strengthened by credit arrangements where Chinese traders sell consumption commodities on trust during the lean season in exchange for payment in kind (copra), with implicit interest rates, using collateral substitutes, and unlimited time repayments; (3) that community-level horizontal networks play an important role in developing off-farm work to generate cash income so that farmers with off-farm income have less dependency on Chinese trader credit and (4) that limited financial resources force Chinese traders to give credit only to creditworthy farmers, based on head of households' age, landholding size, and participation in off-farm work that deliver short-period cash income.

**Key words:** credit constraint, remote areas, Chinese traders

### **INTRODUCTION**

There is a growing amount of literature that emphasizes the role of social networks as a basis for economic activity (Lyon, 2000; Berry, 1997; Fafchamps, 1996; and Woolcock, 1998). In developing countries, social networks in agricultural production and marketing are important since both traders and farmers face a high risk for price fluctuation and poor harvest, have no formal insurance against such risks, and high transaction cost to obtain market information. Farmers should make use of various types of social networks to cope with possible risks and to improve their access to useful information. Bardhan and Udry (1999) describe the micro-foundations of network on interlinked transactions between a trader-lender and a farmer-lender in agricultural economies. Traders often lend to farmers in exchange for a promise to deliver the crop at a predetermined price discount. The interlinked contract reduces farmers' and traders' transaction costs of finding each other in the product market. Even though the farmers face credit market imperfections, interlinkages allow the trader to counteract the possible effects of the imperfection of the farmers' production efficiency and to obtain the maximum surplus over the farmers' reservation income.

The function of markets in generating social networks is still a matter of debate. On the one hand, More (1994) recognizes that markets can erode existing social networks by deteriorating social norms that constitute their basis. On the other hand, Hirschman (1982) argues that the repeated

practices of transactions at the markets, based even by purely economic incentives, can generate moral values that are shared by the people concerned, and the shared values can eventually be embodied by social networks.

In this paper, the latter idea is regarded to be acceptable as an analytical framework: This paper focuses on a remote rural area in Indonesia, where disadvantages in terms of the risks and transaction costs mentioned above are more severe. In turn, farmers and traders in the research area activate various social networks to stabilize the economic transactions. In remote rural areas, traders play a key role in mediating between farmers and outside markets. A vertical<sup>1</sup> working relationship between traders and farmers is often accompanied by a credit arrangement, which utilizes social networks as collateral substitutes. Previous studies found that third-party guarantees, tied contracts, and threats of loss of future access are common devices in informal financial contracts (Adams and Fitchett, 1992; Biswanger, McIntire, and Udry, 1989; Zeller, 1994). In this study, the characteristics of informal financial arrangements between traders and farmers and credit constraint problem in particular are examined in order to contribute information to the study of social networks and credit access in Indonesia (Okten and Osili, 2004; Grootaert, 1999).

The research area is at the center of coconuts production in Indonesia. Coconut production covers a total area of 3.76 million hectares and involves 20 million smallholder farmers (Ministry of Agriculture, 2001). The marketing of coconut production is conducted mainly by traders, especially by Chinese traders, who also give loans to farmers. The social networks that farmers use to develop off-farm jobs also require further investigation. Recent studies highlight a significant role of off-farm jobs for rural households in Indonesia (Booth, 2002). Households conducting self-employment activities need information on input supply (i.e., materials and labors) and market access for products. Meanwhile, casual laborer households need networks for information on labor recruitment. In the research location, a majority of farmers conduct off-farm jobs, and farmers make use of local horizontal<sup>2</sup> networks to obtain access to information and markets: Chinese traders are not involved in these networks, unlike the above-mentioned networks for coconut products marketing.

This study sought to: 1) describe the credit arrangements in coconut marketing transactions in a remote rural area, 2) describe social networks for coconut farmers' off-farm works, and 3) determine factors influencing credit constraint on coconut farmers to traders' credit.

## **RESEARCH METHODS**

### **Research Area**

Riau province, located on Sumatera Island, is a suitable area for the improvement of coconut production (Abdurahman and Mulyani, 2003). This area is the center of coconut production (1.6 million hectares) in Indonesia. The coconuts are produced by more than half a million smallholder farmers (Ministry of Agriculture, 2001). Most of the coconut plantations are located in the Indragiri Hilir district (519 thousand hectares), of which 85.1% of the area belongs to smallholder plantations. In 2000, it contributed the highest shares to regional income (20.8%), with an export value of 408.9 thousand USD. The center of coconut production located in Riau province is situated in Indragiri Hilir district (Fig. 1). The total land mass of this district is nearly 19 thousand Km<sup>2</sup>, and the distance to the province's capital is 212 km (a journey of 12 hours by car). This district is divided into 17 administrative sub-districts, and Tembilahan is the political and economic center. Most of the land

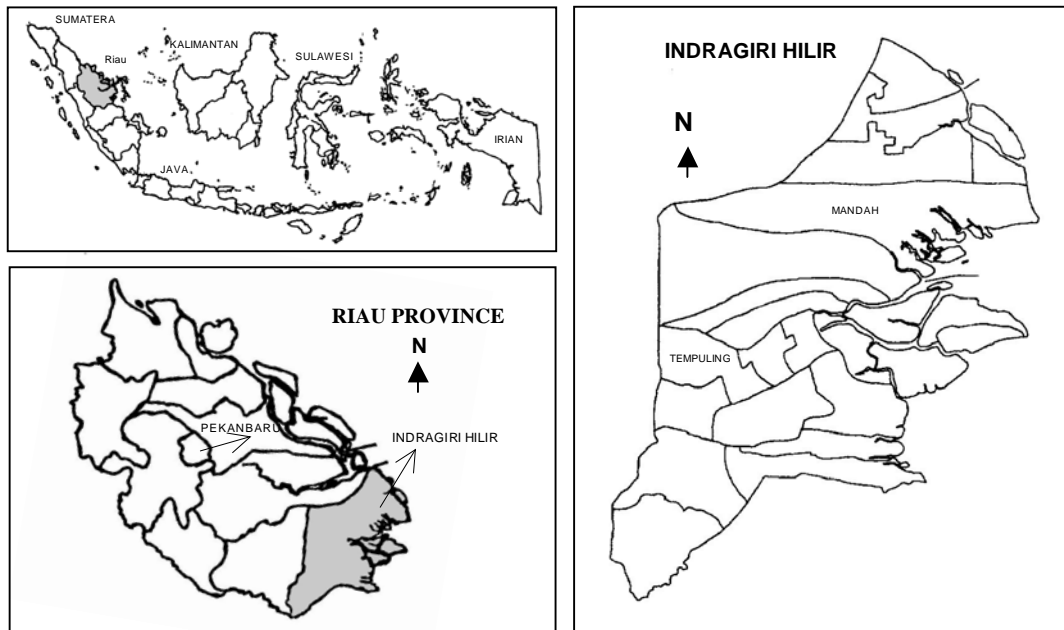
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<sup>1</sup> A vertical network refers to the marketing network between farmers and Chinese traders, in which Chinese traders have a higher position as both price makers and lenders.

<sup>2</sup> A horizontal network refers to relationship among coconut farmers, where everyone has an equal position.

(93.3%) in this region is lowland, ranging from 0-3 meters above sea level. This district consists of hundreds of islands that are also crisscrossed by hundreds of rivers and canals. Rivers play an important role for inter-island transportation because most people live along a coast or river. People utilize ditches not only for drainage management but also for transportation. These conditions make people's mobility highly dependent on river tides. Most households have small boats for family transportation, but medium- and large-sized boats are owned only by rich households that use them for operating a public transportation service.

The development of tree crops cultivation in this area has been supported by financial institutions and the local commodity market. The formal financial institutions available there are commercial banks<sup>3</sup> (7), cooperatives (131), and village banks (1), but most of farmers are restricted from these formal institutions because of collateral requirement and high transaction cost. Additionally, farmers only have access to informal institutions such as friends, relatives, traders, or financial self-help groups (SHGs). The local commodity market consists of weekly and daily markets (74). Weekly markets are used by farmers and traders to sell their products, particularly in remote areas, while daily markets are mainly used by farmers to get daily consumption goods, especially food. In addition, farmers also have access to small local shops (87) to get daily consumption. Other important commodity markets are fish markets (48) and fish auctions (7) (Statistic of Indragiri Hilir District, 2000).



Source: Statistic Indonesia, 2005

**Fig. 1.** Location of research site and of Indragiri Hilir District, Riau Province

The total population of Indragiri Hilir district in 2000 was about 556 thousand with a population growth of 1.58 % per year. The majority of the population is indigenous ethnic Malay. Immigrants in this district are ethnic Banjar (migrated from South Kalimantan), Javanese (migrated from Middle Java), Bugis (migrated from Makasar, South Sulawesi) and Minang (originally from

<sup>3</sup> Numbers in parentheses indicate the number of institutions in Indragiri Hilir district

West Sumatra) ethnic. Most of population regardless of ethnicity is Muslim. In 2000, 74.39 % of the labor force was engaged in the agricultural sectors.

The primary data used in this study were collected through in-depth interviews with coconut farmer households in two sub-districts of the Indragiri Hilir district, Tempuling and Mandah. The two sub-districts were chosen because they represented the general condition of the district that consists of both mainland and islands. The Tempuling sub-district is located in the inland area; therefore, it functions as the economic and political center for the districts. This sub-district has better transportation and financial infrastructure. Meanwhile, the Mandah sub-district represents the outland area; it consists of small islands, and it is a place where the majority of the poor farmers are located. This area can only be reached by water transportation (4 hours by boat from the central district), and a farmer's transportation is highly dependent on river tides.

The investigation was conducted from April to October 2002 in these two sub-districts. In the Mandah sub-district, research was conducted in the villages of Igal (31 farmers) and Belaras (28 farmers). In the Tempuling sub-district, research was conducted in the villages of Tempuling (31 farmers) and Sei Ara (14 farmers). The ethnicity of the respondents in this study consist of indigenous Malay (66 households), Banjar (25 households) and Javanese (13 households).

A profile of the respondent farmers is described in Table 1. First, the average age of the heads of household was 46.2 years and 44.9 years in Mandah and Tempuling, respectively. The old ages observed reflects a general trend of aging farmers in Indonesia. Second, the average household head's level of education was only 2.7 years, meaning that the majority of farmers in both areas did not complete a formal basic education. Third, the average number of dependent family members in both areas was 4.2 persons. Fourth, the majority of farmers in the Mandah sub-district were ethnic Malay, while the majority of farmers in Tempuling sub-district were Banjar. Tempuling was one of the destinations for the government's transmigration programs; as such, there are many Javanese farmers who came to the area. Fifth, the landholding size between farmers in the two sub-districts was significantly different. The average landholding size in Tempuling was much larger than in Mandah. Farmers of Banjar ethnicity in Tempuling have the highest landholdings, averaging of 7.1 hectares per farmer.

**Table 1.** Profile of coconut farmers interviewed in Indragiri Hilir District, 2002.

Variables	Mandah			Tempuling		
	Total	Average	SD	Total	Average	SD
Number of farmers (HHs)	59			45		
Age of head of household (years)		46.2	9.5		44.9	11.7
Formal education of head of households (years)		2.7	1		2.7	0.8
Number of dependent (persons)		4.2	1.7		4.2	1.9
Farming experience (years)		25.7	12.8		21.9	11.9
Ethnicity (HH)						
Malay	55			11		
Banjar	1			24		
Javanese	3			10		
Landholding (ha)		4.5	3.3		6.3	10.8

#### **Model of Credit Constraint by Chinese Traders**

The previous section already described that marketing relationships between coconut farmers and Chinese traders are strengthened by tied credit arrangements. However, some farmers may

receive credit constraint from Chinese traders. Although a tied marketing-trade contract may secure coconut supply, Chinese traders might conduct credit constraint because of their limited financial resources to less creditworthy farmers.

In this study, households' access to Chinese traders' credit will be measured by asking farmers about their credit experience during the last one year. Households are identified as unconstrained if they received credit from Chinese traders. Among non-borrower, indirect method was used to classify who are likely to be credit constrained from Chinese traders; households are classified as unconstrained if their total income exceeds the mean total income of total respondents.

A logit probability model is used to determine factors influencing farmers' probability of being credit constraint by Chinese traders. The dependent variable has binary value of 0 if households were unconstrained and 1 constrained. Determinant of factors influencing probability of credit constrained compute using following equation:

$$\text{Prob (Y)} = f (\text{I, H, A, L, In})$$

Where:

I = a vector of households individual characteristics, such as age (+), number of dependent (+)

H = a vector of human capital, such as education (-)

A = a vector of asset, such as landholding (-) and total asset (-)

L = Location characteristics

In = a vector of income characteristics, such as dummy short periodical income<sup>4</sup> (-)

## **RESULTS AND DISCUSSION**

### **The Income Structure of Coconut Farmers in the Indragiri Hilir District**

This section examines the income structures of coconuts farmers (Table 2). Larger landholding does not necessarily mean a higher total income. The larger landholders (more than 4 hectares) in Mandah have a higher income than those farmers with mall landholding; however, in Tempuling, the situation is the opposite. This fact highlights the important role of off-farm work towards a household's total income. Most farmers, regardless of their landholding size, conduct pluriactivities (Table 2). The off-farm income earned through these activities significantly contributes to farmer's total income. The choice of off-farm activities may differ due to capital endowment, level of education and location.

The on-farm income contributes the highest share of the total income of the larger landholding farmers, 49.8 and 68.3 % in Mandah and Tempuling, respectively. The agricultural income is mostly derived from coconuts, 48.6 % in Mandah, and 59.8 % in Tempuling. As compared with a significant difference in average landholding between the larger and smaller landholding farmers in both areas, the coconut income difference is rather small. A few larger landholder-farmers did not harvest all their coconuts because of the decreased price of copra. They abandoned the furthestmost plots since the harvesting cost was too high compared to the potential coconut income.

The income structure of smaller landholding households between two areas is different (Table 2). In Mandah, off-farm income has a higher contribution to total income, especially from self-employment activity. The most common self-employment activity conducted by farmers is

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<sup>4</sup> Dummy of short periodical income will be explained in next section (framework for analyzing off-farm work)

fishing because they have an advantageous location and because it delivers daily cash income. Some farmers conduct an agribusiness of sago processing since it is a staple food for the majority of households in this remote area.

Meanwhile, in Tempuling, on-farm income still contributes the highest share of smaller landholder farmers' total income, while the second biggest share comes from self-employment. Many of the farmers also engaged in fishing and in the brown sugar home industry<sup>5</sup>. A few farmers in Tempuling generate income from their capital by conducting a renting business, particularly of copra processing tools and boats. While farmers in both areas also participate in casual labor work, farmers in Mandah mostly worked as agricultural laborers, particularly in harvesting coconuts, while farmers in Tempuling have the opportunity to work as industrial or construction laborers.

As for larger landholding households, on-farm income contributes the largest share to total income. The off-farm income structure of larger landholder-farmers in Mandah was different from that in Tempuling. In Mandah, fishing as self-employment plays an important role in generating cash income. Some farmers, who can take advantage of their educational background, have access to work in the public sector. In Tempuling, larger landholding farmers specialize in renting processing tools and boats. The larger landholder farmers in both areas, especially those with low formal education, also engage in casual work as agricultural laborers.

**Table 2.** Total income of coconut farmers by landholding in Indragiri Hilir District, 2002.

Source of Income	Mandah				Tempuling			
	<=4 Ha (n=33)		> 4 Ha (n=26)		<=4 Ha (n=25)		> 4 Ha (n=20)	
	Value	%	Value	%	Value	%	Value	%
On-farm Income	2,897.3	38.9	3,896.8	49.8	3,854.5	46.4	5,379.6	68.3
- Coconuts	2,866.0	38.5	3,800.9	48.6	3,529.5	42.5	4,706.9	59.8
Off-farm Income								
Labor	695.7	9.3	873.8	11.2	703.4	8.5	934.1	11.9
- Agric Labor	458.8	6.2	667.5	8.5	244.7	2.9	590.4	7.5
Salary	77.1	1	1,033.3	13.2	401.7	4.8	469.1	6.0
Self-Employed	3,387.6	45.5	1,763.7	22.5	2,704.0	32.5	708.8	9.0
Rent	17.0	0.2	0	0	503.0	6.1	380.5	4.8
Others	369.6	5	260.0	3.3	143.5	1.7	0	0.0
TOTAL	7,444.3	100	7,827.6	100	8,310.1	100	7,872.1	100
Landholding (Ha)	2.2		7.5		2.4		10.7	
Productivity (ton/Ha)	1.6		1.5		1.6		1.5	
Number of borrowers (HH)	18 (55)		17 (65)		10 (40)		12 (60)	
Average loan of borrower (000 IDR)	1,350		2,176.4		845.0		1,756.3	

Note : Net income was calculated by considering the depreciation cost ( $\square=0.1$ ). Labor incomes consist of industrial, agricultural and construction labor. Self-employment activities consist of fishing, agribusiness and trading. Households categorized as smaller and larger landholders with respect to the 4 Ha border. Productivity was calculated only for harvested land.

<sup>5</sup> Farmers produced brown sugar from coconut liqueur. The liqueur is tapped daily from young coconut trees and processed into brown sugar with traditional methods in the farmer's home.



### **Copra Marketing and Credit Access in Indragiri Hilir District**

Most farmers have limited market access due to a naturally poor location and high transportation costs. The poor access to more profitable markets is especially a problem for farmers living in Mandah. Most of them sell copra only to the village trader since the central sub-district market can only be reached by a four-hour boat ride, which would incur a high transportation cost. In contrast, farmers in Tempuling have a more favorable location<sup>6</sup>, so they can sell not only to village and sub-district traders but also directly to the copra processing industry.

The marketing of copra is dominated by Chinese traders (*taukeh*). The village copra market structure is oligopsony because only two or three traders exist. Most of traders in both areas are under contract supply with Coconut Oil Processing Company<sup>7</sup> so they have to develop networks with farmers to secure copra supply. These networks also include a credit arrangement for coconut farmers. Traders own shops that sell food, clothes, and other daily necessities. Farmers usually take goods from a trader's shop to smooth out their consumption. Farmers suffer from a cash income shortage since they have to wait four months between harvests. Traders will take note of a farmer's credit and charge an implicit interest rate with an indefinite time repayment schedule. The Chinese traders thus act as informal lenders, using copra market contracts and the threat of loss of future coconut market and credit access as collateral substitutes.

The form of copra marketing networks between farmers and traders was radiate: traders are at the center of transactions, while farmers have little contact with each other. Only traders provide the price information since most of farmers, regardless of their location have no other access to market information (Table 3). A small number of farmers received market information from other farmers and from the radio (only in Tempuling). The close tie in the working relationship between farmers and traders is shaped by the credit arrangement. This condition especially occurs in remote areas like Mandah due to low market competition. Judging from the percentage of borrowers and the amount of credit, farmers in Mandah are more dependent on Chinese traders than those in Tempuling (Table 2). The majority of farmers in Mandah sell copra to village traders because of a credit agreement<sup>8</sup> (Table 3). This dependency can be strong since credit repayment can be extended by a farmer's requests. Such credit arrangements require farmers to sell copra to Chinese traders because they are afraid to lose future access to both copra market and credit. Farmers also have close friendships with Chinese traders since they live in the same community. In contrast, the most important factor for farmers in Tempuling, concerning copra marketing, is location. They prefer to sell copra in the most convenient place since they are not tied by any credit arrangement.

Farmers in both sub-districts are highly dependent on informal credit from Chinese traders (Table 4). Credit from strong network ties (family, relatives and friends) is low since most of them have limited contact with family members due to naturally poor location and high transportation cost. The geographic isolation and irregular cash income prevented financial self-help groups from developing among coconut farmers. Meanwhile, formal credit is only accessible by farmers who work as government employees.

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<sup>6</sup> Farmers can carry the coconuts not only by boats but also by bicycles, motorcycles, or chart.

<sup>7</sup> The Sambu Group today has emerged as the single largest integrated coconut industry in Indonesia, showcasing three factories and a massive plantation (100 thousand Ha of hybrid coconuts plantation and pineapples). The factory is situated in Guntung and Pulau Burung sub-districts, neighboring the Tempuling sub-district. The company produces crude coconut oil, virgin coconut oil, desiccated coconuts, coconut cream, creamed coconuts, and copra extraction pellets.

<sup>8</sup> In reality, even non-borrowers farmers in Mandah sell to village traders but with different reasons than non-borrowers farmers. The reasons to sell copra to village traders are remoteness of location (53 %) and history of receiving credit (23%). In contrast, all non-borrowers farmers in Tempuling sell copra to sub-district traders due to convenient locations (78%).

**Table 3.** Farmers' market counterpart and information source in Indragiri Hilir District, 2002.

Variables	Mandah		Tempuling	
	Marketing Counterpart		Marketing Counterpart	
	Village traders	Sub-district traders	Village trader	Sub-district Traders
Source of market information				
1. None	4 (7.5)	0 (0)	4 (12.1)	1 (3.0)
2. Other farmers	10 (18.8)	3 (5.7)	3 (9.1)	1 (3.0)
3. Traders	33 (62.3)	3 (5.7)	21 (63.6)	3 (9.1)
4. Radio	0 (0)	0 (0)	1 (3.0)	2 (6.1)
Reason of copra market counterparts				
1. No other options	8 (15.1)	0 (0)	0 (0)	0 (0)
2. Price	2 (3.8)	3 (5.7)	4 (12.1)	2 (6.1)
2. Loan	25 (47.2)	2 (3.8)	8 (24.2)	0 (0)
3. Location	12 (22.6)	1 (1.9)	13 (39.4)	3 (9.1)
4. Low transportation cost	0 (0)	0 (0)	1 (3.0)	2 (6.1)

Note : Research to market access was answered by only 53 HH in Mandah and 33 HH in Tempuling.  
All answers were singular as most of farmers sell copra to single counterparts.

**Table 4.** Credit access by source and landholding in Indragiri Hilir District, 2002.

Source	Mandah			Tempuling		
	≤ 4 Ha (n=33) 000 IDR	> 4 Ha (n=26) 000 IDR	Total (n=59) 000 IDR	≤ 4 Ha (n=25) 000 IDR	> 4 Ha (n=20) 000 IDR	Total (n=45) 000 IDR
Formal Credit	8,500 (2.34) (n=2; 6.1%)	15,000 (24.8) (n=1; 3.8%)	24,500 (25.0) (n=3; 5.1%)			
Informal Credit						
Family & Friends	1,540 (4.2) (n=5; 15.2%)	3,100 (5.1) (n=2; 7.7%)	4,640 (4.8) (n=7; 11.9%)		2,520 (10.7) (n=4; 20%)	2,520 (7.6) (n=4; 8.9%)
Input Traders	2,000 (5.5) (n=1; 3.0%)	4,000 (6.6) (n=2; 7.7%)	6,000 (6.1) (n=3; 5.1%)	1,000 (10.6) (n=1; 4%)		1,000 (3.0) (n=1; 2.2%)
Coconut Traders	24,300 (66.9) (n=18; 54.5%)	36,992 (61.0) (n=17; 65.4%)	61,292 (62.6) (n=35; 59.3%)	8,450 (89.4) (n=10; 40%)	21,072 (89.3) (n=12; 60%)	29,522 (89.4) (n=22; 48.9%)
Financial SHG		1,500 (2.5) (n=1; 3.8%)	1,500 (1.5) (n=1; 1.7%)			
Total	36,340 (100)	60,592 (100)	97,932 (100)	9,450 (100)	23,592 (100)	33,042 (100)

Note : Number in parenthesis represents the share of credit by source to total credit

The most important factor differentiating copra price is location. Copra prices in Mandah are significantly lower than in Tempuling at  $\alpha=1\%$  (Table 5). The low prices are caused by high transportation costs and less market competition, which in turn has led to farmers becoming highly dependent on credit arrangements with traders. Meanwhile, there is no price difference by landholding size. Neither small nor large landholders have any bargaining power, since transaction units are too small. None of the respondents joined agricultural cooperatives or farmers' groups for joint-marketing activity.

The negative impact of a credit arrangement on copra price occurs only in remote areas. The cost of a loan is determined by the bargaining power between traders and farmers. In Mandah, traders charged an implicit interest rate<sup>9</sup> of 30.3% per year on credits by offering a lower price to borrower farmers.

There is a significant price difference between borrower and non-borrower farmers ( $\alpha=10\%$ ) (Table 5). This agreement is less harmful to farmers since the price difference is still lower than the informal market interest rate (36-120% per year), although most of them are restricted to other financial institutions. In addition, credit repayment is flexible and can be extended upon a farmer's request. In contrast, traders in Tempuling did not charge an implicit interest rate because they have to keep a working relationship with farmers by providing credit under tight market competition.

**Table 5.** Copra price difference by location and landholding in Indragiri Hilir District, 2002.

No	Differences	Price	Mean	T
1	Location	Price in Mandah	813.7	-4.2***
		Price in Tempuling	880.9	
2	Landholding	Price of Small Farmers	842.9	-0.6
		Price of Large Farmers	851.7	
3	Loan and Location	Price of borrower in Mandah	801.5	1.7*
		Price of non-borrower in Mandah	842.5	
		Price of borrower in Tempuling	880.5	0
		Price of non-borrower in Tempuling	880.5	

Note : \*\*\* Significant at  $\alpha=1\%$ . \*\* Significant at  $\alpha=5\%$ . \* Significant at  $\alpha=10\%$

## Credit Access and Off-Farm Work

### A framework for analyzing off-farm work in the Indragiri Hilir district

A coconut farmer's dependency on traders' loans for consumption goods is related to his opportunity to conduct off-farm work that delivers cash income. As mentioned above, most of coconut farmers regardless of their landholdings engage in several kinds of off-farm activities. This section examines the relationship between the farmers' credit dependency the types of their off-farm work.

A matrix serves as a framework to categorize off-farm work. Off-farm work is categorized as either remote market oriented (RM) or local market oriented (LM), depending on where farmers get the information and resources needed for their off-farm work and on where farmers sell the products of their off-farm works (Table 6).

Fishing is categorized as RM; farmers, who fish, sell their catch to Chinese traders. Chinese traders process it into salty fish and sell them to the remote market. Farmers often sell fish to the same trader to whom they sell copra. In addition, women and children from fisherman-farm households sometimes work as laborers in the Chinese traders' salty fish business. They are paid in kind (fish) rather than with cash. Basically, a farmer's fishing activity is dependent on Chinese traders, as the case of copra. However, the dependency seems to be weaker with fishing than it is with copra. Farmers can transport fish with their own small boats; copra, on the other hand, would require bigger boats for transport, in addition, in Tempuling, fresh fish can be sold at the local

<sup>9</sup> The implicit interest rate is calculated by the income loss of farmers due to price discrimination.

daily/weekly markets for local consumption.

**Table 6.** Types of off-farm works of coconut farmers in Indragiri Hilir District, 2002.

Market Category	Type of works	
	Short Periodical Income (SPI)	Long Periodical Income (LPI)
Remote Market (RM)	Fishing	(Coconuts)
Local Market (LM)	Sago and brown sugar processing, government official, industrial labor, trading, fishing	Construction worker, agricultural labor, tool rental

Other off-farm work is categorized as LM. In the case of sago processing, farmers utilize local networks with neighboring farmers, to get information about the location of materials (e.g. the location of matured sago trees) and to recruit the laborers for processing. The product, a staple food, is sold in the local market. Farmers who process brown sugar utilize material from local coconuts and sell the product to the local market. Industrial laborers, construction laborers (who mainly build local houses), and agricultural laborers, are recruited through the local information network, and their working sites are in the local area. The renting of tools (copra processing tools, sago processing tools and big boats) as an off-farm work is closely related to the local market as just explained. Additionally, there are some fisherman-farmers who can be considered independent from Chinese traders.

Another pair of categories - short period income (SPI) and long period income (LPI) – based on the frequency of opportunities for cash income. Generally speaking, as far as a loan for daily necessities is concerned, LPI group farmers have a greater need for loan to smoothing consumption than SPI group farmers. The SPI group includes activities that generate a relatively constant monthly income, such as employment as a government official or as an industrial laborer. The self-employment off-farm works such as trading, fishing, and sago and brown sugar processing are conducted regularly all year round and are expected to bring constant cash income; fishermen can get fish constantly and get cash income shortly after selling them to local traders. Brown sugar and sago processing farmers receive daily/weekly cash income since they usually sell their product at a daily/weekly local market.

In contrast, the LPI group includes activities that generate cash income over a period longer than one month. Some LPI off-farm works is related to coconut harvesting activity, such as harvesting labor and renting tools for processing and boats for transporting coconuts. Meanwhile, the demand for artisans and construction workers is fluctuated due to the small number of the construction sites. Many of the farmers in both areas engaged in fishing because it generates steady cash income with only a small capital requirement. Farmers in Tempuling have more options to conduct SPI and LPI off-farm activities since they have more opportunities to work as industrial or construction laborers. The type of agribusiness activity in each area is different. Farmers in Mandah mainly process sago processing, the staple food in that area, while farmers in Tempuling mainly process brown sugar.

By combining the two types of the categorization mentioned above, a matrix can be constructed (Table 6). In the joint category of RM-LPI, no off-farm work is included. The following discussion, places farmers who do not conduct off-farm work into this group, taking into consideration that coconuts are the main products of their agricultural activities and that coconuts are regarded as RM-LPI products.

### Types of Households Income and Dependency on Traders' Credit

This section will analyze SPI and LPI households' dependency on credits from Chinese traders. Each household was categorized as either SPI or LPI, based on their highest off-farm income. Table 7 shows both SPI and LPI households' income and credit dependency to Chinese traders. Four indexes are adopted to show the extent of credit dependency (e.g., percentage of borrowers, loan/land value, loan/asset value, and loan/income). In Mandah, as shown in Table 7, SPI households have a higher total income than LPI households, and, as expected, SPI households have a higher SPI income than LPI households, and less LPI income than LPI households. The dependency on traders' credit, measure as the percentage of borrowers, is higher for LPI households because they need credit for smoothing consumption. LPI households have twice as many loans as SPI households. There are also significant differences on loan/land value, loan/asset value, and loan/total income between two groups.

In general, access to formal credit institution is limited. In Mandah, LPI households have as twice as much credit as SPI households. In contrast, LPI households in Tempuling have less credit but a higher dependency compared to SPI households.

**Table 7.** Household income and dependency on trader credits of SPI and LPI households by location in Indragiri Hilir District, 2002.

Variables	Mandah			Tempuling		
	SPI (n=38)	LPI (n=21)	t-value	SPI (n=19)	LPI (n=26)	t-value
Total Income (000 IDR)	7,359.1	5,519.3	1.53	7,872.9	6,656.4	0.72
Total SPI (000 IDR)	4,836.8	113.7	6.59***	3,372.9	170.5	4.2***
Total LPI (000 IDR)	23.8	1,503.7	-4.09***	481.1	562.0	-0.29
Loan (000 IDR)	707.1	1,621.4	-1.52	1,163.2	559.2	1.22
Borrower (HH)	19(68)	16 (76)		7 (36)	15 (58)	
Loan/Land value	22.7	57.9	-2.21**	16.3	26.5	-0.74
Loan/Asset value	33.0	77.4	-1.93*	22.3	29.5	-0.50
Loan/Total income	103.0	309.0	-1.86*	102.0	91.0	-0.04

Note: LPI income does not include coconut income. \*\*\* Significant at  $\alpha=1\%$ . \*\* Significant at  $\alpha=5\%$ .

\* Significant at  $\alpha=10\%$ . Number in parentheses is percentage.

### Determinants of Factors Influencing Credit Constraint on Coconuts Farmers

The previous section described the dependency of farmers, most of whom are restricted from formal credit, on credit from traders. However, many farmers are also restricted from informal credits. The number of households with access to a trader's credits was 57 households, or 55% of total respondents. The other 47 households had no credits from traders. By looking at their total income, those households can be classified as either credit constrained or non-credit constrained. Eight households received no loans from Chinese traders but were classified as non-credit constrained households since their total income was higher than the mean total income. These households can be regarded as households with no need for loans. Thirty-nine households had no credit and can be regarded as credit constrained households.

The determinants of being credit-constrained by the traders are shown in Table 8. The Logit estimation results show four variables have significant influence a household's probability of being credit constrained from Chinese traders' loans. Those variables are the head of household's age, landholding, total asset, and a dummy variable of short period income (SPI).

**Table 8.** Determinants of being credit-constrained by Chinese Traders (Logit estimate).

Predictors	Coefficient	Odds Ratio
Constant	0.644	1.904
Age	0.047	1.048*
Education	-0.614	0.631
Landholding	-0.165	0.848*
Total asset	0.000	1.00**
D_Short period income	-1.468	0.230***
D_Location	0.647	1.910
-2 Log likelihood 107.640		
Cox & Snell R Square 0.250		
Nagelkerke R Square 0.341		
Percentage Correct Prediction 74 %		

Note: \*\*\* Significant at  $\alpha=1\%$ . \*\* Significant at  $\alpha=5\%$ . \* Significant at  $\alpha=10\%$

The age of the head of household has a positive coefficient and significant at  $\alpha=10\%$ . It implies that an older household head has a higher probability of being credit constrained. A farmer's creditworthiness relates to his ability to manage a coconut plantation, since credit was paid in copra. Older farmers were considered to be less productive since coconut production requires physical work.

Landholding is significant at  $\alpha=10\%$  with an odds ration of less than 1. It means the smaller landholder households have a higher probability of being credit constrained. In research area, traders have clear information on farmers' landholding since they are living in the same community. Chinese traders expect loan payment in kind (copra) so larger landholder farmers are more creditworthy to them. As a result, smaller landholder farmers are less preferable because they produce fewer coconuts.

Total assets is significant at  $\alpha=5\%$  with an odds-ratio of 1. This means that all farmers regardless their total assets, have the same probability of being credit constrained. Traders use tied contracts and threats of loosing future access to copra market and credit transactions as collateral substitutes. A farmer's total assets are meaningless for traders since they do not have legal rights to confiscate a farmer's assets in case of defaulted loans.

The dummy of SPI is significant at  $\alpha=1\%$  with an odds ratio of 0.228. The SPI households have lower probability of being credit constrained. There are two reasons behind this fact. First, the Chinese traders value them as creditworthy borrowers since they have steady cash income. Second, traders want to secure not only coconut but also fish supply. Chinese traders own salty fish processing companies and need the fish supply from farmers. Credit arrangements with farmers will guarantee supply input for coconut and fish. Among 57 households who received traders' credit, some of them (32%) fished. Farmers have an incentive to sell their fish to the same Chinese traders who also own a salty fish business. They have low probability of violating a Chinese trader's expectations since they are afraid to lose future market access to both coconut and fish.

In contrast, Chinese traders regard coconut farmers with long periodical income, LPI-RM in Table 6, as non-credible borrowers. In spite of repeated market transactions, they do not have

access to Chinese traders' credit. Chinese traders' capital is limited, so they can only provide credit to creditworthy farmers. Although LPI households need credit for consumption, many of them are restricted from credit and have to survive on subsistence level.

## **CONCLUSIONS**

In a coastal remote area in Sumatra Island where coconut is the main crop, Chinese traders play a key role as intermediaries for coconut transactions between farmers and a huge coconut oil company. The structure of the local coconut market is oligopolistic because of the high transportation cost, and Chinese traders developed radiate vertical networks with farmers to secure copra (dried coconuts) supply because they have to fulfill their supply contract obligation with a big coconut oil processing company. The vertical networks are strengthened by Chinese traders' credit arrangements. Chinese traders sell daily necessities on trust and get repayment in kind (copra) with implicit interest rates. Although payment can be easily rescheduled, farmers will try not to betray credit-for-copra trade arrangement because they are afraid to lose future access to the coconut market and credit. .

Meanwhile, farmers are making use of both vertical and horizontal networks within the communities to develop off-farm work. The fishing marketing structure, where farmers sell fish to Chinese traders, is similar that of the coconut market. In sago processing, farmer make use of horizontal networks among neighboring farmers to get information on input location and sold the product in local market. Many farmers received credit constraint from Chinese traders. Older farmers are more likely to be credit constrained since they are considered to be less productive because coconut production requires physical labor. Small landholder farmers have a high probability of being credit constrained. Chinese traders put priority on larger landholding farmers so they can collect copra more efficiently. Coconut farmers who do not have off-farm work or having periodical income have higher probability of being credit constrained because Chinese traders regard them as non-creditworthy. However, these types of farmers are the ones who are really need credit for consumption during the lean season.

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**TECHNICAL EFFICIENCY IN THE PRODUCTION OF  
SUGAR CANE IN CENTRAL NEGROS AREA, PHILIPPINES:  
AN APPLICATION OF DATA ENVELOPMENT ANALYSIS**

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**ABSTRACT**

This paper attempts to identify the sources of input use inefficiency in sugar cane production in the Central Negros area, Philippines. Non-parametric Data Envelopment Analysis was used to determine the relative technical, scale and overall technical efficiencies of individual farms which use the same type of inputs and produce the same output (cane). Under a specification of variable returns to scale, the mean technical, scale and overall technical efficiency indices were estimated to be 0.7580, 0.9884 and 0.7298, respectively. The major source of overall inefficiencies appears to be technical inefficiency rather than scale effect. Input use differences between the technically efficient and inefficient farms are highly significant in terms of area, seeds and labor inputs. There was no significant difference in the use of fertilizer and power inputs. For many farms, labor is the most binding constraint, followed by land and power inputs while seeds and NPK fertilizer are not binding.

This paper also provides evidence that the overall technical efficiency of sugar cane farmers in Central Negros is positively related to farmers' age and experience, access to credit, nitrogen fertilizer application, soil type and farm size.

**Key words:** scale efficiency, frontier efficiency, input use, sugar cane production

**INTRODUCTION**

Sugar has always been a major contributor to the Philippine economy. In 2006, it accounted for 1.03% of gross national product. In terms of total agricultural export revenue, it accounted for 3.37%. As an industrial crop, it provides a significant source of livelihood through farming, processing and trading activities. Currently, there are approximately 58,996 sugar cane farmers in the Philippines, cultivating around 398,720 hectares of sugar cane land. Around 5 million people are employed in the industry and other sugar-related activities. From a net importer of sugar in 1995, the country achieved self-sufficiency in 2003 this being earlier than the 2005 target year under the Sugar Master Plan. The growth rate of sugar production has been achieved mainly through the expansion of cultivated areas. Sugar cane was planted in 382,956 hectares for crop year 2007, up from the 372,339 hectares in crop year 1995-96. However, this pattern of growth can no longer continue due to the on-going land conversion, competition from other crops and the declining land frontier.

Although the government has identified some 60,250 hectares as potential sugar cane plantation sites, this available resource could only supply the market with 222 to 225 million liters of bioethanol for the 5% mandate for next year (10% blend for 2011). Therefore, a strategy for developing the Philippine sugar cane industry should focus on increasing farm productivity. The country's national average yield of 60 tons cane per hectare is still one of the lowest among sugar producing countries in Southeast Asia. At the farm level, productivity varies enormously.

The high costs of fuel and fertilizer as well as the unstable world and domestic sugar prices over the last year now have discouraged farmers to invest in their farms. Moreover, sugar producers lament that the impending cut in the tariffs of sugar under the Asean Free Trade Area (AFTA)-Common Effective Preferential Tariff (CEPT) scheme could further erode their competitiveness. By 2010, existing tariffs on sugar products, ranging from 28- 38%, will go down to between zero and 5% under the AFTA-CEPT. By 2010, the sugar cane industry will experience some imbalance when the country begins implementing the Biofuels Act and when sugar tariffs reduce to zero. In view of the vital contribution and role of the industry to the Philippine economy, the production of sugar cane must be given proper support by the government if it is to be made competitive. This can be attained by improving the technical efficiency of the sugar cane farmers, that is, their ability to achieve maximum output within their resources and current technology.

This paper investigates sugar cane farms' efficiency in use of inputs and attempts to determine the factors influencing such efficiencies. An understanding of how productive efficiency arises will help craft interventions to make sugar cane farmers become more efficient and competitive.

## **METHODOLOGY**

### **Study Area and Sampling Procedure**

The study area was Negros, a small island in the Philippines. Negros accounts for around 55 per cent of the total area planted to sugar cane nationwide, thus accounting for the province's largely mono-crop character. The province has two pronounced seasons, wet and dry. The dry season is from late December to May for the northern part, and from November to May for the southern portion. The rainy season starts in June, reaches its peak in September and ends in October for the northern part. For the southern portion, the wet season begins in June, attains its peak in August and tapers off towards November. The northern part of the province, largely influenced by the proximity of the seacoast, is of coralline origin. The southern part, especially the interior, strategically influenced by the presence of the volcano Kanla-on, is of volcanic origin.

The central portion of Negros Island was chosen as it has relatively homogeneous farm samples in terms of geographic characteristics, market conditions and farming practices. The random samples were selected from stratified sub samples based on farm size. In the Philippines, farms with less than 10 hectares are considered small; less than 50 hectares, medium; and above 50 hectares, large for sugar cane production. This farm size classification was followed in the study. A total of 140 respondents equally distributed over the study area were interviewed using a structured questionnaire. Out of 140 respondents, 127 were deemed of reliable information. The survey was conducted for crop year 1997-98, beginning in September 1997 and ending in August 1998.

### **Analytical Procedure**

**Frontier efficiency measurement using DEA.** The measurements of efficiency and the estimation of production frontiers were researched extensively after Farrell's (1957) seminal work. The efficiency of a firm has two components: technical (or physical) efficiency and allocative (or price) efficiency. Technical efficiency (TE) measures the ability of a farm to produce maximal potential output from a given input. Allocative efficiency (AE) measures the ability of a farm to utilize the cost-minimizing input ratios or revenue-maximizing output ratios. One needs to be technically efficient before one can be allocatively efficient and attainment of both is required for economic efficiency (Coelli, 1996).

Further studies on efficiency measurement decomposed technical efficiency into purely technical and scale efficiency. Scale efficiency measures the optimality of the firm's size, or when it

operates where average and marginal products are equal (Forsund *et al.*, 1980). Scale inefficiency takes two forms- either increasing or decreasing returns to scale. A farm displaying increasing returns to scale (IRS) [economies of scale] is too small for its scale of operation. Unit costs decrease as output increase. In contrast, a farm with decreasing returns to scale (DRS) is too large for the volume of activities that it conducts. Unit costs increase as output increases.

Estimation of a production frontier differs depending on the assumptions made about the outer bound of the frontier, which may be deterministic or stochastic, while the technique for estimation may be parametric, or non-parametric. Currently, the stochastic frontier and the deterministic non-parametric methods are the primary approaches and these involve econometric methods and mathematical programming respectively (Coelli, 1995). The choice between these techniques depends on the underlying reasons for estimating productive efficiency. This paper uses the deterministic, non-parametric approach using Data Envelopment Analysis (DEA) because it can identify the sources and the level of inefficiency for each farm unit.

This method measures the relative efficiency of the Decision Making Units-DMUs (farms in this study) by estimating an empirical production frontier from the actual input and output data from each farm. The efficiency score of a farm is then measured by the distance between the actual observation and the frontier obtained from all the farms under evaluation. This frontier is constructed by the solution of a sequence of linear programming (LP) problems – one for each farm in the sample.

DEA can be either input- or output-orientated. The input-orientated DEA method defines the frontier by seeking the maximum possible proportional reduction in input usage, with output levels held constant, for each farm. The output-orientated DEA method seeks the maximum proportional increase in output production with input levels held fixed. The two measures provide the same technical efficiency scores when constant returns to scale (CRS) technology applies, but are unequal when variable returns to scale (VRS) is assumed (Färe *et al.*, 1994). This paper assumes a VRS technology and selected an output orientation because the concern is to maximize output from a given set of inputs, rather than the converse.

An output-oriented LP model, developed by Charnes *et al.* (1978) is defined as:

$$\begin{aligned} \max_{\theta, \lambda, s_i^-, s_i^+} \quad & z_k = \theta_k + \varepsilon \cdot \bar{1} s^+ + \varepsilon \cdot \bar{1} s^- \\ \text{subject to: } \quad & \theta_k Y_k - Y\lambda + s^+ = 0 \\ & X\lambda + s^- = X_k \\ & \lambda_{ji}, s_{ki}^-, s_{mi}^+ \geq 0 \end{aligned}$$

where  $Y$  denotes an  $s \times n$  matrix of output measures;  $X$  denotes an  $m \times n$  matrix of input measures;  $X_k = \{x_{ik}\}$  denotes inputs ( $i = 1, 2, \dots, m$ ) employed by farm  $k$  ( $k = 1, 2, \dots, n$ );  $Y_k = \{y_{rk}\}$  denotes outputs ( $r = 1, 2, \dots, s$ ) produced by farm  $k$ ;  $s^+$  and  $s^-$  are slack variables;  $\lambda$  is an intensity (weight) vector;  $\varepsilon$  is a non-Archimedean (infinitesimal) constant;  $\bar{1}$  are row unit vectors of dimension  $1 \times s$  (outputs) and  $1 \times m$  inputs; and  $\theta$  is a scalar defining the proportional augmentation applied to all outputs of farm  $k$ .

Non-zero elements of the optimal  $\lambda$ - identify the set of dominating farms on the production frontier, against which farm  $k$  is evaluated. Dominating farms are on the frontier and define the reference point (peers) for the DMU  $k$ . The presence of the non- Archimedean (infinitesimal)

constant in the objective function allows the maximization over  $\theta$  to preempt the minimization involving slack variables, *e.g.*, regardless of the values of  $s^+$  and  $s^-$ , their multiplication by  $\varepsilon$  will not allow them to have any impact on  $\theta$ . The optimization is computed in a two-stage process. First, maximum augmentation of outputs is achieved by obtaining the optimal value of  $\theta^*$ . In a second stage, the DMU is moved onto the efficient frontier via slack variables  $s^{+*}$  and  $s^{-*}$  (Charnes *et al.*, 1997).

The above LP is solved  $N$  times – once for each farm in the sample. Each LP produces a  $\theta$ -parameter and a  $\lambda$ -vector. The  $\theta$ -parameter provides information on the technical efficiency score for the  $k$ -th farm and the  $\lambda$ -vector provides information on the *peers* of the (inefficient)  $k$ -th farm. The peers of the  $k$ -th farm are those efficient farms that define the facet of the frontier against which the (inefficient)  $k$ -th farm is projected. The optimal solution to each problem,  $\theta^*$ , which satisfies  $1 \leq \theta^* \leq \infty$ , measures the maximal proportional increase in output levels for the  $k$ -th farm with inputs held constant. Hence,  $1/\theta^*$  measures technical efficiency of the  $k$ -th farm, where the technical efficiency score will lie between zero (inefficient) and one (efficient). If  $\theta = 1$ , no increase in outputs is possible, which means the farm lies on the frontier and is thus technically efficient under Farrell's definition.

The output-oriented VRS model is obtained from the CRS model by adding a convexity constraint  $\sum \lambda = 1$  to the CCR model. The model was developed by Banker *et al.* (1984) and is called the output-oriented BCC model. The measure of technical efficiency obtained in this model is also named 'pure technical efficiency' as it is free of scale effects. Therefore, the scale efficiency values for each analyzed farm can be obtained by the ratio between the scores for technical efficiency with constant and variable returns. Thus:  $SE = TE_{CRS} / TE_{VRS}$ . Production is scale efficient if  $SE=1.0$ , or if the  $TE_{CRS} = TE_{VRS}$ .

A critical issue in non-parametric programming technique is its sensitivity to the selection and number of inputs and outputs to be used as they can affect the discriminating powers of DEA (Boussofiane *et al.*, 1991). Thus, the list of variables must be reduced to include only the most relevant factors (judgmental screening). This could be done through aggregation of variables into summing factors. In terms of the number of observations, it should exceed the total number of inputs and outputs several times. The larger the sample, the larger is the probability of capturing high performance units which determine the efficiency frontier (Golany and Roll, 1989).

In this paper, the input-output data used was treated as follows:

**1. The Output.** The farmers' share of raw sugar, measured in 50 kilo per bag (LKg), was the output considered. Data on molasses was not collected because it was assumed that its inclusion would have minimal bearing on the efficiency measurement, as generally the molasses and sugar production are highly correlated.

**2. The Inputs.** The cultivation of sugar cane involves around 21 farm operations. The input factors were reduced by grouping the variables into major farm practices *e.g.*, person-days for plowing, harrowing and furrowing were grouped into one variable- land preparation practice, and so on. All operations that used animal power (expressed as person-animal days) were combined as well as the operations that used machines (expressed as person-tractor days). Likewise, all of the operations that used hand power *i.e.*, the preparation of seed pieces, planting, replanting, liming, fertilizing, weeding, irrigation and land clearing were combined into one factor and expressed in person-days. In addition, the output and the inputs of the two types of crop culture (*i.e.*, ratoon and plant crops) were aggregated.

Further reduction of inputs was considered. Since land preparation and cultivation are carried out by person-animal power and/or by person-machine combinations, they were combined into the number of hours of power used. Based from the survey data on person-animal days and person-machine days, the conversion factor derived for sugar cane cultivation was 1 hour of animal work = 0.13587 hour of machine work. Only land planted to sugar cane, *i.e.*, cropped land, is included in the analysis.

For fertilizer input, determining the amount of NPK nutrients applied enabled a direct comparison. While cane points and stools used in planting and replanting were combined (both were expressed in *lacsas* = 10,000 cane points or stools). Hence, the inputs used include cropped area (hectares); seeds and planting materials (*lacsas*); an aggregated NPK fertilizer input (kilograms); power (hours) and an aggregated labor input (person-days). The decision to use these factors was made on the grounds that these inputs represent the significant resources under the planter's control that enable the DMUs efficiency levels to be discriminated between. This does not mean that all other inputs are irrelevant, but that with the data available they did not help discriminate. The summary statistics for variables used in the efficiency analysis are shown in Table 1.

**Table 1.** Summary statistics of the physical inputs and output (per farm).

Items	Mean	Std Deviation	Minimum	Maximum
Output- LKg sugar	2,170.11	3,198.88	19.20	17,730.35
Input				
Area (ha)	36.96	50.55	.50	310.00
Seeds ( <i>lacsas</i> )	217.73	306.38	.00	1772.50
NPK (kgs)	29,963.68	44,881.37	64.00	240,020.00
Power (hrs)	884.12	1,228.50	8.15	8,038.35
Labor (person-days)	4,291.50	6,097.65	41.00	34,584.50

After the input-output variables were organized, the models were solved using DEA linear programming models with the aid of the Warwick DEA computer software package developed by Thanassoulis and Emrouznejad (1996).

#### Regression analysis using the Tobit model

In the context of policy implications, it is more important to determine what influences inefficiency (or to which variables it is related) than simply to measure it. Hence, the DEA scores were regressed on farm specific characteristics using the Tobit model in Limdep Version 7 software. Limited dependent variables (scores of DEA are bounded by 0 and 1) were used instead of the usual regression system. Since the parameter estimation of the Tobit model is usually done by maximum likelihood, it provides consistent and asymptotically efficient estimators for parameters and variance (Greene, 1997). This implies validity of standard inference procedures, such as t statistics and F tests.

The general model formulation with a limited dependent variable, as proposed by Greene, is given by  $y_i^* = X_i\beta + \varepsilon_i$ , where  $y_i^*$  is a latent variable;  $X_i$  represents a vector of explanatory variables; and  $\beta$  are the parameters to be estimated. It is assumed that the errors are normally distributed, with

mean zero and  $\varepsilon^2$ ,  $\varepsilon \sim N(0, \sigma^2)$ . Considering that in this paper the efficiency scores were defined by DEA, where the limit for a unit to be efficient is 1 ( $y^c = 1$ ), the observed variables ( $y_i$ ) were defined as follows:

$$\text{If, } y_i^* < y^c, \text{ then } y_i = y_i^*$$

$$\text{If, } y_i^* > y^c, \text{ then } y_i = y_i^c$$

For the dependent variable, the DEA scores obtained in the CRS model was chosen for its high accuracy in discriminating efficiency *i.e.*, every efficient farm in the CRS model is mandatorily efficient in the VRS model. Thus, overall technical efficiency scores were regressed on different combinations of explanatory variables. The explanatory variables used were: (1) the actual age (AGE) of the farmer; (2) farmer's years of formal schooling (EDUC); (3) the years in sugar cane farming (EXPER); (4) the number of extension exposures (EXTN) for the past two years. This latter variable was the number of visits the farmer made to demonstration trials and research centers, group discussions, training on farm practices, and extension advice on various farm practices; and (5) a simple dummy variable for credit access was also included ( $D_{\text{crdt}} = 1$  if the farmer had access to credit, otherwise zero).

The variables for topography and soil type were measured as fractions of the area with flat (FLAT), slightly rolling (SROL) and rolling (ROL) topography, and the fraction of the area with clay loam (CLAY), sandy clay loam (SCLAY) and sandy loam (SANDY) soil. However, after initial testing, it was evident that only one variable for topography and soil type was necessary (TOPO = 1- FLAT, 2= SROL and 3= ROL and STYPE= 1 CLAY LOAM, 2= SANDY CLAY and 3= SANDY LOAM).

The total NPK of fertilizer was also included as an explanatory variable (it should be noted that this was also used as an input in the technical efficiency measurement). However, it was disaggregated into nitrogen (N), phosphorus (P) and potassium (K) variables to determine, as far as possible, which nutrients contribute to farm efficiency. The level of significance in hypothesis testing for the farm and farmer's characteristics and adoption of technology was set at 5 per cent.

## **RESULTS AND DISCUSSION**

### **Efficiency Analysis**

Almost 81% of the sample farms are inefficient (Table 2). The mean efficiency level of 0.777 implies that, on average, the respondents are able to obtain around 78% of potential output from a given mix of inputs. This also implies that around 22% of production, on average, is foregone due to technical inefficiency. In other words, the shortfall of the observed output from the frontier output primarily reflects the inefficient use of the factors that are within the control of the farmers. The technical efficiency levels of the inefficient farms range from 0.3945 to 0.9933 so there is a potential to increase farm output from between 0.7 and 60% from the existing level of inputs.

Of the 127 farms, 24 were identified as DEA-efficient. These 24 farms defined the efficient frontier and represent the best practice farms for combining land, seed, NPK fertilizer, power and labor to produce maximum sugar output. As expected, the efficient farms achieved a higher yield in terms of tons cane per hectare (tc/ha) than the inefficient ones.

T-test for equality of means shows that the output differences are significant at the  $p=0.05$  level (Table 3). In terms of input use, on average, technically efficient farms used lesser inputs (except land) than inefficient ones. The difference in the use of seeds is highly significant, while less significant in the use of power and land. There was no significant variation in the use of NPK and

labor inputs.

**Table 2.** Distribution of technical efficiency scores.

<b>Efficiency Score</b>	<b>All farms Frequency</b>	<b>Per cent</b>	<b>Minimum</b>	<b>Maximum</b>
1.00	24	18.9	1.00	1.00
0.90-0.99	15	11.8	0.9005	0.9933
0.80-0.89	20	15.7	0.8067	0.8964
0.70-0.79	22	17.3	0.7005	0.7966
0.60-0.69	23	18.1	0.6084	0.6982
0.50-0.59	15	11.8	0.5106	0.5989
0.40-0.49	7	5.5	0.4407	0.4997
0.30-0.39	1	0.8	0.3945	-
Total	127	100		
Mean		0.777		(0.168)
Median		0.758		
Coefficient of Skewness		-0.190		(0.215)
Coefficient of Kurtosis		-1.037		(0.427)

Numbers in parentheses are standard errors.

**Table 3.** Average input-output data: Purely technically efficient and inefficient farms.

<b>Farm Class</b>	<b>Yield** (tc/ha)</b>	<b>Area* (ha/farm)</b>	<b>Seeds ** (10,000/ha)</b>	<b>NPK (kg/ha)</b>	<b>Power* (hrs/ha)</b>	<b>Labor (person days/ha)</b>
Efficient	55.93	54.55	4.34	632.45	18.99	101.57
Inefficient	48.10	32.86	5.79	698.11	23.50	106.84

Note: Independent sample test was applied for equality of means. This test is not dependent on the assumption of normality as for most tests. The level of significance in hypothesis testing was set at 10 per cent.

\*\*\*Significant at 1 per cent level

\*\* Significant at 5 per cent level

\* Significant at 10 per cent level

To determine if inefficiency is the consequence of the farms' scale of operation, the technical efficiency (CRS) was decomposed into pure technical efficiency (VRS) and scale efficiency. Table 4 shows the overall technical efficiency (OTE), pure technical efficiency (PTE) and scale efficiency (SE) indexes of the respondents. The data reveals that the major source of overall technical inefficiency appears to be technical, as against scale efficiency. Mean scale efficiency of the sample farms is relatively high (.95) as inefficiency only accounts for around 4 per cent. This further confirms that sugar cane farms' inefficiencies were mainly due to improper input use.

**Table 4.** Overall, technical and scale efficiency index for sugar cane farmers in Central Negros, CY 1997-98.

Efficiency	Overall technical efficiency (OTE)	Pure technical efficiency (PTE)	Scale efficiency (SE)
Number of efficient farms	12	24	14
% efficient	9	19	11
Maximum score	1	1	1
Minimum score	.3933	.3945	.6977
Mean score	.7431	.7771	.9582
Median score	.7298	.7580	.9884
Standard deviation	.1637	.1684	.0633

In order to substantiate the nature of scale inefficiencies, the analysis further disaggregated into those farms that exhibit IRS and DRS. Information as to whether a farm is operating at increasing or decreasing returns to scale can prove useful in indicating a potential redistribution of farm resources *i.e.*, increase the input size if IRS and decrease the input size if DRS were prevailing to maximize average productivity. In brief, the most productive scale size is the output scale that maximizes “average product”. In the Warwick version of DEA, the range of the omega ( $\Omega$ ) values for DMUs under variable returns to scale (BCC model) is interpreted as follows: (1) if the range is positive, IRS hold at the part of the efficient boundary where the DMU is located; (2) if the range is negative, DRS hold; and (3) if the range includes 0, CRS hold.

Of the 127 sugar cane farms, 9 per cent are operating at CRS, 42 per cent are operating at IRS, while 49 per cent are operating at DRS (Table 5). It would appear that larger increase (5%) in technical efficiency could be achieved by addressing the problem of IRS rather than DRS farms.

**Table 5.** Technical efficiency and various returns to scale for sugar cane farms.

	Constant Returns to Scale	Increasing Returns to Scale	Decreasing returns to scale
Number and (%)	12 (9)	51 (42)	64 (49)
Ave. measure of TE (%)			
OTE	1.00	.6723	.7502
PTE	1.00	.7198	.7809
diff		.05	.03

Table 6 gives the input levels for the farms grouped according to scale efficiency. The presence of DRS on larger farms may be attributed to lack of managerial ability to utilize the available land effectively. By and large, except for land input under IRS farms, the data suggests the need to decrease most inputs with, no doubt, more efficient management of the resources. This is the difficult part.



**Table 6.** Average input use of sugar cane farms (by various returns to scale).

VRS	Yield (tc/ha)	Ave. Area (ha/farm)	Per Hectare			
			Seeds (10,000/ha)	NPK (kg/ha)	Power (hrs/ha)	Labor (person day/ha)
CRS farms (12)	54.63	41.01	3.34	515.13	19.50	98.90
IRS farms (51)	43.26	8.87	5.82	652.65	21.34	97.05
DRS farms (64)	53.67	58.59	5.62	744.02	24.29	114.15

As expected, the overall technically efficient farms achieved a higher sugar cane yield per hectare than the inefficient ones. However, the t-test for equality of means shows that the output differences are not significant (Table 7). In terms of input use, on average, overall technically efficient farms used less input (except land) than inefficient ones. It should be noted that for this particular sample, the most productive farm size is around 41 hectares. However, differences in the use of inputs except seeds and NPK are not significant.

**Table 7.** Average input-output data: Overall technically efficient and inefficient farms.

Farm Class	Yield (TC/HA)	Area (ha/farm)	Seeds (10,000/ha)	NPK (kg/ha)	Power (hrs/ha)	Labor (person day/ha)
Mean (Overall technically inefficient- OTIE)	49.06	36.54	5.74	703.50	22.97	106.57
TE & SE (Overall technically efficient – OTE)	54.64	41.01	3.34	515.13	19.51	98.90

T-test for equality of means between OIE and OE farms show that except seed and NPK fertilizer, there are no significant variations.

This paper shows that there are important input use inefficiencies in sugar cane production in Central Negros. This can be interpreted by the 'slack' variables in the DEA estimation. A slack value indicates the amount by which a DEA model constraint is not satisfied, and therefore represents the amount by which an input is overused relative to how the most efficient farms use the input. Thus, technically efficient farms do not have excess inputs while technically inefficient farms have one or more excess inputs.

Table 8 shows that NPK fertilizer input appears to be in surplus for many farms (63%), as well as the seeds, followed by power, labor and land. This is sensible as the seeds (cane tops) can be taken from the other farms and are sometimes free of charge. These cane tops are not included in the processing of sugar cane as they contain less sugar. While excesses in NPK fertilizer usage can be attributed to improper fertilization and non soil test based application. Testing is very important in determining actual fertilizer requirements of soils. Similar results in the analysis of input use were obtained by Gül (2006) in apple farming and Alemdar and Ören (2006) for wheat farming in Southern

Anatolia, Turkey. Thus, from these results, technically inefficient farms can reduce their input use by around 17, 25, 31, 21 and 18 percent of land, seeds, NPK fertilizer, power and labor, respectively and still achieve, on average, around 44 per cent increase in production.

**Table 8.** Analysis of slack inputs and adjustment to inputs and output: All technically inefficient farms.

Input & Output	TIE Farms N=103	Percent of Total	Percent of Input and Output Adjustments to Attain 100% Efficiency			
			Mean	Std Dev	Minimum	Maximum
Output LKg sugar/ha			44.45	32.31	0.70	153.50
Inputs						
Land	45	44	17.52	14.14	1.10	66.00
Seed	65	63	24.91	16.66	1.10	78.20
NPK	59	57	30.98	15.73	2.60	72.30
Power	40	39	21.03	12.54	3.30	55.30
Labor	19	18	17.67	10.28	2.10	35.30

DEA also determines those variables that effectively constrain production, and hence efficiency. Thus, next to land, labor is the main constraint, effectively limiting output for approximately 80 per cent of the sampled farms. Labor shortage, especially during the time of harvesting, is a serious problem as it can delay the operation which leads to high sugar-yield losses. To demonstrate how DEA is used to evaluate the input decisions of technically inefficient farms, and to estimate potential yield gains from reallocating inputs, consider farm 118 with an efficiency score of .6084. The production practices and its referents (farms 91, 25, 47 and 124 that are efficient and, through a linear combination (*lambda* values), form the boundary point on the ray created by the example farm) are compared in Table 9. The use of some inputs (*e.g.*, NPK fertilizer) by farm 118 is 'excessive.' This comparison would suggest strategies for farm 118 to rationalize the use of its inputs. As noted *lambda* (these are the weights in the linear combination (composite farm) of farms 91, 25, 47 and 124) values provide a composite farm which would produce the equivalent level of output, but by using lower levels of some of the inputs.

**Table 9.** Input use levels of farm 118 and its referent farms.

Variables included in the DEA model	Input Use of Farm 118	Input Use Levels of the Referent Farms				Compo site Farm
		Farm 91	Farm 25	Farm 47	Farm 124	
<i>Lambda</i> values		0.003	0.684	0.300	0.013	
Output LKg sugar/ha	49.09	91.60	79.56	93.73	80.98	83.86
Inputs						
Area	44.10	83.20	58.30	10.00	78.00	44.14
Seed/ha	5.33	6.50	5.24	6.50	5.00	5.62
NPK/ha	1022.06	1039.00	515.82	692.50	1048.00	577.31
Power/ha	30.12	51.95	24.29	16.10	41.91	22.14
Person day/ha	115.19	147.52	112.01	151.10	121.98	123.97

### Sources of Inefficiency

Tobit regression analysis on the relationships between technical efficiency scores and farmer's experience, age, access to credit, soil type, N fertilizer and farm size show that all coefficients except age, N-fertilizer and soil type (sandy loam soil) are positive (Table 10).

**Table 10.** Results of Tobit regression analysis.

Variable	Overall Technical Efficiency			
	Coefficient	Standard Error	P[  Z  > z ]	Mean of X
Experience	.0317	.0177	.0734	17.18
Age	-.0147	.0108	.1747	51.42
Dummy variable proxied for CREDIT	.7884	.3592	.0282	.5862
Soil Type	-.2997	.1682	.0749	2.039
N fertilizer	-.0054	.0018	.0032	238.42
Farm area	.0100	.0033	.0022	38.04
Log likelihood function	-71.8019			
Sigma	1.2646	.2170		

The age variable does not have a significant relationship with farmers' efficiency. However, its inclusion in the equation improved the explanatory power of the model. Age and experience are generally related, though the impact on efficiency is not necessarily the same. In this analysis, the age coefficient is negative while experience is positive. This finding is in parallel with Msuya and Ashimogo (2005) whose study found experience to be a better predictor of technical efficiency than age for Mtibwa Sugar Estate outgrowers in Tanzania. They argued that sugar cane cultivation is very strenuous giving the younger farmer an advantage. Farmers' experience was found to be a good predictor of efficiency, better than education and exposure to extension services. Sugar cane farmers' expertise probably assists in ensuring the optimal timing and use on inputs. This confirmed the findings of Kalirajan and Shand (1985), who used a sample of South Indian farmers and found experience to be a better predictor of production efficiency than education. They argued that in cases where new technology is well adapted to local conditions, technical knowledge (or expertise) might be more important than education (Antle and Crissman, 1990).

The dummy credit variable shows a positive relationship with farmers' technical efficiency. Access to credit may be an instrumental motivation to produce efficiently apart from being able to purchase the inputs necessary for production efficiency. This proved the findings of Nchare (2007) who found access to credit to be significantly correlated with technical efficiency of coffee producers in Cameroon. However, for coffee producers in Vietnam, although access to credit is positively correlated with efficiency, the pattern is statistically weak (Rios and Shively, 2005).

The sign of sandy loam soil is negative which is unexpected. Around 46% of the flat area is sandy loam which is ideal for sugar cane growing. Low lying land floods easily so that coarse-textured soils are desirable especially in areas with heavy rainfall. This means a flat area with sandy loam may yield more production in good weather conditions, but the drought in Crop Year 1997-98 may have interfered. Sandy loam soil can hold less moisture than clay loam and sandy clay loam soil. Even the new varieties planted to 49% of the sandy loam soil did not help in increasing productivity as  $D_{HYV}$  did not show any significant effect on efficiency. The N-fertilizer variable shows a negative and significant impact on efficiency. This may be due to the improper application of N-fertilizer in

that the farmers may have applied too much N, which can be detrimental to the plant as it produces toxic substance. The positive sign of farm size suggests that bigger farms are more efficient. This is in contrast to rice farming (in the Philippines) as analyzed by Herdt and Mandac (1981) and Lingard, Castillo and Jayasuriya (1983). However, these findings confirm the conclusions reached by Msuya and Ashimogo (2005) that farm size significantly determines levels of technical efficiency in sugar cane production. However, Zyl *et al.* (1995) took note of the findings for sugar cane production in Eastern Transvaal that showed small-scale farms (on average of 7 hectares) were as efficient as the large-scale (on average of 68 hectares) ones.

## **CONCLUSIONS AND RECOMMENDATIONS**

The most interesting feature resulting from the use of DEA is the data obtained for individual farms. This can be used by any extension workers as an instrument in giving advice to farmers on a one-on-one basis on how to improve their production efficiency. DEA results enable examining the adjustments that can be made in the use of inputs on inefficient farms by comparing them with their 'peer' or "referent" farms. Furthermore, the DEA slack variables provide an indication of the inputs that are in excess supply. In this study, NPK fertilizer appears to be in surplus for many farms, as well as the seed input. The labor input was the main constraint, effectively limiting output for approximately 80 per cent of the total sample. The most productive scale size (or optimum scale size) of each input could also be determined.

This study showed that there are important resource-use inefficiencies in sugar cane production in Central Negros. Central Negros sugar cane farmers could increase their output by 22% through better use of available inputs by rationalizing the use of NPK, especially N- fertilizer, and seed inputs. A soil test should be conducted to determine fertilizer requirements of the soil in Central Negros. The proper selection of seed pieces should be adopted to realize potential benefits.

However, it should be noted that inefficiency is not just a result of the amount of inputs used. Factors such as the timing of fertilization, other cultural practices, and exogenous factors such as age and experience, also affect efficiency. The strong positive effect of experience on efficiency implies that learning-by-doing would likely be important as newer, more productive technology becomes available. Extension education could be effective by targeting farmers with longer farming experience as the traditional concept among the older farmers that 'experience is the best teacher' may mean they may well be more receptive. But this also means the younger farmer's lack of experience needs replacing with good extension. The negative effect of age, although not significant, suggests that policies to induce youth to return, or go into sugar cane farming, could be important.

Capital should be made easily available, and in sufficient amounts, to service the capital needs of the farmers and other borrowers. The mills could also promote agricultural partnerships on this. Millers could give credit and technical guidance to small producers in return for the delivery of a specific quantity and quality of cane at a stipulated time. The collective efforts of farmers and millers can mean production efficiency and economic prosperity.

Soil management practices should also be given priority and practices that prevent erosion and help water retention and thus increase efficacy of fertilizer should be encouraged. In terms of NPK fertilizer application, the DEA analysis indicated that this input appears to be in surplus for many farms. In the estimated regression model, the negative effect of N fertilizer on efficiency is alarming. Information regarding the time and proper application of fertilizers should be disseminated to realize the benefits from fertilizer use. This could be done through soil analysis and management program. Further development of the extension service responsible for the dissemination of the importance of soil analysis and soil management should be considered as a serious instrument for increasing sugar cane production and thus profit.

The positive effect of farm size on efficiency implies that larger farm sizes could have a beneficial impact on the efficiency of the Philippine sugar industry as a whole. This, however, runs against the trend set by the land reform law (CARL) which pursues social equity.

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## **SUITABLE TIMING OF APPLICATION OF PELLETIZED COMPOST AND FARMERS' ACCEPTANCE IN CAMBODIA**

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### **ABSTRACT**

The suitable timing for application of pelletized compost and the evaluation of local farmers' acceptance of composting and pelletized compost making was investigated in Wat Chas village, Prey Chhor district, Kampong Cham province, Cambodia. There was no significant difference between the microbial counts in compost and the initial count in pelletized compost. But the microbial count of 12,228 cfu/g dry mass at 7 days was significantly highest at 99% confidence level, then gradually decreased with time. The microbial count at 21 days was lower than that found in the initial pelletized compost. Before the first workshop, 88.4% of the farmers applied chemical fertilizer and 86.0% applied manure or compost. However, after 4 workshops on composting and pelletized compost making, 85.0% of farmers adopted compost making and application while 51.5% made pelletized compost. A better understanding and increased knowledge led to the greater farmer participation, which was directly connected to farmers' acceptance of organic farming.

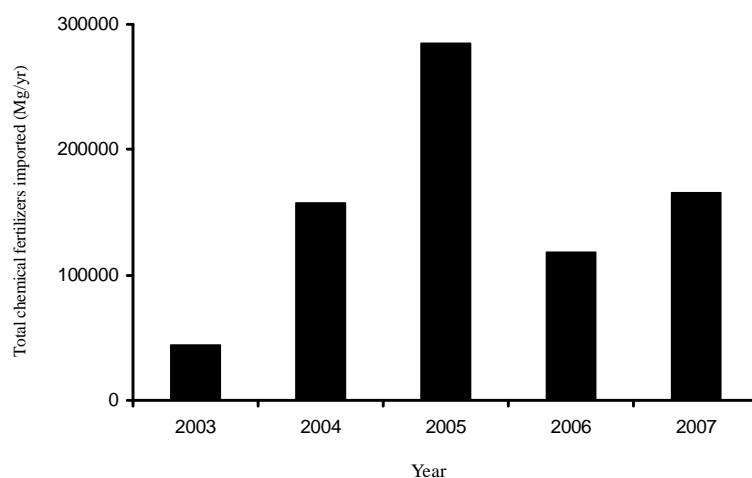
**Key words:** participatory, pellet compost

### **INTRODUCTION**

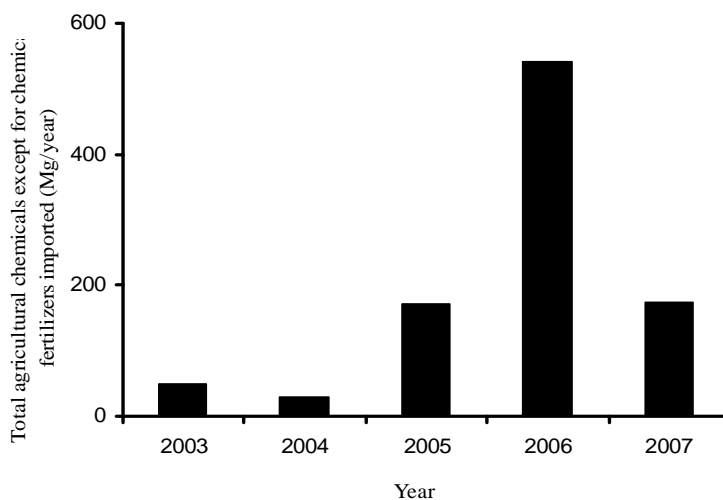
Agriculture is the most important economic sector in Cambodia, both in terms of contribution to income and to employment. Agriculture has contributed 44.8 % of GDP in 1998, and 28.5% as in 2007, and represented the primary form of employment for at least 70% of the population. The agricultural sector also has a significant potential for contributing to poverty reduction in the development of Cambodia. In the agricultural sector, crop production is the largest (52.2%), followed by fisheries (24.8%) animal production (15.6%) and forestry production (7.3%). Rice is the largest crop sector and production increased from 4.0 million metric tons (MMT) in 2000 to 4.7 MMT in 2007. The total cultivated area for rice production in 2007/2008 was 2,585,905 ha, in which 2,241,114 ha was planted in the wet season. The average rice yield in 2007-2008 was 2.621 tons per ha. However, agricultural production in Cambodia is still being developed (MAFF, 2008).

In Cambodia, sandy soils cover a large proportion of the country, on account of the siliceous sedimentary formations that underlie much of the kingdom. Sandy soils are, therefore, the most prevalent in agricultural lands of Cambodia. In rain-fed lowland rice ecosystems, more than half of the rice-growing soils are categorized as having low productivity potential. These soils are strongly to moderately acidic in reaction, very low to low in exchangeable potassium, very low in organic carbon, total nitrogen, and effective cation exchange capacity and very low to moderate in extractable P (Cambodian Government, 2006).

In order to improve the agricultural production, Cambodia needs to import chemical fertilizers from many countries. The importation of chemical fertilizers rapidly increased from 2003 to 2005, decreased in 2006 and increased again from 2007 (Fig. 1). Agricultural chemicals are also imported and increased from year to year (Fig. 2).



**Fig. 1.** Chemical fertilizers imported to Cambodia



**Fig. 2.** Agricultural chemicals except for chemical fertilizers imported by Cambodia

Pel (2008) also reported that low rice production in the dry season has increased rapidly in Cambodia. Actually, low rice production increased at the expense of flooded area and flooded forest; and is significantly correlated with the increased use of chemical pesticides and fertilizer. However, farmers still use banned pesticides in the flooded area. Intensive vegetable and low rice production lead to indiscreet and risky application of pesticides with insufficient farmer experience, lack of proper knowledge and information. The overuse of pesticides causes adverse effects in the wetland. The disposal of empty pesticide containers in edges of rice fields and homestead is a big concern.

In Cambodia, many agricultural and environmental problems occur due to the misuse of agricultural chemicals or pesticides. However, these problems affected not only to the environment system but also human health (Alternative Agriculture Forum, 1992). With the support from



government and non governmental organizations (NGOs), many of Cambodian farmers realized and looked for the better practices which can harmonize with the natural environment and health. Organic fertilizers, especially composts are very important and have been introduced to Cambodian farmers.

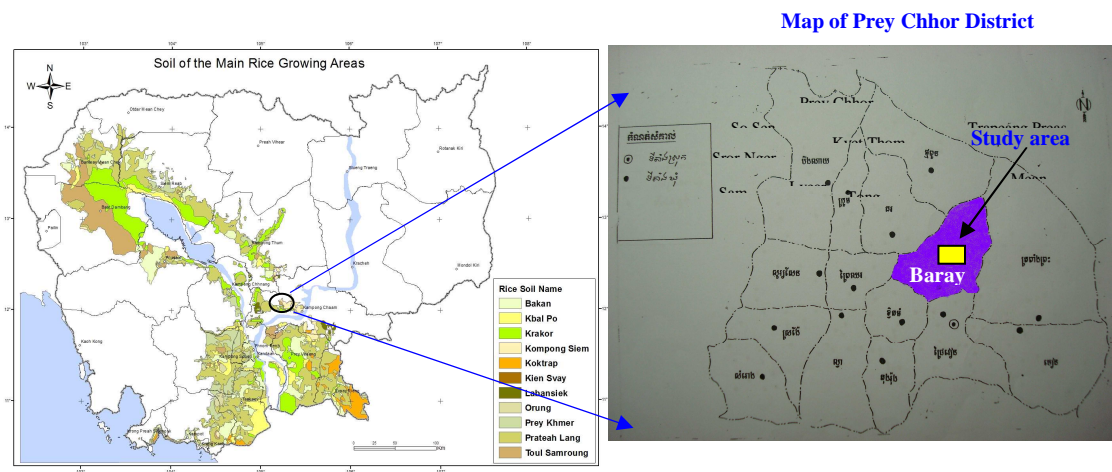
So, research interest has focused on suitable organic fertilizers in Cambodia. According to a previous study of pelletized formed compost compared with chemical fertilizer or conventional compost from a viewpoint of reducing soil and nutrient loss under various rainfalls. Siriwattananon and Mihara (2008) reported that pelletized compost was effective for decreasing soil and nutrient losses from agricultural fields. But little work has been done in order to evaluate the suitable timing of application of the pelletized compost. Also, attention should be paid to increase the farmers' acceptance through effective capacity building of the farmers to achieve sustainable agriculture which balances economical, social and environmental aspects.

This study sought to investigate the suitable timing of application of pelletized compost and to evaluate local farmers' acceptance of compost and pelletized compost making.

## RESEARCH SITE AND METHODS

### Research site

The research was conducted in Wat Chas village, Baray commune, Prey Chhor district, Kampong Cham province which is located around 90 km from the capital city of Phnom Penh. It covers 60 ha including 48 ha of rice fields, 5 ha of vegetable orchards and 7 ha for residential purposes. The total population is 484 persons including 152 women. There is no school in this village. As Wat Chas means 'Old Pagoda', this village has a long history and the villagers have preserved their own culture and traditional agriculture methods.



**Fig. 3.** Location of research site

The climate in Prey Chhor district is tropical monsoons, with a rainy season and a dry season. The rainy season is from April to November and average annual rainfall is 1,549 mm. The daily average maximum and minimum temperatures are 34.7°C in April and 21.5°C in January, respectively. Based on topography and land use, this area can be divided into 3 zones: upland, lowland and wetland zone.

Wat Chas village is located in the lowland zone, where rice and vegetables are cultivated. About 95% of the people living in this zone are farmers, 40% are under the poverty line, 30% are living under food security, and 20% look for other extra jobs outside the village. Farmers in this village have several small rice milling machines, a few pumping machines and 2 threshing machines.

The soil at Wat Chas had a pH of 5.1 and an effective cation exchange capacity of 1.9 cmol/kg. The total nitrogen and total carbon concentration of the soil was  $5.18 \times 10^{-2}$  mg/kg or  $6.34 \times 10^{-4}$  mg/kg, respectively. As the soil has very low total nitrogen content and in effective cation exchange capacity, fertilizers should be added to maintain agricultural productivity.

### **Suitable timing of application of pelletized compost experiment**

A previous study reported that pelletized compost was effective in decreasing soil and nutrient losses from agricultural fields (Siriwattananon and Mihara, 2008). But before promoting pelletized compost in Wat Chas village, field trials were conducted to evaluate the suitable timing of application of the pelletized compost based on microbial count. The pelletized compost, consisting of conventional compost, clay soil and molasses at the ratio of 10: 1: 0.01, was developed from conventional compost. The mixing ratio was based on a former study (Mihara et al. 2005). Materials were mixed with water and extruded with a mincing machine. The shape of pelletized compost is approximately 0.5 cm in diameter and 1 cm long (Fig. 4).

Conventional compost, having a total nitrogen content of  $3.01 \times 10^{-4}$  mg/kg and total carbon of  $44.6 \times 10^{-4}$  mg/kg, was made from plant and kitchen residues (Table 1). Urea was added in the fermentation process to increase the temperature at around 75 degree Celsius thus eliminating pathogen or bacteria. In addition, total nitrogen or total carbon concentration of pelletized compost was  $2.75 \times 10^{-4}$  mg/kg or  $39.6 \times 10^{-4}$  mg/kg, respectively.

**Table 1.** Chemical properties of compost, pelletized compost or soil

Sample	Total nitrogen	Total carbon	C/N
	( $\times 10^{-2}$ kg/kg)	( $\times 10^{-2}$ kg/kg)	
Compost	3.01	44.60	14.8
Pellet compost	2.75	39.60	14.4
Soil	0.29	8.03	27.4

After making pelletized compost, the changes in water content, amount of microorganism, ammonium nitrogen and nitrate nitrogen were observed in the laboratory. Water content was measured by the oven dry method, amount of microorganism by the dilution plate method, ammonium nitrogen by the Nessler method and nitrate nitrogen by the cadmium reduction method (Buurman et al. 1996, Hach Company 1994). The pelletized compost was kept in the laboratory under the temperature at 25 degrees Celsius and the relative humidity at 70%.



**Fig. 4.** Pelletized compost made from the experiment

### **Farmers' acceptance of composting and pelletized compost making**

The promotion of organic farming through composting and pelletized compost making was conducted in Wat Chas village. Farmers' acceptance and participation level were discussed through 4 workshops held from August 2007 to December 2008. The questionnaire surveys were carried out to evaluate farmers' perception after every workshop. Four workshops focused on introducing organic farming for sustainable agriculture

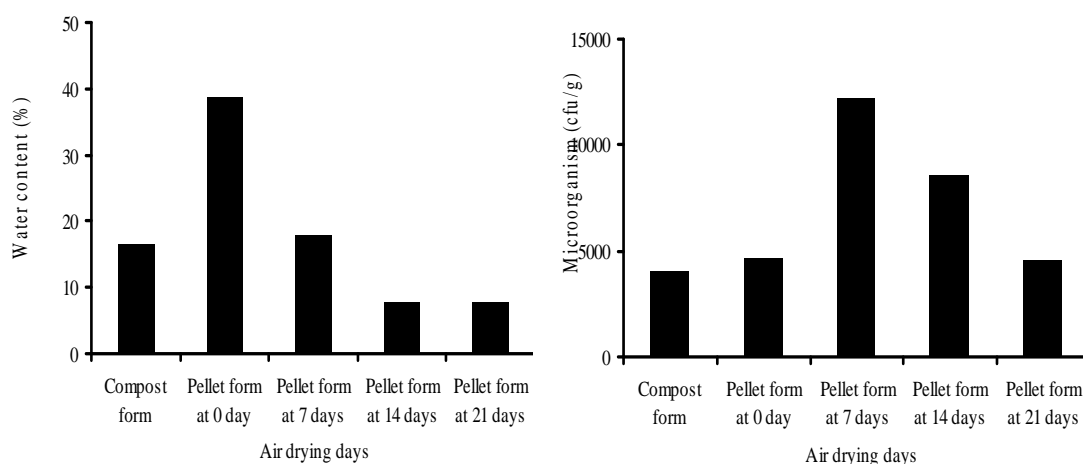
The first workshop in August 2007 focused on introducing concepts of organic farming for sustainable agriculture, the second in December 2007 was on compost making using local materials and applying compost, the third in August 2008 was on making of pelletized compost employing the mincing machine, and the fourth in December 2008 was the farmers' report of composting and pelletized compost making by themselves.

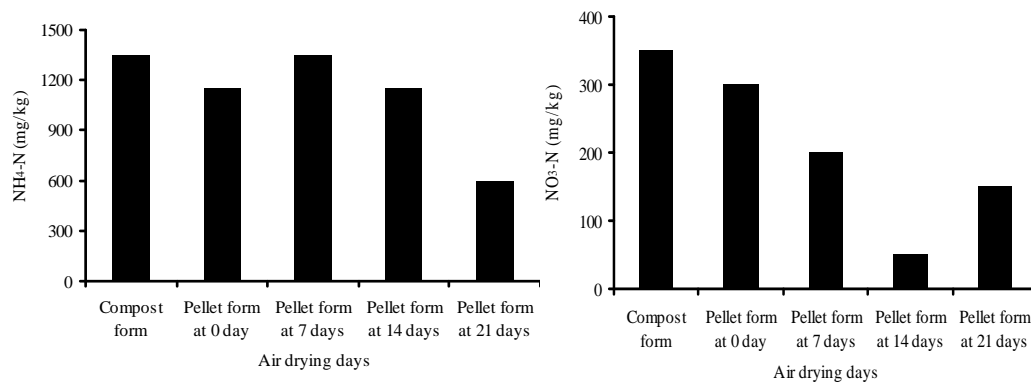
## **RESULTS AND DISCUSSION**

### **Suitable timing of application of pelletized compost**

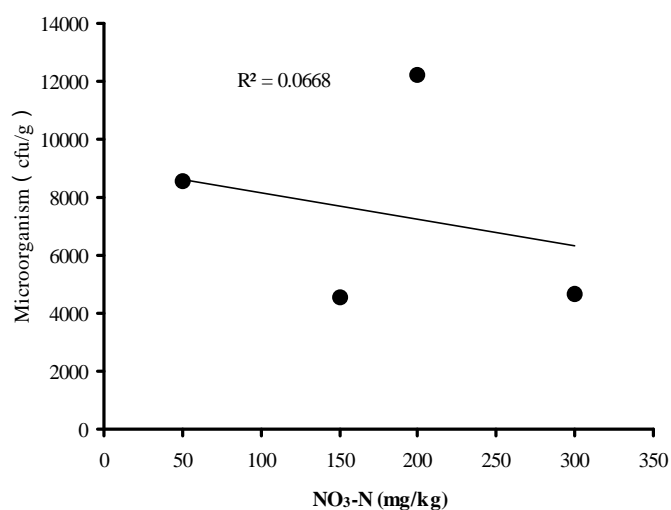
The changes in water content, amount of microorganism, ammonium nitrogen and nitrate nitrogen after forming pelletized compost are summarized in Fig. 5. As water was added for extruding the mixture, the water content of the initial pelletized compost, at 38.6%, was higher than that of compost. But there was a tendency for the water content to decrease with time. The water content became steady at 7.7% after 14 days. There was no significant difference between the microbial count of compost and that of the initial pelletized compost. But the microbial count was significantly highest at 7 days, increasing to 12,228 cfu/g dry mass, at 99% confidence level. The microbial count gradually decreased with time, and was lower than the initial pelletized compost at 21 days, although there was no significant difference at 99% confidence level.

The microbial counts were not correlated with nitrate nitrogen, but slightly correlated with ammonium nitrogen (Figs. 6 and 7). The suitable timing of application of pelletized compost, therefore, may be around 7 days after preparation of pelletized compost. In cases when this has to be stored, pelletized compost should be applied within 21 days.

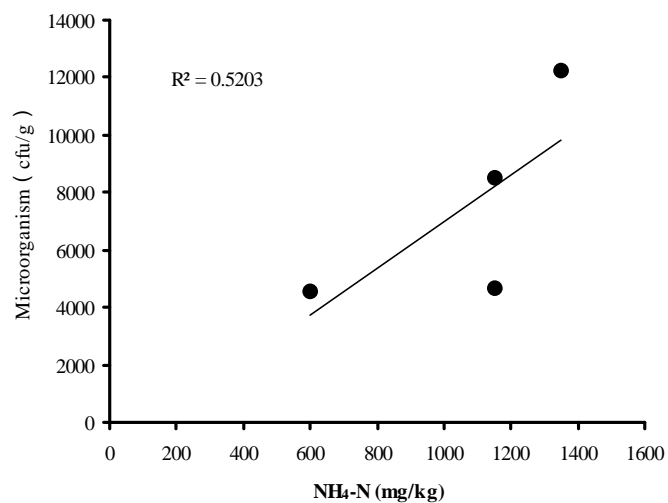




**Fig. 5.** Changes in water content, amount of microorganism, ammonium nitrogen and nitrate nitrogen after forming pelletized compost



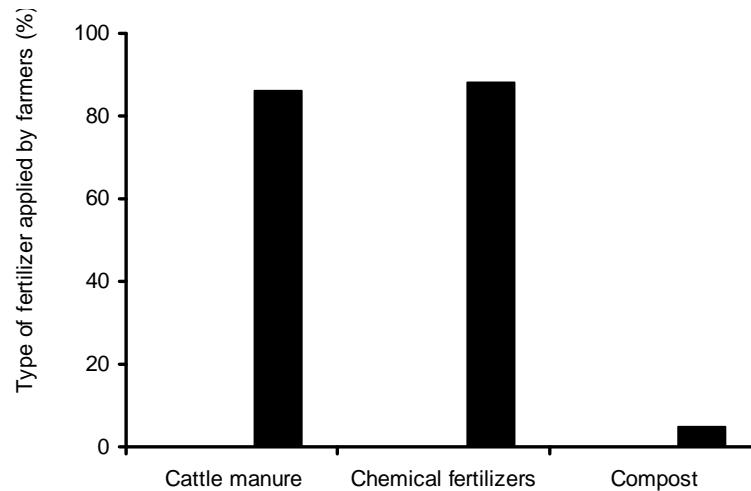
**Fig. 6.** Relationship between amount of microorganism and nitrate nitrogen



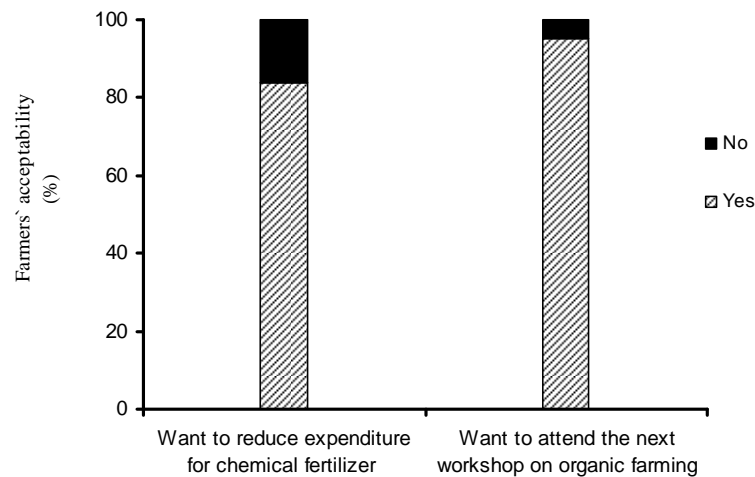
**Fig. 7.** Relationship between amount of microorganism and ammonium nitrogen.

### **Farmers' acceptance of composting and pelletized compost making**

The results of the questionnaire survey conducted before the first workshop showed that 88.4% of farmers used chemical fertilizers while 86.0% applied manure or compost (Fig. 8). Only 4.6% of the farmers had an experience to apply compost. However, after the first workshop on introducing organic farming for sustainable agriculture, 83.7% of farmers mentioned that they wanted to reduce the expenditure for chemical fertilizer. Also, 95.3% of farmers expressed that they want to join the next workshop on organic farming.

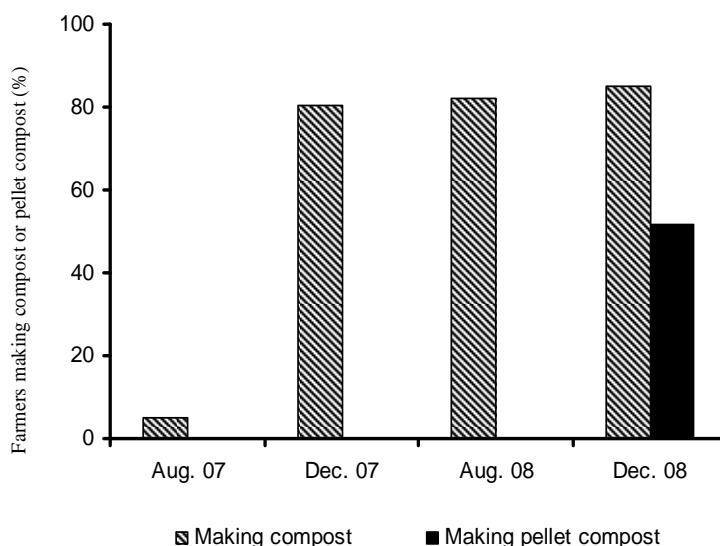


**Fig. 8.** Types of fertilizers applied by farmers



**Fig. 9.** Farmers' acceptance of organic farming

The second workshop on making and applying compost was held in December 2007, and then pelletized compost making was introduced at the third workshop in August 2008. At the fourth workshop, farmers shared their experiences on pelletized compost in December 2008. About 85.0% of farmers made and applied compost while 51.5% made pelletized compost (Fig. 10).



**Fig. 10.** Changes in farmers of making compost or pelletized compost

The level of participation was evaluated according to the answers in the questionnaire survey and attitudes of farmers in workshops. There are various levels or degrees of farmers' participation as shown in Table 2. The evaluation of level or degree of farmers' participation is important for increasing farmers' acceptance for organic farming. At the beginning of the first workshop, although many farmers attended, it was evaluated as low participation at Level 2 or 3, because most of them participated only in response to the request for attendance. However, farmers became active after understanding the benefits of composting demonstrated in the first and second workshops and pelletized compost making at the third workshop. In the fourth and last workshop, farmers' participation was very high and they were willing to adapt pelletized compost technology. So the degree of farmers' participation was evaluated as interactive participation at Level 6.

It was concluded that the deeper farmers' perception led to the higher farmers' participation. This is directly connected to farmers' acceptance of organic farming.

**Table 2.** Level of participation

Typology	Characteristics of each type
1. Manipulative participation	People participate by being told what is going to happen or has already happened
2. Passive participation	People participate by answering questions by researcher using questionnaire surveys
3. participation by consultation	People participate by being consulted, and external people listen to views
4. Participation for material incentives	People participate by providing resource, for example labor or other material

**Table 2.** Level of participation (continued)

Typology	Characteristics of each type
5. Functional participation	People participate by forming groups and objectives related to the workshop
6. Interactive participation	People participate in joint analysis
7. Self-mobilization	People participate by taking initiatives independent of external institutions to change systems

## CONCLUSION

Organic fertilizer application through composting of local materials is the easy way which enhances the quality of life for farmers and society, and in the long term it enhances environmental quality and the resource in which agriculture depends. However, there are limits of compost application, so pelletized compost was developed for an alternative fertilization including for soil and nutrient conservation. The recommended timing of application of pelletized compost may be around 7 days passed after forming pelletized compost.

Additionally, for achieving sustainable agriculture balancing among economical, social and environmental aspects, it is important to increase the farmers' acceptance through effective capacity building of farmers. In this study, grouping of farmers was also an effective way for facilitating among farmers through exchanging knowledge and experiences related to agricultural practices in sustainable way. The deeper farmers' perception through workshops led to the higher farmers' participation, and directly it connected to farmers' acceptance for organic farming.

## ACKNOWLEDGEMENTS

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## CHARACTERISTICS AND FUNCTIONS OF LABOR INSTITUTIONS IN RURAL JAVA: A CASE STUDY IN YOGYAKARTA PROVINCE

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### ABSTRACT

Although social-economic differentiation has remarkably changed village societies in rural Java, villagers still maintain strong relationships. These relationships fall under the mutual assistance described as *gotong royong*. The institutions of *gotong royong* cover a wide area of activities. The market economy is likely to weaken the stabilizing function of rural community, but this weakening process will not be so simple. Thus, although the impact of the penetration of the market economy in rural society is inevitable, mutual assistance activities can still serve a positive function. Much of the previous research on *gotong royong* has focused on general descriptions of institutional functions and coverage area. In contrast, few studies have conducted detailed analysis of institutional characteristics, function and share in farming operation, and the framework structure of institutions within the context of exchange theory, which emphasizes such factors as timing, equality, and type of reciprocity. The present study provides novel insights into the changes and current situation of labor institution practices mainly for collective works and labor exchange in rural Java. The study specifically aimed to evaluate the characteristics, categorization, and function of the labor institution in farming operations and to identify factors that influence changes in and maintenance of labor institution practices.

**Key words:** mutual help, *gotong royong*, agrarian, community, Indonesia

### INTRODUCTION

Much of the development literature has studied the positive psychosocial effects of rural communities. The function of community arises from the principle of reciprocity, and a breakdown in this community can explain at least to some extent failures of the market and the government<sup>1</sup>. In rural communities of Indonesia, specifically in rural Java, social relationships and human cooperation<sup>2</sup> that are driven by reciprocal transactions and mutual assistances among rural people are still thriving. This system of reciprocal transactions is widely known as *gotong royong*, and it plays an important role on how rural people allocate labor. Most of the research conducted so far on practices of *gotong royong* in rural Java has focused on general descriptions of the activities involved and their coverage. However, in-depth empirical study dealing with specific characteristic and function of each institution, function in farming operation and categorization of institution based on principle of exchange theory such as timing, equality and type of reciprocity has not been carried out.

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<sup>1</sup> The comparative advantage of community lies in the supply of local public goods (including provision of a social safety net) as compared with the market advantage in the supply of private goods and the state advantage in the supply of global and pure public goods (Hayami, 2006a).

<sup>2</sup>Over the past decade, interest among social scientists continues to grow in research on issues of human cooperation that deal with "social capital" (Grootaert and Bastelaer, 2002).

To address the research gap, the present study provides novel insights into customs of labor institutions in rural Java. In particular, the study aimed to (1) evaluate the characteristics and activities of labor institutions in farming operations, and (2) identify factors that influence changes and maintenance of labor institution practices.

## REVIEW OF RELATED LITERATURE

Cooperation in a community is developed by a group of people connected by mutual trust through extensive personal interactions that are based on consent and equitable division of labor among community members in order to move in a socially desirable direction (Hayami, 2006b). Motivation to cooperate is rarely only based on simple payoff maximization; it is usually based on reputation building, trust, scorekeeping, and punishment (Palameta, 1998). Much of human behaviour does not appear to be motivated by a selfish preference for increases in physical goods and services (Robinson and Flora, 2003). Further, Kircher *et.al.* (1996) argue that human motivation cannot be reduced to the rational pursuit of self-interest. Many people tend to follow the norm of reciprocity in their social-economic cooperation.

According to the principle of reciprocity, human cooperation is sustainable because it is mutually beneficial and it overlaps social norms such as solidarity and generosity, cohesiveness, social approval, and a social safety net. In addition to the pattern of human cooperation, Fehr and Rockenbach (2004) argue that enforcing “social norm” and “strong reciprocity” are essential prerequisites to establish cooperation. Gouldddner (1960) concisely stated that the norm of reciprocity involves certain actions and an obligation to repay the benefit received. As theorized by Befu (1977), the norm of reciprocity is very important in the context of social exchange<sup>3</sup> and it dictates that people should help and not injure those who have helped them.

One type of exchange is referred to as generalized and balanced. Concerning generalized reciprocity, the requital may come very soon, and it may never come at all. Balanced reciprocity<sup>4</sup> is characterized by precise balance: the reciprocation is the customary equivalent of the thing received and it occurs without delay, meaning that utility is provided within a finite period.

Communities in rural Java have maintained tight cooperation under a sense of mutual reciprocity that takes the form of mutual assistances of *gotong royong*, including maintenance of rural infrastructures, joint work to cope with natural disasters, mutual help for house construction and daily agricultural operations, and labor and financial support for important ceremonies (*slametan*)<sup>5</sup>.

*Gotong royong* refers to a community-based and supportive ethics system derived from the Javanese village tradition of communal work and responsibility, in which the individual has certain moral obligations to the wider society (Rigg *et al.*, 1999). Mutual assistance helps to ensure that community members carry comparable loads and thereby share the burden of economic and social survival (Sumarjan and Breazele, 1993). The traditional spirit of mutually helpful activities arises out of mutual group interest, solidarity, reciprocity, and responsibility (Martaamidjaja and Rikhana, 1996). In fact, *gotong royong* satisfies not only public purposes but also private needs (Subejo and Iwamoto,

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<sup>3</sup> In the classical definition, an exchange refers to a *transaction* that is *reciprocated*. A transaction is the process whereby one transactor transfers an object to another transactor (Gregory, 2004).

<sup>4</sup> Balanced reciprocity is similar to the concept of economic exchange involving cost-benefit calculations and “contractual basis arrangements,” such as in the case of typical labor exchange group.

<sup>5</sup> The concept of *slametan* (literally “safe” or “happiness”) is a placid existence made possible by the absence of troubles and obstacles (Jay, 1969).

2003). Several scholars have confirmed the importance of *gotong royong* activity in rural Java (Kartodirdjo, 1978; Raharjo, 1979; Anonim, 1985; and Sairin, 2001).

Koentjaraningrat (1961) has analyzed in detail the different types of practices in rural Java described by *gotong royong*: (1) times of family bereavement and other calamities, (2) community work projects, (3) ritual feasts (*slametan*), (4) upkeep of ancestral graves, (5) construction and major repairs to houses, (6) agricultural production, and (7) collective labor.

Collective activity under *gotong royong* can be classified in one of three ways: (1) direct exchange, (2) generalized reciprocal assistance, and (3) labor mobilized on the basis of political status (Bowen, 1986). Theorizing in broader terms, Kawagoe *et al.* (1992) categorized *gotong royong* activities into three coverage levels: public work at the village level, public work at the hamlet or neighbourhood level, and mutual help for private purposes at the household level.

Even though socioeconomic conditions in rural Java are changing, village communities still maintain tight relationships (Ishikawa, 1981; Scott, 1976; and Rosen, 1975). Nevertheless, the changes in community activities and community social-economic conditions have likely affected the sustainability of cooperation behaviour in rural villages. Sullivan (1992) founded that people at the rural-urban interface in Java were still practicing collective activities, mainly for maintaining public facilities and helping one another to build houses. Some type of institutions for mutual help have disappeared or changed in response to economic interest of community and modernization process.

Most of the research conducted so far on *gotong royong* has focused on general descriptions of the activities involved and their coverage. However, in-depth empirical study dealing with specific characteristic and function of each institution, function in farming operation and categorization of institution based on principle of exchange theory such as timing, equality and type of reciprocity has not been carried out. To address this research gap, the present study provides insights into customs of labor institutions in rural Java.

## METHODOLOGY

Field research was carried out in 2002 and 2003 covering four hamlets of the rural area in Yogyakarta Province. Data for this study were collected using techniques interviews, focus group discussions (FGDs), and analysis of documentation. Personal interview which was done in the study referred to Henn *et.al* (2006) as the face to face interview. The interview was done with selected households and community leaders such as hamlet heads and neighborhood chiefs. Gibbs (1997) stated that FGDs in principle is organized discussion with a selected group of individuals to gain information about their views and experiences of a topic. Benefit of the FGDs includes gaining insights into people's shared understanding of everyday life and the ways in which individuals are influenced by others in a group situation.

The following hamlets were studied: Planggok and Somokaton in Margokaton Village of Sleman District, in northwest Yogyakarta; Watugajah in Girijati Village in the Gunung Kidul District, in southern Yogyakarta; and Jati in Giricahyo Village, also in the Gunung Kidul District. Selection of study sites considered the transformation process of labor institution practices in the research sites with different in resource endowments and job opportunities. The first two hamlets are located in lowland area which has the most favorable resources and high population mobility. The second hamlet is located in hilly area but close to coastal area where villagers to some extent have access on off farm jobs. The last hamlet is situated in the most remote area which has the most unfavorable resources endowment and very small access on off farm jobs. Regarding the sample households for interviewing, we have asked hamlet heads to choose appropriate farming families in proportion to the households' structure in landholding. In each hamlet, 30 households were selected and interviewed,

meaning that a total of 120 households were interviewed in the four surveyed hamlets. The interviewed households in each hamlet represented about 20-30 percent of total households in the hamlet.

Interviews were conducted using a questionnaire that had been pre-tested with a selected group of village members. Survey results were analyzed using descriptive and analytical methods. In term of the survey data, it has been picked out several related variables that pertained to theoretically relevant issues such as general condition of research sites, proportion of kinship relation, mutual helps and farming labor inputs. For the qualitative and descriptive analysis, we reviewed and categorized qualitative responds dealt with issues raised by the theory such as general characteristic of institutions, categorization of labor institutions and persistence level of the institutions. FGDs were held in each hamlet in order to obtain more detailed knowledge in addition to the surveys and to cross-check the results from direct interviews. The field research was conducted in four hamlets with different social, economic, and physical conditions. Table 1 shows the location and major characteristics of the research sites. The following discussion addresses three main factors for the research sites: (i) the physical conditions of farming, (ii) economic conditions, and (iii) social structure of the community.

**Table 1.** General conditions of the research sites.

<b>Item</b>	<b>General Condition</b>			
Research site (hamlet)	Plangkok	Somokaton	Watugajah	Jati
Village	Margokaton	Margokaton	Girijati	Giricahyo
District	Sleman	Sleman	Gunung Kidul	Gunung Kidul
Area condition	Lowland	Lowland	Upland	Upland
Soil type and topography	Clay, flat	Clay, flat	Clay/limestone, terraced	Limestone, terraced
Distance from city (km)	10	10	32.4	40
Road condition	Asphalted	Asphalted	Asphalted/ traditional	Traditional
Transport facilities	Small car/motorbike/ bicycle	Small car/ motorbike/bicycle	Small bus/ truck	Truck/ motor bike
Irrigation system	Technical	Traditional	Traditional/ rain-fed	Rain-fed
Population	430	604	641	622
Number of households	97	163	130	115
Total land area (ha)	41.3	44.5	191.5	129.5
Paddy field	31.0	23.0	22.1	-
Dry field	-	-	144.2	127.0
Compound	6.8	17.1	25.2	2.5
Others	3.5	4.4	-	-
Ave size of farmland (ha)	0.32	0.14	1.28	1.10

Source: Village data in 2002

Water availability and soil conditions are important aspects of the physical conditions at the research sites. Water availability is greater in Plangkok and Somokaton, so farmers there enjoy relatively better conditions. Farmers in Plangkok can obtain enough water for irrigation even during the dry season, which allows for repeated cultivation of rice paddies. Farmers in Somokaton, on the other hand, take water from small springs that can supply enough water for paddy production in the rainy season and the first dry season only. The cropping pattern in Somokaton is paddy to paddy to secondary crops. In contrast, the irrigation conditions in Watugajah and Jati are much less favorable. Both hamlets are located on a hilly area built on a hard coral reef. While Watugajah can draw on some springs for paddy production in the rainy season, Jati has no source of water other than rainfall.

Farmers in Jati generally can grow only upland crops once a year, whereas farmers in Watugajah can grow paddy in the rainy season and secondary crops in the first dry season. Both Watugajah and Jati are located on a hilly area where terraced fields with stone walls have been constructed and maintained for many years through communal labor. People in Jati enjoy a reputation as excellent builders of terrace fields, to the extent that neighboring hamlets and villages ask them to construct their own terraced fields. This requires "group sales of labor" organized at the community level. In this way, physically difficult conditions in hilly coastal areas have necessitated and diversified group cooperation and have led to the organization of labor institutions.

The labor market is an important determinant of each village's economic conditions. Availability of off-farm job opportunities should affect farmers' perceptions of the opportunity costs of labor and should therefore reduce their motivation to join group activities. Of the hamlets studied, Planggok and Somokaton enjoy the most accessibility to urban areas. Distance from the city center is only 10 km and the transportation system is well organized. Villagers in both hamlets can easily commute to the city center, where a broad variety of non-farm jobs is available.

By contrast, Watugajah and Jati are located approximately 30-40 km from the city center, making it difficult for villagers to commute to the city center for daily work. In this sense, Jati has the worst access to a city. Several years ago, a small truck provided informal transportation from a market place near Jati to a coastal area hosting a local wholesale market, retail shops, and tourist industries. This new transportation link permitted the people of Jati to connect with "other worlds": selling products at the market, buying daily necessities for their own consumption or trading, and working in the tourist industries such as hotels and shops. Such transport linkages, however, remain uncommon in the hamlets studied. For example, villagers must rely on *ojek* service (chartered motorbike) to get from Jati to the market place, from which they can take the truck into the city. Thus, the hamlet of Jati has been separated from the outside world for many years, and this has contributed to the persistence of older types of labor institutions, as will be explained in greater detail later.

Social factors in the hamlets studied emphasize on kinship, which overlap considerably with neighbor relations. Mutual help among relatives has been practiced from generation to generation, especially in financing, labor exchange, and ceremonial (*slametan*) activities (Table 2). A tight social relationship among kin is far more extensive and far deeper in upland and remote hamlets, such as Jati in this study, where 80 percent of relatives live in the same village. This reflects low population mobility. We can assume that it is less difficult to provide mutual assistance when relatives live so close to one another.

**Table 2.** Kinship relations in the four surveyed hamlets.

Hamlet	Number of sample households	Number of relatives (both sides)				Places of residence			
		Total	Parents	Brothers	Sisters	Same house	Same hamlet	Same village	Other villages
Planggok	29	288	116	86	86	45	78	31	134
Somokaton	30	307	116	91	100	40	115	49	102
Watugajah	30	310	120	103	87	47	72	68	121
Jati	30	309	120	94	95	71	121	56	59
Composition (%)									
Planggok		100	40.3	29.9	29.9	15.6	27.1	10.8	46.5
Somokaton		100	37.8	29.6	32.6	13.0	37.5	16.0	33.2
Watugajah		100	38.7	33.2	28.1	15.2	23.2	21.9	39.0
Jati		100	38.8	30.4	30.7	23.0	39.2	18.1	19.1

Source: Household survey in 2002

The practice of inviting or being invited to ceremonies (*slametan*) is very common at our research sites. Even in Planggok with its higher population mobility, 81 percent of relatives usually invite one another to their *slametan* ceremonies. Providing mutual financial assistance is also quite common, varying from 70 percent in Planggok to 85 percent in Jati. Relatives also help one another in labor-intensive tasks, with the frequency of such assistance varying from 62 percent in Planggok to 84 percent in Somokaton and Jati. Further details are provided in Table 3.

**Table 3.** Mutual help among relatives in the four surveyed hamlets.

Hamlet	Mutual help (% of household)				Invitation to <i>slametan</i> (% of household)	
	In money		In labor		Yes	No
	Yes	No	Yes	No		
Planggok	70.8	26.7	62.8	34.7	81.3	13.2
Somokaton	78.2	20.8	84.0	15.0	93.5	5.5
Watugajah	80.0	18.7	72.9	25.8	89.4	8.7
Jati	85.1	12.3	84.1	13.3	88.7	4.9

Source: Household survey in 2002.

## RESULTS AND DISCUSSION

### Types and Characteristics of Labor Institutions

Villagers have organized institutions dedicated to specific activities and purposes. Some institutions can support similar activities and purposes. For instance, in farming operations, villagers can employ labor from several types of institution such as various exchange labor and hired labor. The present study focuses not only on the general functions of village labor institutions, but also on the specific types and characteristics in the different hamlets studied. The following discussion explains the major characteristics of each labor institution. This study identified eight categories of labor institutions practiced in the four hamlets: *gerakan*, *gugur gunung*, *rewang* and *layatan*, *sambatan*, *krubutan*, *gantian*, and *buruh tani* (Table 4). These were the only labor institutions practiced in the surveyed areas, based on villagers' reports.

(a) *Gerakan* is a joint activity in which community members construct or maintain public facilities. This activity is usually initiated by formal leaders in the community, such as hamlet heads and RW/RT<sup>6</sup> chiefs. Such work projects can include constructing, repairing, or cleaning mosques, meeting rooms, roads, irrigation channels, springs, graveyards, and guardhouses. Organization of activity varies from RT to RW or even hamlet level. The working schedule and manner of contribution to the joint effort are flexible. The frequency of each activity depends on the conditions of each public facility.

(b) *Gugur gunung* is a joint activity to cope with emergency needs such as fires, landslides, and house destruction. The community therefore gives this activity the highest priority. *Gugur gunung* is commonly organized at the RT level, but in the case of big disasters, the hamlet as a whole coordinates joint work. Because of the critical importance of these activities, participation is extremely high, approaching nearly 100 percent. In the case of emergencies, the person who first discovers the affected area delivers the information to community members immediately for

deliberation and action. The work is usually continued until the rescue/rehabilitation work finishes. The core of participants comes from RT or RW or even the greater hamlet.

(c) *Rewang* and *Layatan*. Both *rewang* and *layatan* involve mutual help for important ceremonies in the village. *Rewang* is conducted at the ceremonial feast for marriages, circumcisions, or celebration of pregnancy. *Layatan*, on the other hand, is mutual help for funerals. Participants contribute by sharing labor or costs (money and food materials) for the ceremonies. It is also important for participants to share the joys or sadness of the host family. Participants commonly consist of neighbors and relatives.

**Table 4.** General characteristic of labor institutions in the four surveyed hamlets.

Type	Characteristics
<i>Gerakan</i>	Joint activities by community members to maintain public facilities such as mosques, meeting rooms, roads, irrigation channels, springs, graveyards, and guardhouses
<i>Gugur Gunung</i>	Joint activities by community members to cope with emergencies such as fires, landslides, and destruction of house
<i>Rewang/Layatan</i>	Mutual help for ceremonial activities such as funeral, marriage, and circumcision
<i>Sambatan</i>	Requested mutual help for house construction/repairing, terrace making, wood transportation, etc.
<i>Krubutan</i>	Exchange labor among small group members for farming activities and domestic work (yearly basis)
<i>Gantian</i>	Simplified type of <i>Krubutan</i> occurring on a seasonal basis
<i>Prayaan</i>	Joint sales of labor to obtain cash income or to create joint assets for the group
<i>Buruh upahan</i>	Hired labor compensated in cash or in kind

Source: Interviews in 2002

(d) *Sambatan*<sup>7</sup> are requests to neighbors or relatives made by a client family wishing to build or repair his house or cattle/goat shed. In Planggok and Somokaton, *sambatan* can be issued at the time of brick baking, and in Jati and Watugajah for major agricultural operations, wood transport, or terrace construction. *Sambatan* is reciprocal aid in which the reciprocity appears to be flexible. The client family is not expected to give immediate returns to their assistants and neighbors, and strictly equal compensation of labor is not required. Asymmetrical help, therefore, may be available to the poor who cannot equally return the kindness of neighbors. Natural limits on kindness apply, however, and those who call for *sambatan* often will have strained relations within the community.

(e) *Krubutan* is joint work that rotates among members of a small group. Normally this involves approximately five people from different households who gather in one group and work together, with the positions on the work team rotating among the households involved. This is the strictest type of labor exchange among the types observed in the four hamlets, since it demands rigid reciprocity and equality in work sharing. Separate *krubutan* groups are organized for men and women, and the groups consist of neighbors, friends, and relatives. Group members gather every day, usually in the afternoon, and work together for agricultural operations, terrace making, wood fetching, and processing of agricultural products, among other activities.

<sup>7</sup> *Sambatan* literally means "requests". *Sambatan* is an institution for providing assistance in response to a neighbor's request (Sullivan, 1992).

(f) *Gantian* is a simplified type of *krubutan*. It is generally organized only during the rainy season; thus, it can be referred to as a seasonal collective group. The number and composition of members is similar to that of *krubutan*. Members rotate working together for farming operations mainly involving land preparation and seed planting.

(g) *Prayaan* is group work like *krubutan* and *gantian*, but it differs in that it requires compensation through cash payments. At the same time, *prayaan* is different from hired labor due to its emphasis on the group. In fact, it can be seen as the group sale of labor, and the pricing differs sharply depending on whether the client is a member or non-member. The numbers of groups and of group members are flexible. The groups are organized separately by gender. Women's groups work mainly in agricultural operations, while men's activities are much broader, comprising agricultural operations, wood and stone collecting, terrace making, and plastering works. The group activity is usually done once a week in the afternoon. The participation of members is high (80-90 percent), and absent members are required to pay a penalty in cash. In using *prayaan*, prices are set for members and non-members. Members can employ a *prayaan* group at a cheaper price. Although the actual price levels differ for each *prayaan* group, all groups use the same principle to distinguish insiders from outsiders (Table 5).

**Table 5.** Wages of *Prayaan* activity.

Hamlet Group of	Watugajah		Jati	
	Men	Women	Men	Women
For members	500-2,000	300-2,500	2,500-5,000	1,000-4,000
For non-members				
Same RT	1,500-2,000	1,500-2,000	3,000-5,000	3,000-5,000
Same hamlet	5,000	3,500-5,000	4,000-7,000	3,000-7,000
Same village	7,000	7,000	7,000-10,000	7,000

Source: Interviews in 2002

Note: In all cases, all workers are given meals.

(h) *Buruh upahan*/hired labor is a type of contractual arrangement between employer (land owner) and employee. Employees offer labor and in return get wages which can be in cash or in kind. The contract is usually not written or formal, but is informal or a trust-based agreement. The most common form of wage paid in rural Java is in cash. Calculation of wage paid is mainly on the basis of a half day or a full day working. Hired labor can be utilised for various farming activities.

### Labor Functions in Farming Operations

Compared to the hamlets studied, Planggok and Somokaton rely on fewer sources of labor in farming operations: villagers use only family and hired labor, and family labor is the predominant source. Hired labor is a larger fraction of labor activities in both of these hamlets compared to Watugajah and Jati, where family labor still predominates. However, sources of labor forces in Jati and Watugajah are more diverse, and they include family, *krubutan*, *gantian*, *sambatan*, *prayaan*, and hired labor. The role and contribution of mutual cooperation for farming is more significant in Watugajah and Jati.

Family labor accounts for 70-80 percent of total labor input in all hamlets. Since exchange labor has already disappeared in Planggok and Somokaton, the residual labor input is covered by hired labor, at the rates of 28.5 percent and 27.7 percent, respectively. On the contrary, traditional types of labor exchange remain important in Jati, where *krubutan*, the strictest type of exchange labor, still



accounts for 19.2 percent of labor input in agriculture (Tables 6). Watugajah is a transitional case, and cash payment to non-family members has become more important. Farming activities in the four hamlets that require relatively high labor input are (i) land preparation, (ii) seeding/transplanting, (iii) weeding, and (iv) harvesting. Irrigation work is also important in the paddy areas (Planggok, Somokaton, and Watugajah). The relatively high labor input for irrigation (15.9 percent) in Watugajah reflects the water scarcity there. It is only during the rainy season that farmers in Watugajah can grow paddy by taking irrigation from natural springs. In Jati, villagers heavily rely on rainwater, so that there is no irrigation work at all.

**Table 6.** Sources of labor input for each farming operation in Watugajah & Jati Hamlets

							%	
Type of Farming Operation	Family	Krubutan	Gantian	Sambatan	Prayaan	Hired	Total	
Watugajah								
Land preparation	62.8	1.4	15.8	2.0	0.0	18.0	100.0	13.2
Seeding/Transplanting	54.9	1.3	9.0	1.5	28.6	4.7	100.0	15.9
Fertilizer/Pesticide application	86.3	0.0	0.9	0.0	0.0	12.8	100.0	4.5
Irrigation/Watering	100.0	0.0	0.0	0.0	0.0	0.0	100.0	15.9
Weeding	85.4	1.0	1.7	0.2	4.6	7.1	100.0	15.4
Harvesting/Threshing/Drying	79.0	1.6	3.1	0.0	3.5	12.8	100.0	29.9
Packaging/Transportation	90.7	0.4	0.0	0.0	7.6	1.3	100.0	1.6
Others	100.0	0.0	0.0	0.0	0.0	0.0	100.0	3.6
Total	78.6	1.0	4.8	0.5	6.4	8.6	100.0	100.0
Jati								
Land preparation	46.6	36.0	0.0	0.0	15.3	2.1	100.0	19.5
Seeding/Transplantation	77.9	13.8	0.0	0.3	6.5	1.5	100.0	9.8
Fertilizer/Pesticide application	94.8	1.7	0.0	0.0	3.5	0.0	100.0	3.7
Irrigation/Watering	100.0	0.0	0.0	0.0	0.0	0.0	100.0	0.2
Weeding	51.5	35.9	0.0	0.0	8.1	4.6	100.0	23.6
Harvesting/Threshing/Drying	88.4	5.7	0.0	1.1	3.5	1.3	100.0	40.5
Packaging/Transportation	76.2	0.7	0.0	23.2	0.0	0.0	100.0	1.4
Others	100.0	0.0	0.0	0.0	0.0	0.0	100.0	1.3
Total	70.7	19.2	0.0	0.8	7.1	2.2	100.0	100.0

Source: Household survey in 2002.

**Table 7.** Sources of labor input on each farming operation in Planggok and Somokaton.

								%
Type of Farming Operation	Planggok				Somokaton			
	Family	Hired	Total		Family	Hired	Total	
Land preparation	69.8	30.2	100.0	13.7	63.4	36.6	100.0	14.7
Seeding/Transplanting	44.3	55.7	100.0	22.9	46.1	53.9	100.0	17.0
Fertilizer/Pesticide application	97.3	2.7	100.0	5.4	99.1	0.9	100.0	6.1
Irrigation/Watering	100.0	0.0	100.0	11.4	97.4	2.6	100.0	10.7
Weeding	84.7	15.3	100.0	24.7	92.9	7.1	100.0	19.9
Harvesting/Threshing/Drying	70.5	29.5	100.0	16.7	62.6	37.4	100.0	30.4
Packaging/Transportation	76.9	23.1	100.0	0.4	65.2	34.8	100.0	0.3
Others	46.4	53.6	100.0	4.9	100.0	0.0	100.0	0.9
Total	71.5	28.5	100.0	100.0	72.3	27.7	100.0	100.0

Source: Household survey in 2002.

Over half of the transplanting work is done by hired labor under *borongan* contract. The traditional harvesting system (*bawon*<sup>8</sup>) remains common, together with the *tebasan* system<sup>9</sup>. Non-family members perform 30-40% of harvesting work. Land preparation under the *borongan* system also depends on hired labor involving a tractor or buffaloes (30% of total labor for land preparation in Planggok, 37 percent in Somokaton). On the contrary, family members apply fertilizer and pesticides and practice weeding.

In Jati, where exchange labor is still important, 36 percent of labor inputs for land preparation and weeding are done by *krubutan*. *Prayaan* is used for various operations, particularly for transplanting (28.6%) in Watugajah and for land preparation (15.3%) in Jati. In Watugajah, hired labor performs a significant proportion of land preparation (18%), fertilizer/pesticide application (12.8%), and harvesting (12.8%). In Watugajah and Jati, forestry production, which includes timber and firewood, still contributes a considerable proportion to farming income. The share of exchange labor for forestry production in Jati is also substantial. It is worth noting that *prayaan* and *krubutan* working groups still play an important role, contributing 27.4 and 7.0 percent, respectively, to total labor activities. In both areas, the largest proportion of labor input for forestry production is pruning.

### Categorization and Principles of Labor Institutions

Analyzing major characteristics of each institution allows us to define categories of labor institutions in the hamlets surveyed. This categorization involves at least four dimensions: (1) purpose, (2) timing of reciprocity (immediate, short-term, and long-term reciprocation), (3) strictness/equality of reciprocity (equal or unequal), and (4) compensation including money, labor, social validation, and benefits drawn from public goods ( Table 8).

**Table 8.** Categorization of labor institutions in rural Java.

Name of Labor Institutions	Purpose		Timing of Reciprocity			Equality of Reciprocity		Type of Reciprocations		
	Public	Private	Immediate	Short-term	Long-term	Strict	Non-strict	Labor	Money	SV, B
<i>Gerakan</i>	+			(+)	(+)	(+)	(+)			+
<i>Gugur</i>	(+)									+
<i>Gunung</i>		(+)			+		+	+		
<i>Rewang,</i>	(+)									+
<i>Layatan</i>		(+)			+		+	+		
<i>Sambatan</i>		+			+		+	+		+
<i>Krubutan</i>		+		+		+		+		
<i>Gantian</i>		+		+		+		+		
<i>Prayaan</i>		+		+		+		+	+	
<i>Buruh</i>										
<i>Upahan</i>		+	+			+			+	

Note: + = existence , (+) = existence in more than one sub-category, SV = social validation, B = benefit drawn from public goods

Based on the framework of purpose, the institutions can be classified into three groups. The first group is *gerakan*, which provides public goods to the community. It is widely considered to be a collective action. The second group is an institution that seeks to satisfy public needs through such

<sup>8</sup> This refers to the system in which community members can participate freely in rice harvesting (Hayami and Kikuchi, 1986).

<sup>9</sup> This refers to the system in which farmers sell standing crops to merchants who employ harvesting workers irrespective of where they live (Hayami and Kikuchi, 1986).

activities as *gugur gunung*, *rewang*, and *layatan*. In application of *gugur gunung* activity for emergency cases, villagers expect other community members to voluntarily give assistance to the victims; in this way, villagers consider that their institutions are not only for private but also for public benefit. For ceremonial events, villagers expect that all members will behave naturally; in this case, the institution is considered to meet not only private interest but also public interest. The third group is institutions for purely private purpose such as *sambatan*, *krubutan*, *gantian*, *prayaan*, and *buruh upahan*. The activities of these institutions typically occur within the framework of contracts.

With regard to the timing of reciprocity, the analytical framework can be extended from immediate, short-term, and long-term. In the case of immediate reciprocity, reciprocation is given or received immediately after the work is completed. Short-term reciprocity is on the time scale of one month to one year. Long-term reciprocity takes on the order of several years. The institutions can be classified into three groups based on the timing of reciprocity. The first group is an institution in which reciprocation can be either short- or long-term; this is the case of *gerakan*. Villagers can use public goods in the short-term or long-term. The second group includes institutions in which the reciprocation is long-term: *gugur gunung*, *rewang*, and *layatan*. Reciprocation can take quite a long time, since many villagers believe that contributions should be compensated over several years, sometimes even through generations. The third group is institutions in which reciprocation is short-term, such as *krubutan*, *gantian*, and *prayaan*. The fourth group is an institution in which reciprocation is guaranteed to be immediate: *buruh upahan*.

Institutions can be categorized based on whether equality of reciprocation is strict (equal) or non-strict (unequal). This leads to three groups of institutions. The first group is an institution in which reciprocity can be either short- or long-term, as in the case of *gerakan*. Villagers may use public goods in a way that reflects their sense of balance between contribution and reciprocation; nevertheless, in some cases, villagers intentionally use more than their contribution, which is the case of free riders. The second group is institutions in which reciprocation is likely to be non-strict: *gugur gunung*, *rewang*, and *layatan*. If community members do not use the labor institution, this means that they only contribute but do not receive reciprocation, or that the contribution is not equal to the reciprocation. The asymmetry between give and take is likely to be accepted with generosity. The third group is institutions in which reciprocation occurs strictly within the framework of a contract, such as *sambatan*, *krubutan*, *gantian*, *prayaan*, and *buruh upahan*. The practice of *sambatan* constitutes an exception, since reciprocity is less strict, primarily in the case of poor families: such families are not required to return an equivalent amount to those that give support to them.

Institutions can be classified into three groups based on reciprocation types. For several institutions--*krubutan*, *gantian*, *sambatan*, *gugur gunung*, *rewang*, and *layatan*--contribution is compensated by labor. The type of compensation for hired labor is cash. Interestingly, for *prayaan*, compensation consists of both cash and labor. Regardless of the type of compensation, all the participants in labor institution activities receive meals. In some institutions oriented to meet purely public interests or a mixture of public and private interests, the reciprocation type is also in a particular form of social validation<sup>10</sup>. Those institutions include *gerakan*, *gugur gunung*, *rewang*, *layatan*, and *sambatan*. In the case of collective action or *gerakan*, rural people may contribute labor, money, or construction materials as reciprocation depending on the form of social validation and the benefits available from public goods. Members who do not contribute to collective action receive a penalty, which can vary from a cash fine, a strong caution from community leaders, and social sanctions such as malicious gossip or even expulsion for severe offenders.

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<sup>10</sup> Active contributors to collective action receive social validation from community members. This validation need not involve financial gain, and it is sometimes referred to as socio-emotional goods (Robinson and Flora, 2003).

Whether social norms or contracts drive the reciprocity mechanism strongly affects the type and equality of reciprocation. The institutions that govern based on social norms usually have specific mechanisms to discipline the offenders. Appropriate contributors receive social validation, whereas offenders and free riders receive various social sanctions. For the institutions that govern on a contractual basis, the consequence of breaking rules or contributing unfairly is termination of the contract. The direct consequence for offenders is difficulty in recruiting labor for various activities, from the perspective of employee who violates a contract, the consequence is difficulty in finding work; in this way, terminating a contract is regarded as a type of sanction.

The institutions oriented toward the public good, such as *gugur gunung*, *rewang*, and *layatan*, can be considered as a type of informal insurance or risk-sharing strategy<sup>11</sup>. The contributions of people can be understood as a kind of premium<sup>12</sup> or social investment in this social insurance system. They should contribute even though they cannot expect reciprocation unless they face emergency events or otherwise require assistance.

### Changes in and Continuity of Labor Institutions

The daily practices of labor institutions have been changing significantly. Villagers in the most remote hamlet, Jati, are still practicing all of the labor institution types. Watugajah, in contrast, is experiencing a transition. In general, villagers in Plangok and Somokaton have the most favourable agricultural resources, highest access to upward mobility and job opportunities, and relatively weak social relationships. Villagers in Watugajah have the medium condition of the factors. On the contrary, villagers in remote hamlet Jati have the most unfavourable resources and lowest access on mobility and job opportunities but they have the strongest social relationship. In contrast, in the lowland areas of Plangok and Somokaton, market economy penetrates massively, causing a remarkable decrease in labor institution practices (Table 9).

**Table 9.** Persistence of labor institutions in four surveyed hamlets.

Labor Institutions	Research Sites			
	Planggok	Somokaton	Watugajah	Jati
<i>Gerakan</i>	+	+	+	+
<i>Gugur Gunung</i>	+	+	+	+
<i>Rewang/Layatan</i>	+	+	+	+
<i>Sambatan</i>	+	+	+	+
<i>Krubutan</i>			+	+
<i>Gantian</i>	(+)	(+)	+	
<i>Prayaan</i>			+	+
<i>Buruh upahan</i>	+	+	+	+

Source: Interviews in 2002

Note: + = the persistence of the labor institution, (+) = disappearance of the labor institution

The characteristics of agricultural resources, mobility access, expansion of job opportunities, and social relationships play important roles in defining the types, persistence, and changes in labor

<sup>11</sup> Rural poor in Asian countries are usually vulnerable to various potential risks, thus they have developed various risk-coping strategies (Balisacan and Fuwa, 2007).

<sup>12</sup> To maintain the effectiveness of community-based safety nets, all the community members must contribute appropriate insurance premiums based on the principle of reciprocity dictated by custom and norms (Hayami, 2006b).

institution practices. The following discussion explores these factors in greater detail. Collective action for maintaining public infrastructures is organized more often in upland hamlets where roads paved by soil and stone are easily damaged during the rainy season. In lowland hamlets, where the opportunity cost of labor has become more expensive, community members contribute either by participating in the work and by contributing food, construction materials, or money. Social sanctions against absent members in the forms of malicious gossip, excommunication, and expulsion remain heavier in Jati and Watugajah, which reflect the tight structure of these communities. Indeed, the cohesion of the communities in Planggok and Somokaton seems to have weakened because of increasing employment in off-farm activities.

In Jati and Watugajah, where most of the land is mountainous, farmers usually grow big trees to provide construction timber in compounds surrounding the house. In addition, housing settlements are located in steep areas. These conditions carry some risks, and the probability of natural disasters is high. Hence, villagers still value the existence of institutions linked to coping with emergencies. It is common for community members to offer assistance spontaneously in any emergency. During the last decade the frequency and labor-intensiveness of ceremonial activities has changed significantly. In particular, the duration of ceremonies in all hamlets has become shorter and simpler, such that marriages last only one day. In Planggok and Somokaton, womens' contributions to cooking and serving guests have decreased, and it has become common for the host family to employ hired labor for the ceremony. Most respondents said that they expect this tendency to become much more pronounced in the future.

*Sambatan* is reciprocal aid between neighbors, but its reciprocity is more flexible than typical exchange labor. The client family is not expected to provide immediate compensation to their assistants and neighbors, and strictly equal compensation is not required. Moreover, the frequency and importance of *sambatan* has decreased with the increase of non-agricultural job opportunities. In Planggok and Somokaton over the last 15 years, hired labor has taken over some activities formerly carried out by *sambatan*.

*Krubutan* activities still play an important role in Jati and Watugajah, particularly during the busy rainy season, whereas the practice has disappeared in Planggok and Somokaton. This disappearance can be attributed to the latter two hamlets' better access to the city center. In fact, the number of joint activity groups and the amount of their activity has declined even in Jati.

According to the respondents, while some *gantian* groups existed in Planggok and Somokaton until the 1960s, the system has since been replaced by a type of contractual hired workers (*borongan*<sup>13</sup>). This suggests that hired labor took the place of exchange *gantian* labor in the early 1970s in Planggok and Somokaton. In contrast, people in Watugajah still need *gantian* for farming operations in order to accomplish the necessary work in the brief window during the busy rainy season without having to pay cash wages. Respondents explained that *krubutan* and *gantian* presented several advantages compared to individual and family labor. First of all, farming operations can be finished within a limited time, which is desirable under unfavourable water conditions, particularly in a rain-fed area like Jati. Theoretically, group work and family labor involve similar total labor inputs. For example, in the case of a *krubutan* group with five members, a client member can benefit from the work of five people on a certain day, but he or she must do group work on the other members' fields on the remaining four days. After one rotation, therefore, a member's acceptance of total labor is the same as his or her contribution to other members. Respondents, however, emphasized the positive effect of group work for fostering the working spirit, which would be very important in the area where farming operations must be finished within a strict time frame. Of course, it cannot be ignored that group work has certain disadvantages as well. The most important

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<sup>13</sup> *Borongan* is a labor contract in which the payment is based on acreage of land as a unit, not on hours worked.

disadvantage is the negative effects caused by opportunistic behavior of group members. However *krubutan* and *gantian* have a mechanism that can reduce the amount of free riding. The close and continuous relationship among the few members is likely to prevent them from behaving opportunistically. Nevertheless, we have to admit that the changes in labor institution has substantially influenced group projects as a result of increasing non-farm job opportunities.

*Prayaan* activity remains common in Jati and Watugajah, but it has disappeared completely from Planggok and Somokaton. In Jati, the groups still maintain a tight structure, and they are employed as a full group. In Watugajah, in contrast, *prayaan* can be used more flexibly by subdividing the members into smaller groups. Group leaders accept orders and arrange the schedule of operations by giving equal labor opportunities to all members. Net income of each group is calculated once a year and divided among members according to their labor contribution. Almost all groups have a rule to separate a certain portion of income for group benefits, such as loan funds to members, kitchenware for leasing, etc. This distribution system clearly shows the group-oriented characteristics of *prayaan* activity.

In lowland hamlets, hired labor has commonly been used for farming operations for a long time. In the transitional hamlet of Watugajah, hired labor is used for limited farming operations. Villagers who have difficulties in exchanging labor (widows, elderly, civil servants, teachers, etc.) began to employ hired laborers even though this remains limited in scale, restricted to rice-planting and woodcutting. In contrast, hired labor remains uncommon in the upland and remote hamlet of Jati. As mentioned above, exchange labor is much more important than hired labor, especially in this remote area.

With the development of the market economy, farmers become aware of the opportunity costs of labor. As a result, they have begun to behave as economically rational and have pursued their self-interest to a greater extent. Thus the motivation of farmers to join reciprocal types of labor institutions tends to decrease sharply with time. As shown by the example of Planggok and Somokaton, hired labor has replaced exchange labor institutions.

Opportunistic behavior is the principal factor that can create disadvantages for group work. The institutions of labor exchange rely on the following mechanisms to prevent such opportunistic behavior from harming group activities: (1) limited membership of a group, (2) close daily contact among neighbors, and (3) overlapping kinship and neighborhood relations. Limited membership of groups is a crucial factor for solving the problem of cooperation. A small number of group members allows direct monitoring, peer monitoring, and tracking of personal reputation. These strategies are essential for controlling moral hazard among members. Close daily contacts and overlapping relationships among group members are referred to as closure of social networks. The closure network is very effective for sustaining cooperative behaviour. Closeness and overlapping relationships among villagers may determine the cohesiveness of the social structure and in turn encourage the effective application of a social sanction system.

Even in Planggok and Somokaton, areas with easy access to urban centers, kinship relations remain tight, especially for ceremonial purposes. Exchange labor for farming operations, however, has been replaced completely by hired labor in both hamlets. The four hamlets studied in the present research reflect different stages in the transition of labor institutions. The impact of the market economy is likely to weaken the stabilizing function of the rural community. But the process will not be so simple. For example, people in Jati invented a quite unique labor institution, *prayaan*, which combined the principle of market economy with that of a non-cash economy. Therefore, although the penetration of the market economy into isolated areas cannot be prevented, mechanisms of mutual support practiced by rural people from generation to generation can still slow the socially destabilizing effects of the market.

## CONCLUSION AND RECOMMENDATIONS

A novel categorization of labor institutions in rural Java has been studied using an analytical framework based on (1) purpose, (2) timing of reciprocity (immediate or long-term reciprocation), (3) strictness or equality of reciprocity (equal or unequal), and (4) type of compensation or reciprocation (money, labor, social validation, and benefits drawn from public goods). In general, labor institutions are conducted and maintained under the principle of reciprocity. The ways of applying the reciprocal principle can be simplified into two categories: (1) reciprocity based on social norms, and (2) reciprocity based on a contractual arrangement.

Practices of labor institutions in rural Java have been considerably changing. The changing process has been more dramatic in lowland area. In the hilly areas of Gunung Kidul District, various types of labor institution for mutual assistance still play an important role, especially in farming operations. Share of labor from labor exchanges to various farming operations is still considerably prominent. Some factors such as agricultural resources favourability, mobility access, job opportunities and tightness of social relationship have been influencing the changes and sustenance of labor institutions practices. In contrast, in lowland areas which commonly holding more abundant resources, greater mobility and access to job opportunities, and weaker social relationships; labor institutions for mutual assistance tend to decline.

Villagers in upland areas where scarcity of resource endowments is much higher and geographic isolation is more persistence, full-use of labor institution's practices for daily needs will be constantly important. Functions of labor institutions covering various activities consist of both farming and non-farming events. In rural lowland areas, despite that market economic activities are part of the whole aspects of community life, functions of labor institutions are still considerably important for villagers at least for coping emergency, ceremonial and house construction activities.

The functions and performance of labor institutions supporting rural community life in rural Java as discussed in this study to some extent also indicate the advantage of community functions as social safety net system. Villagers in the rural area which are commonly facing various risks and high uncertainty may full-use and strengthen the practices of labor institutions to overcome those problems.

The author firmly believes that this paper can be an important first step towards future comprehensive analysis on the functions of labor institutions in rural communities. In-depth study on each institution with regard to functions, arrangement mechanism, influencing external and internal factors, supplementary and complementary among institutions will be important topics for the next study.

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## SUPPRESSION OF FUSARIUM ROOT ROT AND SOUTHERN BLIGHT ON PEANUT BY SOIL SOLARIZATION

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### ABSTRACT

Both southern blight (*Sclerotium rolfsii*) and Fusarium root rot (*Fusarium solani*) are the important soil-borne diseases found in peanut (*Arachis hypogaea*) in the Bogor area, including the Seed Technology Experimental Station of Bogor Agricultural University (IPB). Solar heating by means of clear polyethylene sheets to control these two soil-borne diseases was performed in naturally infested soil in the experimental station. The temperature in the moistened field soil covered with transparent polyethylene sheets increased dramatically by solarization particularly in the upper 5 cm layer. Soil solarization suppressed incidence of both diseases and enhanced crop yields significantly. Soil solarization for 1, 2, and 3 weeks suppressed southern blight by 75.3, 79.3, and 91.0 percent, and Fusarium root rot disease by 74.5, 81.2, and 83.9 percent, respectively. The average dry weight of fulfilled pod yields increased by 43.9, 48.8, and 80.5 percent in soils solarized for 1, 2 and 3 weeks, respectively. A higher population of the total bacteria, actinomycetes, and fungi were found in solarized soils. Changes in microbial populations induced by soil solarization might contribute in the diseases suppression beyond the physical effects. The phenomenon of increased growth response (IGR) also occurred in this study besides disease suppression.

**Key words:** *Arachis hypogaea*, soil-borne diseases, transparent polyethylene sheets, IGR

### INTRODUCTION

Peanut is one of the important protein resources in daily diet in Indonesia. Average annual production of this crop in Indonesia, 702,861 ton can not covered the average annual consumption, 836,560 ton. Though many peanut varieties have the potential to produce between 2.5 – 3.3 ton/ha based on research activity, only about a half (1.08 ton/ha) of the potency has been performed in practically (Manurung, 2002). One of the limiting factors causing the decrease in productivity is plant pathogens. As the peanut pods produced on the tip of the flower pegs initially grow downward into the soil to mature, these are exposed to many soil microorganisms including fungal pathogens. Several soil fungal plant pathogens, such as *Fusarium*, *Sclerotium*, *Rhizoctonia*, *Rhizopus*, *Pythium*, *Verticillium*, *Sclerotinia*, *Cylindrocladium*, *Penicillium*, and *Aspergillus* species have been reported as causal agents of peanut diseases throughout the growing areas in the world (Kokalis-Burelle et al., 1997). Among these soil-inhabiting fungal plant pathogens, *S. rolfsii* and *F. solani* are the most devastating and economically important in many peanut growing areas in Indonesia (Semangun, 1993). Since 1987, these two fungi have caused devastating diseases which affect adversely many kinds of field experiments, not only phytopathological but also the other aspects in the Seed Technology Experimental Station-Bogor Agricultural University (IPB).

In ecological views, the management of soil-borne plant pathogens should be emphasized in the promotion of soil health as it provides an environment that allows maximum yields with reduced

risks of loss and minimal environmental contamination. Since 1976, when the first publication appeared on solarization involving the use of polyethylene sheets (Katan et al. 1976), many studies have explored its uses and effectiveness under different environmental conditions (Greenberger et al., 1987; Lopez-Herrera et al., 1994; Chellemi et al. 1997; Mc Govern et al. 2000). The use of this method to control soil-borne diseases as well as weeds and arthropod pests seems to have a promising approach since the phase out of methyl bromide in developing countries was implemented in 2005. Many investigations seemed to show that soil solarization raised the equilibrium of many physical, chemical and biological factors that promoted soil health (DeVay and Katan, 1991).

## **MATERIALS AND METHODS**

### **Soil solarization**

Field experiments were carried out in naturally severely infested soil in the Seed Technology Experimental Station-Bogor Agricultural University (IPB), where peanut has been grown frequently, from November 2001 to April 2002. Individual plots, 5 x 5 m<sup>2</sup>, were arranged in a randomized complete block design (RCBD) consisting of four treatments each with three replications. Solarization was carried out on soils amended with chicken manure (200 ton /ha) and moistened by irrigated one day before mulching. Plots were mulched with 0.05 mm transparent polyethylene plastic sheets for one, two, and three weeks during November and December. Non-mulched plots were weeded once a week to let solar heat reach the soil surface optimally as treated plots. Soil temperatures were measured daily and recorded for solarized and non-solarized treatments at 5 and 15 cm depths. Soil temperatures were recorded daily every three hours from 06 am to 06 pm using a soil thermometer at three points in each representative treatment.

### **Planting and maintenance**

After solarization, the peanut seeds (cv. Gajah) were sown at a 25 cm distance in rows and 50 cm in between rows. Cultural practices were done as needed to maintain good plant growth, including fertilization of TSP, urea, KCl, (each 600 kg/ha), weeding (2 times), and irrigation during the vegetative phase when needed.

### **Disease development and yields**

Disease development was recorded once a week by observing percentage of wilted plants from one to nine weeks after planting. At each observation, all wilted plants were uprooted to determine the causal agents, whether *Fusarium* or *Sclerotium*. The data of disease incidence was expressed as cumulative number with previous observation weekly. To measure the effect of soil solarization on yields, pods were harvested from all plants without two furrows from the edge of each plot. Pods were exposed to full sunny days in a cemented drying area for 5 days. Crop production was estimated as the dry weight (ton) of fulfilled pods per hectare.

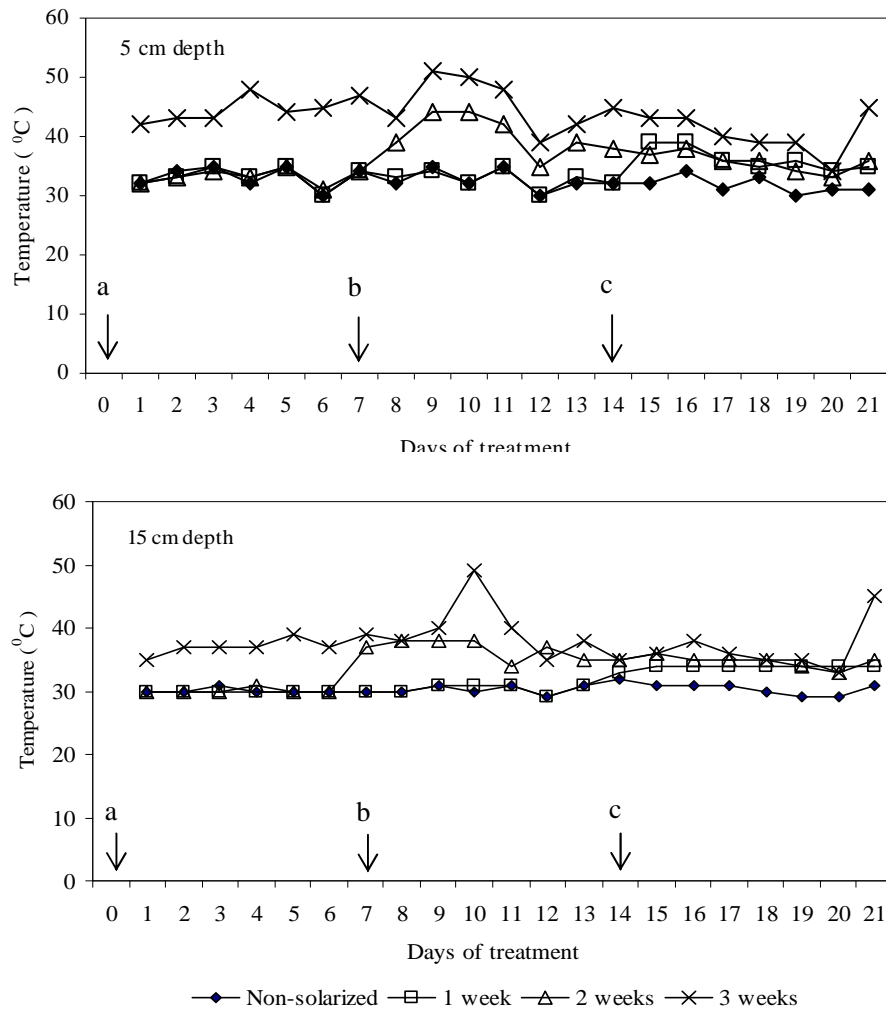
### **Soil microbial count**

Soil samples were taken from of each experimental plot (5 – 15 cm depth) at the end of soil solarization. Composite samples (five sub samples from each plot) were taken to determine total microbial population, including fungi, bacteria and actinomycetes, using serial dilution methods. Composite soil samples were mixed well from each replicate plot, and 10 g soil were taken; 100 ml sterilized distilled water was than added, shaken for 20 minutes using rotary shaker, allowed to settle and diluted with blank sterilized water. At the proper dilution for colony counting, 0.1 ml of soil suspension was transferred into the various media in Petri dishes, spread with L-shaped glass rod and incubated at 28<sup>0</sup>C. The media used in this experiment were Martin Agar, Chitin Agar, and Tryptic Soy Agar 1/10 strength, to determine the population of fungi, actinomycetes, and bacteria,

respectively. Bacterial, fungal and actinomycetes colonies which appeared on the plates were counted 48 - 72 hours, and 7 – 9 days after incubation, respectively.

## RESULTS

The highest soil temperature reached 50°C or higher in mulched and solarized plots during November (Fig. 1). Overall, daily maximum temperatures reached at 5 and 15 cm depth in the solarized soil were higher than non-solarized controls, especially in two and three weeks treatments. The mulching of moist soils raised the soil temperature and the highest temperature was in the upper layer at 5 cm depth (Fig. 1). Maximum soil temperatures in the other deeper layer (15 cm) also increased in mulched soils compared to the non mulched soil. The differences in the maximum temperatures between mulched and non mulched soils after three weeks were 17 ° and 15 ° C at the 5 and 15 cm depth, respectively.



**Fig. 1.** Daily maximum soil temperatures in solarized and non-solarized soils at depths of 5 and 15 cm. Letters a, b, c mean starting days of 3 weeks, 2 weeks, and 1 week solarization treatments, respectively.

The development of two diseases, Southern blight and *Fusarium* root rot disease in peanut, were suppressed by soil solarization for 1, 2 or 3 weeks (Fig. 2). This treatment also reduced significantly the disease incidence in nine weeks after planting compared to non-solarized (Table 1). The highest reduction in disease incidence was seen in the 3-weeks solarization plot although there was no statistical significance among treated plots. Solarization for 1, 2, and 3 weeks reduced the *Fusarium* (*F. solani*) disease incidence by 74.6 %, 81.7 %, and 83.9 %, respectively, as compared with the non-solarized. The reduction of stem rot (*S. rolfisii*) disease incidence was up to 75.3 %, 79.1 %, and 91.0 % in plots solarized for 1, 2 and 3 weeks, respectively (Table 1).

The disease suppression development was reflected in the better peanut growth performance and the significant increase in pod yields dry weight when compared with the non-solarized. Target disease was not seen in the solarized field one month after planting and the greener canopies were still seen in the treated plots even at harvest compared with the non-solarized. Conversely, wilted plants caused by the two targeted diseases were present in the untreated plots, and leaves almost fell down on the day of harvest (figures not shown). Solarizing the soil for 3 weeks showed the highest pod yield, and significantly different compared with one week treatment and non-solarized. Plots with solarization treatments increased the dry weight of fulfilled pods yield by 43.9 to 80.5 % relative to untreated (Table 2). Although not statistically significant, soil solarization tended to give the best result in the percentage of fulfilled, and reduced the empty pods (Table 2).

**Table 1.** Influence of soil solarization on the disease incidence of stem blight and *Fusarium* disease.

Treatments	Disease incidence <sup>v</sup>			
	Southern blight (%)	Reduction over non-solarized (%)	<i>Fusarium</i> disease (%)	Reduction over non-solarized (%)
Non-solarized	12.89 a	-	23.34 a	-
1 week solarization	3.19 b	75.2	5.93 b	74.8
2 weeks solarization	2.69 b	79.1	4.26 b	81.7
3 weeks solarization	1.16 b	91.0	3.76 b	83.9

<sup>v</sup> Data of nine weeks after planting; Values followed by different letters in the same column are significantly different according to Duncan Multiple Range Test ( $p = 0.05$ )

**Table 2.** Influence of soil solarization on yield and pods quality of peanut.

Treatments	Dry Yield		Pods quality	
	Full filled pods (ton/ha) <sup>w</sup>	Increase over non-solarized (%)	Full filled pods (%) <sup>w</sup>	Empty pods (%) <sup>w</sup>
Non-solarized	0.41 c	-	89.20 a	10.78 a
1 week solarization	0.59 b	43.9	91.80 a	8.19 a
2 weeks solarization	0.61 ab	48.8	91.24 a	8.74 a
3 weeks solarization	0.74 a	80.5	93.07 a	6.93 a

<sup>w</sup> Values followed by different letters in the same column are significantly different according to Duncan Multiple Range Test ( $p = 0.05$ )

The results also showed a significant increase in the total population of microorganisms, especially bacteria and fungi, in soil after solarization, but the actinomycetes was not significantly affected by the treatments (Table 3). The most recorded fungi were the genera of *Trichoderma*, *Aspergillus*, *Cladosporium*, and *Fusarium*.

**Table 3.** Effect of soil solarization on microorganisms population.

Treatments	Total microorganisms population (log cfu / g soil) <sup>x</sup>		
	Bacteria	Actinomycetes	Fungi
Non-solarization	8.29 b	5.51 a	3.81 c
1 week solarization	8.66 a	5.56 a	4.05 b
2 weeks solarization	8.53 ab	5.76 a	4.06 b
3 weeks solarization	8.51 ab	5.97 a	4.32 a

<sup>x</sup> Values followed by different letters are significantly different according to Duncan Multiple Range Test ( $p = 0.05$ )

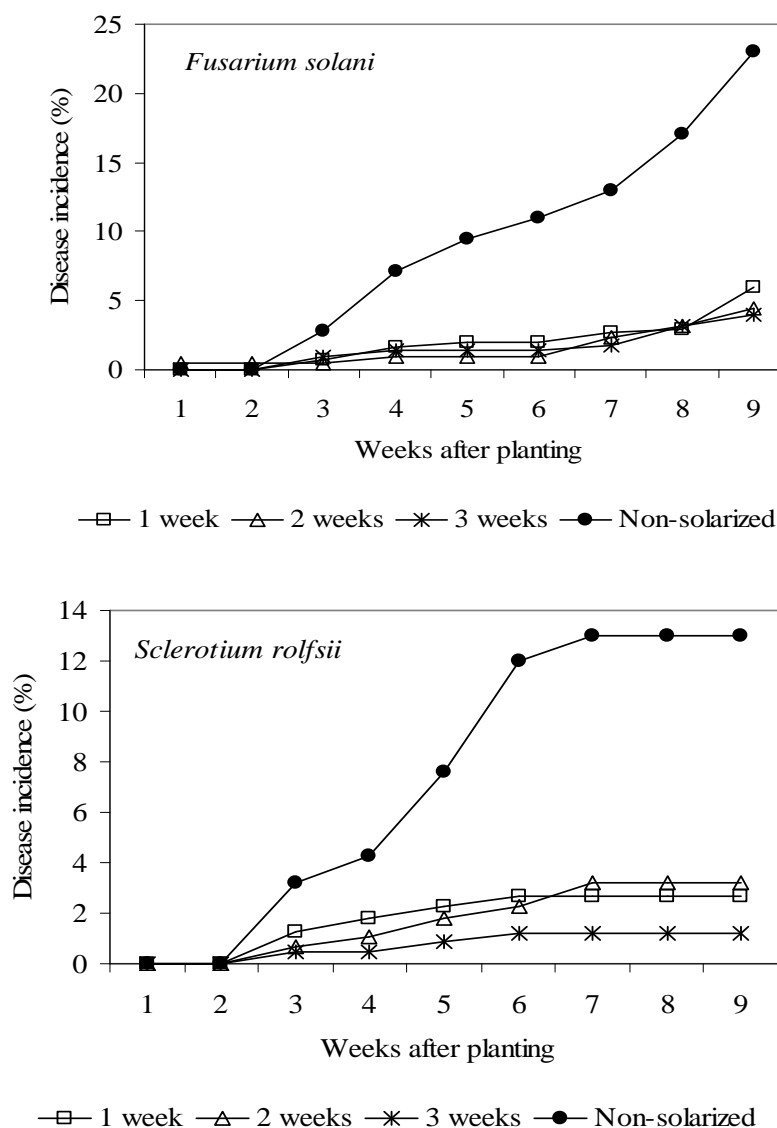
## DISCUSSION

The diseases caused by *F. solani* and *S. rolfii* were considerably suppressed by soil solarization (Figure 2) and the disease incidences were reduced up to 83.9% and 91.0 % compared with the non-solarized, respectively (Table 1). In this study, the average solarized soil temperature at 5 and 15cm depth increased 3.5 to 10.3<sup>0</sup>C and 1.2 to 6.6<sup>0</sup>C compared with the non-solarized, respectively (data not shown). A lower soil temperature increase in another study showed significant reduction in *F. oxysporum* populations in southern Spain (Rafael et al., 1991). These results suggest that the suppression of *Fusarium* disease in this study was affected physically by the increase of soil temperatures. Although the difference in the solarization periods did not significantly affect incidences of both diseases, the disease suppression effects increased with the extension of the solarization period (Table 1). The extension of the solarization period enables control of the pathogens that inhabit in deeper soil layers and/or less sensitive to heat. The extended period of solarization was required to achieve 90 to 100 % mortality of *Verticillium dahliae* sclerotia in deeper soil layers (Katan, 1987).

Another field experiment also showed that suppression of club root disease incidence on cabbage was higher when the solarization period was extended up to 7 weeks (Widodo and Suheri, 1995). Significant control effect in various regions in the world, with different pathogens, were obtained usually within 20 to 60 days of solarization (DeVay and Katan, 1991). Longer soil exposure to higher temperatures achieved during solarization caused of cracking *S. rolfii* sclerotia and increased its vulnerability to antagonistic microorganisms (Kartini and Widodo, 2000). Increasing of soil temperatures during solarization suppressed average population of weeds and several groups of pathogen, including fungi, bacteria and nematode in Western Oregon (Pinkerton et al., 2000).

This result suggests that microbial processes induced by soil solarization might contribute to suppression of the two targeted diseases beyond the physical effect as showed in the increase in total microbial population, especially fungi (Table 3). The most frequently obtained fungi in this experiment, that may potentially be antagonistic to microorganisms, were *Aspergillus*, *Trichoderma*, and *Cladosporium*. *Aspergillus* appeared most frequently as colonies on sclerotia buried in the solarized soil (data not shown). In another study, the population of actinomycetes was significantly higher in solarized than untreated soils and may contribute in club root suppression (Widodo and Suheri, 1995).

More vigorous growth of peanut in 30 days after sowing was shown in solarized plots and disease symptoms were not obtained. More plants survived and a greener canopy found several days before harvesting in solarized plots indicated that this treatment may promote plant growth and increase their productivity (Table 3). Beyond the disease control, the phenomenon of increased growth response (IGR) was frequently seen in solarized soils (Katan, 1981; Gamliel and Katan, 1991; Stapleton and DeVay, 1984; Chen and Katan, 1980; Widodo and Suheri, 1995; Pinkerton et al., 2000). The manifestation of IGR in solarized soils has been indicated as the involvement of physical, chemical, and microbial changes. However, the changes which result in a new microbial balance in the soil are apparently related to the long-term effect of IGR, and might be as one of an economically approach in soil borne plant diseases control and increasing the genetic potential of cultivated crops.



**Fig. 2.** Effect of soil solarization on the development of Southern blight (*S. rolfsii*) and *Fusarium* root rot disease (*F. solani*) in peanut.

## CONCLUSION

Soil solarization using transparent plastic for 1, 2, and 3 weeks significantly suppressed the two soil borne diseases, *Fusarium* root rot and Southern blight, on peanut and increased yield potency. The extension of the solarization period resulted in higher disease suppression and yield increase which might be induced by some microbial processes during soil solarization.

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## **ECONOMIC IMPACT OF SANITARY AND PHYTOSANITARY MEASURES ON PHILIPPINE PINEAPPLE EXPORTS**

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### **ABSTRACT**

This paper determined the economic impact of sanitary and phytosanitary (SPS) measures on Philippine pineapple exports in accord to the implementation of the World Trade Organization (WTO) agreement on the application of SPS measures and compliance to importing countries' standards. As the Philippine SPS standards for fresh and processed pineapple were revealed to be at par with the Codex standards and that of the major trading partners, namely: Japan, South Korea, Canada, the Netherlands and the United States; the country has maintained its export competitiveness in the pre- and post-SPS regimes.

Results of the multiple regression analysis revealed that foreign exchange rate, domestic production, and export price positively affected the value of pineapple exports while domestic price negatively influenced the value of pineapple exports. Australia, which has imposed stringent SPS requirements, registered a declining import volume of Philippine fresh pineapple as shown by a significant and negative coefficient of SPS dummy variable. In general, in spite of the insignificant effect of SPS measures on total value of Philippine pineapple exports, there are still production-, marketing-, and trade-related problems in the industry that require policy directions in order to remain competitive in traditional and emerging foreign markets.

**Key words:** export competitiveness, Philippine National Standards, Codex standards

### **INTRODUCTION**

*Ananas comosus* Merr., known locally as “*pinya*”, has been sold as a fresh fruit but later developed into value-added products, namely: canned (slices, chunks, tidbits); concentrate; prepared; dehydrated; juice; vinegar; wine; pie; tart; “empanadita”; nata de piña; marmalade; jam; candy; machi ne decorticated fiber; hand woven piña cloth; handmade paper; and others. The main commercial cultivars of pineapple include Cayenne Lisse or Smooth Cayenne, Queen, Red Spanish, Abacaxi, Singapore Spanish, Selangor Green, Española Roja, Perola, Perolera, MD2, Josapine, and RL41; where the first four varieties are internationally traded. In the Philippines, Smooth Cayenne, Queen, Cabezona and Sugarloaf are popularly grown (Morton 1987).

The country's accession to World Trade Organization (WTO) is part of the trade reforms which started in the 1980s to improve market access and enhance export competitiveness. The main elements of the agriculture agreement are tariff and non-tariff reforms; reduction of State subsidy excluding agricultural R&D, irrigation, and market infrastructure; decrease in export subsidies; and removal of anti-trade bias of SPS measures. The General Agreement on Tariffs and Trade (GATT) in Article XX allows governments to adopt measures necessary to protect human, animal or plant life or health, provided that they do not arbitrarily or unjustifiably discriminate or use these as disguised protectionism. The WTO Agreement on the Application of SPS measures provides the basic rules for ensuring a transparent, scientifically defensible, and fair health laws and regulations. It includes basic rights and obligations of member countries; principles of harmonization, equivalence and

transparency; risk assessment; regionalization on import ban; and implementation and oversight of SPS measures (WTO 1994). However, the WTO noted that SPS measures can be very effective in protectionism due to its being technical and deceptive (Becker 2006). Various ex-ante and ex-post studies have shown that SPS measures have reduced the volume of exports of selected agri-based products in developing countries (Cook 2001; Otsuki, Sewadash, and Wilson 2000 as cited by Authukorala and Jayasuriya 2004; Ignacio 2004; Miranda 2004; and Marquez 2005). So far, no study has been done in the Philippines measuring the effects of SPS standards on the value of Philippine fresh and processed pineapple exports.

This study sought to: (1) assess the Philippine SPS standards versus Codex and other standards adopted by importing countries of Philippine pineapple exports; (2) determine the effects of SPS measures and other factors on the volume and value of pineapple exports; (3) compare the export competitiveness of pineapple exports before and after the WTO agreement on the application of SPS measures; and (4) identify problems in the pineapple industry and recommend appropriate policy directions with special concerns on SPS measures affecting the export competitiveness of the Philippine pineapple.

## **METHODOLOGY**

Primary and secondary data were collected from national and international organizations/institutions. Primary data covered in the study include: (1) port, storage and distribution costs; export margin; and (2) domestic wholesale prices of fresh and processed pineapple products, which were obtained through personal interview of five processor-cum-exporters. These sample respondents which accounted for 30 percent of the registered processor-cum-exporters were selected using purposive sampling based on the list provided by the Department of Trade and Industry (DTI) and the Department of Agriculture-Agribusiness and Marketing Assistance Service (DA-AMAS).

Secondary data used in the study were: (1) world pineapple exports retrieved from the Food and Agriculture Organization (FAO) of the United Nations; (2) Gross Value Added (GVA) in agriculture, domestic production and prices, area planted, yield, and consumption of pineapple gathered from the Bureau of Agricultural Statistics (BAS); (3) export prices and volume and value of Philippine pineapple exports obtained from the DTI-Bureau of Trade Promotions (BETP); (4) average annual foreign exchange rate taken from the Bangko Sentral ng Pilipinas (BSP); and (5) local and international standards for pineapple products.

The Philippine National Standards (PNS) for pineapple were furnished by the Bureau of Plant Industry-Sanitary and Phytosanitary Standards Information System (BPI-SPSIS), Bureau of Agriculture and Fisheries Product Standards (BAFPS), Fertilizer and Pesticides Authority (FPA), Bureau of Food and Drugs-PNS (BFAD-PNS), and DTI Bureau of Product Standards (BPS). For international standards, these were collected from the FAO/World Health Organization (WHO) Codex Alimentarius Commission; FAO International Plant Protection Convention; and standards bureaus and government portals of top importing countries of Philippine pineapple exports, namely: the United States, Japan excluding Okinawa, South Korea, Canada, and the Netherlands. Australia's SPS measures were also gathered due to the country's trade dispute filed against Australia (WTO 2002). Using stringency analysis, the local and international standards were compared and contrasted.

Multiple regression analysis was used to determine the effects of SPS measures and other factors on the value of Philippine pineapple exports. Three functional forms (i.e. linear, semi-log and double-log) were estimated and tested to determine the best model using the following criteria: (1) coefficient of determination ( $R^2$ ); (2) number of significant variables with logical sign; and (3) F-ratio.

Below is the model expressed in three functional forms:

$$\begin{aligned} \text{XVAL}_t &= \beta_0 + \beta_1 F_t + \beta_2 \text{PRODN}_t + \beta_3 \text{DP}_t + \beta_4 \text{EP}_t + \beta_5 \text{SD}_t + e && \text{(Linear)} \\ \log \text{XVAL}_t &= \beta_0 + \beta_1 F_t + \beta_2 \text{PRODN}_t + \beta_3 \text{DP}_t + \beta_4 \text{EP}_t + \beta_5 \text{SD}_t + e && \text{(Semi-log)} \\ \log \text{XVAL}_t &= \log \beta_0 + \beta_1 \log F_t + \beta_2 \log \text{PRODN}_t + \beta_3 \log \text{DP}_t + \beta_4 \log \text{EP}_t + \beta_5 \log \text{SD}_t + e && \text{(Double-log)} \end{aligned}$$

where:  $\text{XVAL}_t$  = value of pineapple exports in year  $t$  (M FOB US\$);  
 $F_t$  = foreign exchange rate in year  $t$  (PhP/USD);  
 $\text{PRODN}_t$  = domestic production of pineapple in year  $t$  (mt);  
 $\text{DP}_t$  = domestic price of pineapple in year  $t$  (PhP/kg);  
 $\text{EP}_t$  = export price of pineapple in year  $t$  (US\$/kg);  
 $\text{SD}_t$  = SPS dummy variable where “0” is designated for pre-SPS (1985-1994) regime and “1” is for post-SPS (1995-2006) regime; and  
 $e$  = error term.

Similar models were used to determine the effects of SPS measures and other factors but this time on the volume of fresh pineapple bound for Australia. Time-series data on the value of exports were incomplete for this trading partner, thus were replaced by the volume of exports as the dependent variable.

Test of two means was employed to determine whether there is a significant difference in the export competitiveness of Philippine pineapple before and after the implementation of the WTO agreement on SPS measures. Student’s  $t$ -test was done at one, five and 10 percent level of significance ( $\alpha$ ). A decision rule was made based on the level of significance wherein a  $p$ -value of less than 0.10 denotes a test statistic greater than the  $t$ -tabular value, thus rejecting the null hypothesis ( $H_0: \mu_1 - \mu_2 = 0$ ). The assumptions of normality, independence, and equal variances were all checked.

Export competitiveness of fresh and processed pineapple was determined using the ratio of export parity price and domestic wholesale price in the pre- and post-SPS regimes. In addition, sensitivity analysis was done to present exporters’ responses on a currency revaluation (PhP 50: US\$ 1) or devaluation (PhP 55: US\$ 1). The decision rule used for the simple price comparison for export competitiveness is shown below:

- (1) For  $P_x/P_d > 1$ , the Philippine pineapple exports are competitive; and
- (2) Conversely, for  $P_x/P_d < 1$ , the Philippine pineapple exports are uncompetitive.

where:  $P_x$  = export parity price (PhP/kg) is the Free on Board (FOB) value of the product adjusted for internal distribution and handling costs, and exporter’s margin; and  
 $P_d$  = domestic wholesale price (PhP/kg) from BAS; and Manila wholesale price (PhP/kg) obtained from the processor-cum-exporters interviewed.

## RESULTS AND DISCUSSION

### Main Players in the World Export Market

In the world market, the main forms of pineapple exported are canned, fresh, juice and concentrates. The average shares of these forms from 1985 to 2005 in terms of volume and value, respectively are as follows: canned (44%, 51%); fresh (40%, 27%); juice (12%, 7%); and concentrates (4%, 5%). For all forms of pineapple exports, the Philippines came as the second major exporting country after Thailand (Table 1).

**Table 1.** Market share in terms of value by form of pineapple exports in the pre- and post-SPS regimes, 1985-2005.

FORM	PRE-SPS (1985-1994)	Market Share (%)	POST-SPS (1995-2005)	Market Share (%)
Canned	Thailand	42	Thailand	41
	Philippines	18	Philippines	15
	Kenya	7	Indonesia	11
Fresh	Costa Rica	21	Costa Rica	28
	Cote d'Ivoire	18	Belgium	15
	Philippines	15	France	11
Juice	Thailand	36	Thailand	32
	Netherlands	16	Netherlands	24
	Brazil	6	Brazil	12
Concentrate	Philippines	58	Philippines	30
	United States	12	Indonesia	17
	Belgium-Luxembourg	7	Thailand	11
All forms	Thailand	32	Thailand	23
	Philippines	17	Philippines	12
	Kenya	5	Netherlands & N. Antilles	8

Source of basic data: FAO (2006)

Thailand has dominated the canned pineapple export market due to five factors: (1) establishment of Dole Thailand Ltd. in 1972; (2) privileges provided by the Board of Investment to industry players; (3) higher domestic demand for fresh over canned fruits; (4) lower import duty on packaging materials; and (5) market development in supermarkets and retailers of importing countries (Asopa 2003). Indonesia has emerged in this industry during the post-SPS with market diversification from 20 countries in 1995 to 52 countries in 1999. Great Giant Pineapple Company, the largest canned pineapple processor in Indonesia, has also expanded acreage from 10,000 to 30,000 hectares between 1979 and 1999 to increase pineapple production (Hadi 2001). Leading processor-cum-exporters in the Philippines and Thailand such as Dole Package Foods Philippines Inc. (Dolefil), Del Monte Philippines Inc., Thai Food Processors' Association, Thai Pineapple Industry Association and Ruam Chai Sapparod have consistently enhanced production resulting to their high shares in the value of world pineapple juice and concentrate exports, respectively (Food Market Exchange 2003).

### **Philippine Pineapple Industry Situationer**

On the average, the country produced 1.5 million metric tons (mt) of fresh pineapple valued at PhP 6.9 billion from 1985 to 2006 (Table 2). The sharp growth in production, area and yield in 1995 and 1999 onwards was mainly due to expansion done by transnational corporations (TNCs) and implementation of the High Value Commercial Crops Development Act of 1995. Conversely, the unfavorable domestic farmgate and wholesale prices of pineapple in 2006 led to the highest decline in production. However, despite the upsurges in the volume (3.04%) and value (8.98%) of pineapple production from 1985 to 2006, the share of this fruit production to GVA in agriculture dropped by 0.43 percent (BAS 2006). Northern Mindanao (48%) serves as the top pineapple producer from 1990 to 2006. Del Monte Philippines Inc., one of the world's leading pineapple corporations, is situated in this region, particularly in Bukidnon. It is followed by SOCCSKSARGEN (39%) where Dole Philippines, Inc. in South Cotabato is located (BAS 2006).

Average domestic pineapple consumption amounting to 654,371 mt increased by 4.42 percent from 1985 to 2006 (Table 2). This is attributed to the higher demand for fruit salads during holiday season by households and fast-food outlets (Medina 2004). Considerably, increasing population has also led to high consumption level. Utilization of pineapple as feeds for cattle and in

processing also grew by 4.42 percent. The share of domestic consumption to world consumption (8.23%) grew by 2.24 percent in the same period. The difference in per capita consumption between the Philippines and world's average (7.92 kg/yr) expanded by 2.74 percent (BAS and FAO 2006).

Nominal farmgate and wholesale prices of fresh pineapple remained generally fluctuating but surged by 6 percent in the pre- and post-SPS periods. Nominal retail prices remained stable with 7 percent growth from 1985 to 2006 (BAS 2006). This could be due to the high price elasticity of demand with stickiness in retail price (FAO 2001; Goldberg 2007; and Perner 2001). In real terms, only wholesale prices ascend between the two periods from PhP16.00/pc to PhP16.80/pc. Some wholesalers who provided inputs to contracted farmers reflected the increases in fertilizer prices in their production cost. Note that the average retail price of urea increased from PhP 7.38/kg in 1995 to PhP 14.84/kg in 2004 and the 0-0-60 fertilizer by PhP 2.39/kg (1995-2000) and PhP 5.68/kg (2000-2004) (FPA 2006). Canned pineapple exports shared 44 percent in volume and 59 percent in value of total pineapple exports from 1985 to 2006. It is followed by fresh (37%, 18%), juice (10%, 6%) and concentrate (9%, 17%) (DTI-BETP 2006). Pineapple concentrate has a greater share in total value compared to pineapple juice denoting higher average export price. Based on export price, the order of ranking is as follows: concentrate, canned, juice and fresh pineapple (Table 2).

### **Direction of Philippine Pineapple Exports**

The Philippines has diversified its export markets in all forms of pineapple exports (Table 3). Filipino exporters give priority to traditional markets, especially those with 22 years of consistent importation, or those which have become regular buyers during the post-SPS regime. Some irregular markets are seen with potentials of becoming traditional markets while emerging markets are being developed to serve as regular foreign markets in the future.

*Canned pineapple.* The United States has topped the pre- (47%) and post-SPS (64%) regimes in terms of share in the volume imported from the Philippines. Proximity and liberalization of markets have led to this shift, except for the United States and Canada which have constantly imported canned pineapple for 22 years. Emerging markets include United Arab Emirates (UAE), Bahrain, Brunei Darussalam (Brunei), People's Republic of China (China), Switzerland and Thailand.

*Fresh pineapple.* Four countries have been identified as traditional markets for fresh pineapple in the post-SPS period: UAE, Hong Kong, South Korea and New Zealand. By volume share, Japan excluding Okinawa (92%, 83%) and South Korea (3%, 2%) ranked first and second in the two periods. In case of the country's trade with Japan, it is anticipated to further improve with the ratification of the Japan-Philippine Economic Partnership Agreement (JPEPA). It will create a Tariff Rate Quota (TRQ) for pineapple smaller than 900 grams under a zero in-quota rate, which is far better than the applied most favored nation rate (17%). For South Korea, the increasing trend in share of imports is expected to continue with the on-going talks on tariff reduction on pineapple exports which started in 2003. Dole Asia, the regional headquarters of the Dole Food Company Inc., grows pineapple in the Philippines and then trades this fruit in Japan, Middle East, Hong Kong and South Korea (SEC Info 2008). Emerging markets include China, Singapore and Taiwan.

*Pineapple juice.* Twenty-two years of constant exportation have been established with the United States, Bahamas, Canada, and Japan excluding Okinawa and Singapore for pineapple juice. Hefty bulk of the share in import volume was captured by the United States (77%, 65%) followed by Canada (6%, 6%). Dole Food Company Inc. has 27 direct selling offices in North America, Europe, Middle East, and Asia where pineapple juice processed in the Philippines is exported. Emerging markets include UAE, Australia, Brunei Darussalam, India and Micronesia.

**Table 2.** Production, area planted, yield, consumption, domestic prices and exports of pineapple, Philippines, 1985-2006.

ITEM	PRE-SPS (1985-1994)	POST-SPS (1995-2006)	AVERAGE (1985-2006)
Production			
Volume ('000 mt)	1,343	1,661	1,517
Value (M PhP)	4,409	9,171	6,887
Area			
(Ha)	49,269	45,010	47,344
Yield			
(mt/Ha)	29.91	36.95	33.19
Consumption			
Volume ('000 mt)	545	746	654
Domestic Prices			
Nominal			
Farmgate (PhP/pc <sup>1</sup> )	3.09	4.33	3.96
Wholesale (PhP/pc <sup>1</sup> )	9.13	17.01	14.69
Retail (PhP/pc <sup>1</sup> )	10.54	22.57	17.10
Real <sup>2</sup>			
Farmgate (PhP/pc <sup>1</sup> )	5.44	4.28	4.62
Wholesale (PhP/pc <sup>1</sup> )	16.00	16.80	16.56
Retail (PhP/pc <sup>1</sup> )	23.48	21.95	22.64
Exports			
Canned			
Volume ('000 mt)	189.70	194.00	192.00
Value (M FOB US\$)	89.70	89.67	90.00
Real <sup>2</sup> Price (PhP/kg)	25.92	19.29	22.30
Fresh			
Volume ('000 mt)	156.50	169.83	164.00
Value (M FOB US\$)	23.10	31.58	28.00
Real <sup>2</sup> Price (PhP/kg)	8.00	7.00	7.83
Juice			
Volume ('000 mt)	33.20	57.25	46.00
Value (M FOB US\$)	7.10	12.25	10.00
Real <sup>2</sup> Price (PhP/kg)	11.60	8.76	10.05
Concentrate			
Volume ('000 mt)	34.50	42.75	39.00
Value (M FOB US\$)	20.60	29.92	26.00
Real <sup>2</sup> Price (PhP/kg)	32.53	29.28	30.76
All forms			
Volume ('000 mt)	413.90	463.83	441.00
Value (M FOB US\$)	140.50	163.42	153.00
Real <sup>2</sup> Price (PhP/kg)	18.49	14.70	16.42

<sup>1</sup>One piece is approximately 2.40 kilograms.

<sup>2</sup>Real price = Nominal price/CPI (2000=100)

Sources of basic data: BAS and DTI-BETP (2006)

*Pineapple concentrate.* Five countries (e.g., United Kingdom and Northern Ireland, the United States, Canada, Lebanon and the Netherlands) have continuously imported pineapple concentrate for 22 years from the Philippines. Germany, formerly a traditional market, is now an irregular market due to the prohibition on the use of ethylene for flower induction (Hube 2004). In terms of share of the export volume in the two periods, the United States (75%, 54%) has topped the rank, followed by the Netherlands (7%, 5%).

### **International SPS Standards, Measures and Procedures**

The set of rules formulated under the GATT-WTO concerning SPS measures reflects the standard requirements that shall be followed by trading parties. At most instances, a country not having its own standard follows the provisions set by standard-making bodies, namely: (1) FAO/WHO Codex Alimentarius Commission (2) World World Organization for Animal Health (OIE); and (3) FAO International Plant Protection Convention (IPPC), with the assistance of other international organizations concerned with food safety and plant health.

In the occasion that a relatively stringent standard is used by a trading partner, the principles of equivalence, harmonization and transparency are reviewed. Numerous documents from the FAO/WHO Conference on Food Standards, Chemicals in Food and Food Trade and series of texts developed from 1991 to 2004 have discussed these principles. An additional international standard followed by trading countries refers to pesticide residues and proper use of pesticide. The Codex Maximum Residue Limits (MRLs) set the allowable amount of pesticide to be present on fresh agricultural exports which is checked through a pesticide residue analysis. The International Code of Conduct on the distribution and use of pesticides adopted in 1985 give guidelines on pesticide use in support of increased food security and health and environment protection. However, its nature of being voluntary provides an option for compliance or non-compliance.

**Table 3.** Number of export markets by type and by form of pineapple exports, Philippines, 1985-2006.

FORM	NO. OF MARKETS ADDED <sup>1</sup>	TYPE		
		Irregular <sup>2</sup>	Traditional <sup>3</sup>	Emerging <sup>4</sup>
Canned	82	52	32	6
Fresh	30	22	6	3
Juice	47	45	17	5
Concentrate	44	40	13	3

<sup>1</sup>No. of markets added = Pre-SPS no. of markets – Post-SPS no. of markets

<sup>2</sup>At least two years of exportation and not qualified as either traditional or emerging

<sup>3</sup>Exportation of 10 or 12 years in either the pre- or post-SPS period

<sup>4</sup>Consistently exporting from 2000 to 2006

Source of basic data: DTI-BETP (2006)

### **Philippine SPS Standards, Measures and Procedures**

Local standards on agricultural commodities are formulated, provided, and/or implemented by government agencies such as the BAFPS, Bureau of Animal Industry (BAI), Bureau of Fisheries and Aquatic Resources (BFAR), National Meat Inspection Service (NMIS), BPI, Philippine Coconut Authority (PCA), Sugar Regulatory Administration (SRA), Fiber Industry Development Authority (FIDA), Cotton Development Administration (CDA), FPA, BFAD-PNS, and DTI-BPS. Specific provisions on SPS measures are prescribed in various legislations, presidential decrees, administrative orders, and the likes.

The Consumers Act of the Philippines (RA 7394) has provisions on product standardization and consumer safety, one result of which is the formation of BAFPS. This body formulates and enforces standards of quality in the processing, preservation, packaging, labeling, importation, exportation, distribution, and advertising of agricultural and fisheries products; conducts research on product standardization; aligns local with the international standards; and conducts regular inspection of processing plants, storage facilities, abattoirs as well as public and private markets in order to ensure freshness, safety and quality of products.



The Agriculture and Fisheries Modernization Act of 1997 (RA 8435) not only aims to modernize Philippine agriculture and fisheries sectors but also prepares them for the challenges of globalization, which include those imposed by SPS measures. The Republic Act 3639 that led to BPI creation provides quarantine services and pesticide residue analysis for plant exports and imports. In relation to pesticide usage, LOI 986 released by BPI resulted to the establishment of pesticide laboratories all over the country to monitor pesticide residues in crops. Consequently, through Presidential Decree No. 1144, FPA was created.

The Plant Quarantine Law (RA 3027) enacted on March 8, 1922 together with the Plant Quarantine Service (PQS) of BPI under DA (PD 1433), which was eventually revised through the Administrative Code of 1987, defines the import and export quarantine procedures in the Philippines. In the import quarantine procedure, Permit to Import Form (BPI Q Form No.1) must be first filed to BPI.

Before releasing an import permit, evaluation and pest risk analysis must be conducted. For imports identified as hazardous or are genetically modified organisms (GMOs), the evaluation, approval and monitoring of the Institutional Biosafety Committee (IBC) and the National Committee on Biosafety of the Philippines (NCBP) are required. Next is the approval of the application and payment of regulatory fees (i.e., four copies of import permit are given to the importer). For inspection upon import arrival, the following must be presented: phytosanitary certificate issued by the Plant Quarantine (PQ) of the country of origin, import permit issued by the PQS, lading or airway bill, and a photocopy of inward cargo manifest and the Bureau of Customs (BOC) entry declaration. For exportation, the following must be settled: import permit from the country of destination stating the terms and conditions; accomplished application for phytosanitary certification; exports (i.e. randomly sampled) to be inspected, examined, and verified submitted at least 48 hours before the actual loading either at PQS or premises of the exporter; and necessary treatments.

### **The Philippines vs Codex and Importing Countries' Standards**

Table 4 summarizes the various SPS standards applied to Philippine pineapple products. For fresh pineapple, Codex standard includes all varieties in its definition while PNS classifies it as Queen Formosa, Smooth Cayenne and Red Spanish. Provisions on de-crowned pineapple are stipulated in Codex, Japan, South Korea and Australia's standards. However, Australia solely accepts de-crowned pineapple as import. Three additional quality requirements are in Codex compared to PNS. In addition, maturity is measured in terms of total soluble solid for the former and maturity index for the latter. Contrarily, sampling method and compliance with specifications are explicitly stated in PNS and Japan's standards as compared to Codex. None of the provisions in Codex, PNS, Japan, and South Korea's standards stand out as detrimental in trade except that of Australia.

Codex has four additional style classifications for canned pineapple compared to United States standards. The former is also lenient as it permits more ingredients in canned pineapple vis-à-vis the latter. Provisions on food additives, contaminants, hygiene and labeling, though the manner of presentation is different, are discussed in both Codex and US standards.

For pineapple juice and concentrates, US standards have identified grade according to quality attributes including color, defects and flavor; and analytical attributes including minimum brix, acid, percent by weight of finished product prior to addition of sweetener, brix to acid ratio, and finely divided insoluble solids. These were also stipulated in Codex, PNS, Netherlands and Canada's standards. It may appear that the provisions on the presence of food additives, contaminants, labeling and hygiene in Codex are more stringent than United States standards for grades of pineapple juice. However, these are addressed in five sections of the Federal Food, Drug and Cosmetic Act of 1938

under the following headings: definitions and standards for food; emergency permit control; regulations making exemption; tolerances for poisonous ingredients in food; and food additives.

Results of the stringency analysis revealed that Philippine standards, in general, are at par with that of Codex; South Korea and Japan for fresh pineapple; the United States and Japan for canned pineapple; the United States and the Netherlands for pineapple concentrate; and the United States and Canada for pineapple juice. Only fresh pineapple export bound for Australia faces stringent measures based on the quarantine conditions formed from the risk management schemes they employed to prevent the 70 out of 186 associated weed pests in entering their country (Table 4). Based on their Final Import Risk Assessment (IRA) dated July 1, 2002, the following courses of action were recommended: (1) registration of source of plantations and fumigation facilities; (2) pest-free area for *Fusarium subglutinans*; (3) de-crowning; (4) in-field control and trapping of *Cryptophlebia leucotreta*; (5) methyl bromide fumigation; (6) packing and labeling compliance; (7) pre-export inspection, storage, and phytosanitary certification and documentation; (8) on-arrival inspection by Australia Quarantine and Inspection Service (AQIS); and (9) review of policy.

### **Philippine Pineapple Export Response to SPS Measures and Other Factors**

The explanatory variables affecting the pineapple export value were foreign exchange rate (F), production (PRODN), domestic price (DP), deflated export price (EP) and SPS measures (SD). Linear functional form with export value as the dependent variable was chosen as the best model for canned, juice and concentrate as it yielded the highest F-ratio,  $R^2$  and number of significant explanatory variables. Conversely, the semi-log functional form fitted the data for fresh and all forms of pineapple (Table 5).

Results of the multiple regression analysis showed that a unit increase in foreign exchange rate (PhP/US\$) would increase the juice export value by FOB US\$ 0.86 million; concentrate export value by FOB US\$ 0.24 million; fresh pineapple export value by 0.02 percent; and export value of all forms by 0.01 percent; setting other factors constant (Table 5). In the international market, a peso devaluation would make Philippine pineapple products, except for canned, become relatively cheaper vis-à-vis other country's pineapple exports.

Domestic production and export value were positively related. A metric ton increase in domestic production would make export value go up by FOB US\$ 62.50 for pineapple juice; FOB US\$ 161.00 for pineapple concentrate;  $5.34 \times 10^{-7}$  percent for fresh pineapple; and  $3.82 \times 10^{-7}$  percent for all forms; ceteris paribus (Table 5). This implies that improving local fresh pineapple production would raise the country's foreign exchange earnings from fresh pineapple, juice and concentrate exports.

Domestic price showed an inverse relationship with export value. A peso increase in domestic price would reduce export value by FOB US\$ 0.94 million for pineapple concentrate; 0.13 percent for fresh pineapple; and 0.05 percent for all forms; ceteris paribus (Table 5). With favorable domestic prices, growers would rather sell their fresh pineapple in the local market rather than process and/or export their produce. Higher export price indicated a direct relationship with export value. Holding other factors constant, a dollar increase in the deflated export price would raise export value by FOB US\$ 135.74 million for canned pineapple; FOB US\$ 58.77 million for pineapple juice; FOB US\$ 28.47 million for pineapple concentrate; 6.57 percent for fresh pineapple; and 2.26 percent for all forms (Table 5).

**Table 4.** Comparison of International and local SPS measures on fresh and processed pineapple exports, 2006

CODEX STANDARD	PNS STANDARD	IMPORTING COUNTRY'S STANDARD	
Fresh pineapple			
Codex Standard for Pineapples CODEX STAN 182-1993, REV. I-1999, AMD. 1-2005	PNS for Pineapples PNS/BAFPS 09:2004	<u>South Korea</u> - similar to Codex	<u>Australia</u>  Risk management schemes:
8 provisions: 1. Definition of produce - fresh pineapple includes all commercial varieties of <i>Ananas comosus</i> (L) Merr. of the family <i>Bromeliaceae</i> 2. Quality - free of abnormal external moisture, excluding condensation; free of damage caused by low and/or high temperatures; and free of pronounced blemishes - maturity based on total soluble solid content in the fruit flesh 3. Sizing - A to H 4. Tolerances 5. Presentation 6. Marking and labelling 7. Contaminants 8. Hygiene	14 provisions: 1. Scope 2. References 3. Definitions - maturity based on maturity index 4. Varieties - Queen Formosa, Smooth Cayenne and Red Spanish 5. Minimum requirements 6. Classification according to general appearance, quality and condition 7. Size classification - SS (batterball), small, medium, large and extra large 8. Tolerances 9. Packaging 10. Marking or labelling 11. Sampling 12. Contaminants 13. Hygiene 14. Compliance with specification * Provision on uniformity not included	<u>Japan</u> - similar to Codex and PNS  Food Sanitation Law No. 233 (December 24, 1947); amended through Law No. 87 (July 26, 2005)  Specifications and standards for food, food additives, etc.; Notification No. 370 (1959); and Notification No. 499 (May 29, 2006) by the Ministry of Health, Labor and Welfare - provision on de-crowned pineapple - pesticide residue limits of 0.5 ppm for deltamethrin and tralomethrin - provision on sampling technique and analysis	1. de-crowning 2. in-field management of arthropod pests 3. standard cleaning and hygiene practices 4. methyl bromide fumigation 5. phytosanitary inspection (pre-export and on-arrival) and treatment 6 pheromone trapping for <i>Cryptophlebia leucotreta</i> 7. area freedom for fusariosis, fruitlet core rot ( <i>Fusarium subglutinans</i> )
* In provisions 2, 3 and 6, both crowned and de-crowned pineapple were described.			

Continued Table 4.

<b>CODEX STANDARD</b>	<b>PNS STANDARD</b>	<b>IMPORTING COUNTRY'S STANDARD</b>	
<u>Canned pineapple</u>		<u>United States</u>	<u>Japan</u>
Codex Standard for Canned Pineapple CODEX STAN 42-1981	- similar to Codex	United States for Grades of Canned Pineapple (March 1, 1990)	- similar to Codex
8 provisions:		13 provisions:	
1. Description		1. Product description	
- styles include that of the US standard in addition to quarter slices, pieces, chips and other styles meeting the criteria prescribed in Article 1, Sec. 4 of CODEX STAN 42-1981		2. Styles	
2. Essential composition and quality factors		- canned pineapple is classified as whole, slices, half slices, broken slices, spears, tidbits, chunks, cubes and crushed	
- include spices, spice oils, mint and vinegar in the other permitted ingredients		3. Definition of terms	
3. Food additives		4. Recommended sample unit sizes	
4. Contaminants		5. Brix measurements	
5. Hygiene		6. Fill of container for crushed style canned pineapple	
6. Weights and measures		7. Minimum drained weights for canned pineapple	
7. Labelling		8. Recommended drained weights for canned pineapple	
8. Methods of analysis and sampling		9. Grades	
		19. Factors of quality and analysis	
		- character and tartness are classified under quality factors	
		11. Requirements for grades	
		12. Sample size	
		13. Lot quality and analytical requirements	
* Provisions on food additives, contaminants, hygiene and labelling were explicitly stipulated.		* Most of the criteria were presented systematically by aid of tables.	

Continued Table 4.

CODEX STANDARD	PNS STANDARD	IMPORTING COUNTRY'S STANDARD	
<u>Pineapple juice and concentrates</u>		<u>United States</u>	<u>Netherlands</u> (for pineapple concentrate)
Codex Standard for Concentrated Pineapple Juice Preserved Exclusively by Physical Means CODEX STAN 138-1983 8 provisions: 1. Description 2. Essential composition and quality factors 3. Food additives 4. Contaminants 5. Hygiene 6. Weights and measures 7. Marking and labelling 8. Methods of analysis and sampling	- similar to Codex	United States Standards for Grades of Pineapple Juice (April 1, 1987) 10 provisions 1. Product description - defines pineapple juice and concentrate based on standards for pineapple juice (21 CFR 146.185) under the Federal Food, Drug and Cosmetic Act of 1938 (FDCA) 2. Styles - unsweetened and sweetened pineapple juice and concentrate 3. Definition of terms 4. Recommended sample unit sizes 5. Grades - US Grade A, US Grade B and Substandard 6. Factors of quality and analysis 7. Fill of container 8. Requirements for grades 9. Sample Size 10. Lot requirements	- similar to Codex  <u>Canada</u> (for pineapple juice)  -similar to Codex
Codex General Standard for Fruit Juices and Nectars CODEX STAN 247-2005 9 provisions: 1. Scope 2. Description 3. Essential Composition 4. Food Additives 5. Processing Aids 6. Contaminants 7. Hygiene 8. Labelling 9. Method of analysis and sampling		* Sections 401, 404, 405, 406 and 409 of FDCA include provisions on food additives, contaminants, labelling and hygiene.	
Sources of basic data: FAO, WHO, and standard bureaus/ministries and government portals of the Philippines and importing countries (2006)			

The SPS dummy variable in fresh, canned, juice, concentrate and all forms of pineapple exports was insignificant at 10 percent probability level (Table 5). This implies that local standards are at par with the Codex and top importing countries' standards, thus the export values were not significantly affected by the SPS dummy variable.

**Table 5.** Results of the regression analysis showing the effects of SPS and other factors on the value of fresh and processed pineapple exports using the most appropriate models, Philippines, 1985- 2006.

ITEM	CANNED	FRESH	JUICE	CONCENTRATE	ALL FORMS
	Linear	Semi-log	Linear	Linear	Semi-log
Intercept	9.14 <sup>*</sup>	1.48 <sup>***</sup>	-9.97 <sup>**</sup>	-9.47 <sup>***</sup>	3.92 <sup>***</sup>
Regression Coefficient					
F	0.29 <sup>ns</sup>	0.02 <sup>***</sup>	0.86 <sup>**</sup>	0.24 <sup>***</sup>	0.01 <sup>***</sup>
PRODN	3.64 x 10 <sup>-5ns</sup>	5.34 x 10 <sup>-7**</sup>	6.25 x 10 <sup>-5***</sup>	1.61*10 <sup>-4***</sup>	3.82x10 <sup>-7***</sup>
DP	-1.05 <sup>ns</sup>	-0.13 <sup>***</sup>	-0.45 <sup>ns</sup>	-0.94 <sup>*</sup>	-0.05 <sup>***</sup>
EP	135.74 <sup>***</sup>	6.57 <sup>***</sup>	58.77 <sup>***</sup>	28.47 <sup>***</sup>	2.26 <sup>***</sup>
SD	-3.29 <sup>ns</sup>	0.06 <sup>ns</sup>	1.32 <sup>ns</sup>	0.48 <sup>ns</sup>	0.02 <sup>ns</sup>
R <sup>2</sup>	0.64	0.87	0.95	0.94	0.87
Adjusted R <sup>2</sup>	0.53	0.83	0.94	0.92	0.82
F-value	5.69	20.80	64.16	51.22	20.70

<sup>1</sup>All F-values are significant at 1% probability level.

<sup>2</sup>\*\*\*, \*\*, and \* significant at 1%, 5%, and 10% probability level, respectively.

<sup>3</sup>ns means not significant at 10% probability level.

Sources of basic data: BSP, BAS, and DTI-BETP (2006)

### Export Competitiveness of Fresh and Processed Pineapple

Using average export parity prices in all countries of destination and average wholesale prices at the national level, Philippine fresh pineapple exports have remained competitive as reflected by its mean price ratio of 1.16 from 1985 to 2006. Though it dropped from 1.18 to 1.14 between the pre- and post-SPS periods, this was not significant at 10 percent probability level. Similar observation was noted in fresh pineapple bound to Japan. Contrarily, the country became competitive in the post-SPS period for fresh pineapple exported to South Korea (Table 6).

Using wholesale prices gathered from processor-cum-exporters, results showed that fresh pineapple destined to Japan and South Korea has gained competitiveness from the pre- (1994) to post-SPS (2006) period. Higher competitiveness could be realized under a devalued currency scenario while a revaluation currency scenario would indicate the opposite (Table 7).

Higher price ratios were computed for canned pineapple exported to the United States and Japan between the two periods. It rose from 1.25 to 1.60 for the United States and from 1.02 to 1.38 for Japan between 1994 and 2006, implying that canned pineapple became more competitive in these countries. A similar finding was noted for fresh pineapple exports in an event of currency devaluation or revaluation (Table 7).

Estimated ratio between the export parity and domestic wholesale prices showed further improvement in export competitiveness for pineapple juice bound to the United States and Canada from 1994 to 2006 under peso devaluation. Conversely, a peso revaluation would reduce price ratios but still, the export competitiveness of this product would be maintained (Table 7).

**Table 6.** Average price ratio of Philippine fresh pineapple in the pre- and post-SPS regimes, 1985-2006.

YEAR	EXPORT PARITY PRICE (PhP/kg)	DOMESTIC WHOLESALE PRICE (PhP/kg)	PRICE RATIO
All Countries			
Average	6.01	5.26	1.16
Pre-SPS	3.47	3.07	1.18
Post-SPS	8.14	7.09	1.14
Difference	4.67 <sup>ns</sup>	4.02***	(0.04) <sup>ns</sup>
Japan			
Average	6.08	5.26	1.17
Pre-SPS	3.48	3.07	1.19
Post-SPS	8.25	7.09	1.16
Difference	4.78 <sup>ns</sup>	4.02***	(0.03) <sup>ns</sup>
South Korea			
Average	4.66	5.26	0.73
Pre-SPS	1.36	3.07	0.36
Post-SPS	7.41	7.09	1.04
Difference	6.05***	4.02***	0.68***

\*\*\* indicate significant relationship at 1% probability level

Sources of basic data: DTI-BETP and BAS (2006)

**Table 7.** Comparison of export parity prices of fresh and processed pineapple with domestic prices during the pre- and post-SPS regimes, Manila, Philippines.

FORM / COUNTRY OF DESTINATION	PRICE RATIO			
	PRE-SPS (1994)	POST-SPS (2006)	PhP 50: US\$ 1	PhP 55: US\$ 1
Fresh				
Japan	0.69	1.22	1.18	1.30
South Korea	0.69	1.05	1.02	1.13
Canned				
United States	1.25	1.60	1.56	1.72
Japan	1.02	1.38	1.35	1.48
Juice				
United States	1.06	1.59	1.55	1.71
Canada	1.16	1.54	1.50	1.65
Concentrate				
United States	1.07	1.00	0.97	1.07
Netherlands	1.37	1.58	1.54	1.69

Sources of basic data: BSP, DTI-BETP, and interviews with processor-cum-exporters (2006)

Among all forms of pineapple exported, only concentrate bound for the United States indicated a remarkable change from being an export competitive (1.07) during the pre-SPS period to a neutral position (1.00) during the post SPS period. It could also become uncompetitive (0.97) under a PhP50: US\$1 exchange rate. Alternately, pineapple concentrate bound for the Netherlands has become more competitive between the two periods (Table 7).

### **Australia's Case on Fresh Philippine Pineapple Exports**

Based on the most appropriate model, 91 percent of the variation in the volume of fresh pineapple bound for Australia could be attributed to the explanatory variables. The significant SPS dummy variable with coefficient having a negative sign confirmed the sharp plunges in the volume of fresh pineapple exported to Australia in 1999 and 2002 by 50 and 67 percent, respectively based on the data from DTI-BETP (Table 8). This result could be explained by the implementation of the Quarantine Proclamation of 1998 and Plant Biosecurity 2002/45.

**Table 8.** Results of the regression analysis showing the effects of SPS and other factors on the volume of fresh pineapple exported to Australia using the most appropriate model, Philippines, 1985-2006.

ITEM	LINEAR MODEL
Intercept	139.57
Regression Coefficients	
F	-0.48 <sup>ns</sup>
PRODN	-2.10 x 10 <sup>-5ns</sup>
DP	-5.49 <sup>ns</sup>
SD	-38.58**
R <sup>2</sup>	0.97
Adjusted R <sup>2</sup>	0.91
F-value	30.35***

\*\*\* and \*\* indicate significant relationship at 1% and 5% probability level

ns means not significant at 10% probability level

Sources of basic data: BSP, BAS, and DTI-BETP (2006)

### **CONCLUSIONS AND RECOMMENDATIONS**

Results of trend analysis showed an upward trend in domestic production, yield, consumption, wholesale price in real terms, and volume and value of Philippine pineapple exports between the pre- and post-SPS periods. The country diversified its export markets as 203 markets were added for canned, fresh, juice and concentrate from 1985 to 2006. Top destinations of the Philippine pineapple exports included South Korea, Japan, the United States, the Netherlands and Canada. The multiple regression analysis revealed that foreign exchange rate, domestic production, and export price positively affected the value of pineapple exports while an upsurge in domestic price reduced the value of pineapple exports. The SPS dummy variable was insignificant and this could be explained by the fact that Philippine SPS standards were found to be at par with Codex and top importing countries' standards and the export parity prices exceeded the domestic wholesale prices for all types of pineapple exports. On the other hand, the SPS dummy variable was significant and found to negatively affect the volume of Philippine pineapple exported to Australia. This is attributed to the more stringent SPS measures of Australia's standards compared to PNS for fresh pineapple.

Despite the competitiveness of Philippine pineapple exports in the international market, there are production-, marketing- and trade-related problems that must be addressed to remain competitive. First, the high cost of fertilizer in the country which has been due to higher tariffs on imported fertilizers; and long clearance process for existing and potential manufacturers, processors, formulators, distributors, repackers, bulk handlers, dealers, and importers must be reduced. This could be done by increasing private sector involvement in fertilizer importation and distribution. By shortening the processing time for fertilizer licensing and registration and lessening the duties on imported fertilizer, a more conducive market for fertilizer players can be established. Organic fertilizer should also be promoted to reduce production cost (i.e., buying inorganic fertilizer and disposing pineapple by-products), improve soil characteristics, meet demand for organically-grown



pineapples, and produce other positive externalities.

Second, the associated health risk of pesticide usage such as diarrhea, dehydration, tremors, nausea, paralysis and death of farmers and local residents must be addressed by fast-tracking the implementation of integrated crop management (ICM). It combines site-specific nutrient management, integrated pest management (IPM), use of improved crop variety, and other crop management practices that minimize the use of chemicals in actual farm operations. In addition, information drives on proper agro-chemical usage could be provided by cooperatives, associations, civil society groups, LGUs and private agro-chemical manufacturers. The government should also require and ensure that the labeling of agro-chemicals is in the language or dialect the farmers are most proficient in.

Third, the high cost of processing inputs (i.e., fuel, electricity, sugar and tin) and limited availability of processing machines, equipment and technologies (i.e., washing and preparation, slice line, juice line, syrup line, packing line, sorting, de-crowning, soaking and washing, peeling, shredding and crushing, juice extraction, finishing, blending and mixing, pasteurization, filling, can closing, cooling, labeling, packaging, and other operations) could be addressed by reducing duties on packaging materials (15%) and food processing machines and equipment; inducing R&D activities that would improve pineapple production and processing among processing firms; and intensifying the sharing of technologies and practices from TNCs to small and medium-sized firms (SMFs). The government may provide loan assistance and fiscal and non-fiscal incentives (i.e., income tax holiday; exemption from taxes and duties on imported spare parts, from wharfage dues and export tax, duty, impost and fees; tax credits; deductions from taxable income; simplification of customs procedures; importation of consigned equipment; and the privilege to operate a bonded manufacturing or trading warehouse), as determined by the DTI's industry and investment group, to firms which will engage in such R&D activities. The same incentives could be given to TNCs which will provide technology transfer to SMFs. Currently, Dole Philippines, Inc., offers HACCP, ISO 9002, ISO 14001, GMP, ISO 9002, and ISP 14001 transfers to its subsidiaries. The programs linking pineapple firms shall be under the supervision of DA-AMAS and DTI's small and medium enterprises development group.

Fourth, the consumer preference on additional standards (i.e., Hazard Analysis and Critical Control Points (HACCP), Good Manufacturing Practices (GMP), International Organization for Standardization (ISOs) such as ISO 9001: 2000 on quality management systems, SA 8000 for socially responsible employment practices, Food Processors Association (FPA) Safe Standards for Food Safety, European Food Safety Inspection Services (EFSIS), Internal Raw Material Assurance, and code for the security of ships and port facilities) could be satisfied by providing assistance to SMFs which have no capacity to comply with these standards. At present, Dolefil and Del Monte Philippines have some of these certifications.

Fifth, the stringent SPS measures employed by some importing countries (e.g., Australia and Germany) could be addressed by facilitating bilateral agreements with these countries. The Philippines, Sri Lanka, Thailand and the Solomon Islands could also pressure Australia to accept the technically feasible alternatives in the fumigation of soil and perishable and durable goods making this treatment optional (FAO 1998). Moreover, the country's unresolved trade disputes with Australia since 2002 and 2003, which were filed before the WTO Dispute Settlement Body, should be tackled. To ensure that Philippine SPS standards will continue to be at par with international standards, the executive and legislative branches of the government must be proactive in intensifying partnerships among public agencies and private companies at the local and international levels on information and knowledge sharing. The Philippines should maintain close collaboration with other governments via the ASEAN Consultative Committee on Standards and Quality (ACCSQ), Sub-Committee on Standards and Conformance (SCSC) under the auspice of APEC, and WTO standard-setting bodies to continue updating the country's standards.

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## **ECONOMIC AND TECHNICAL ASSESSMENT OF ORGANIC VEGETABLE FARMING IN COMPARISON WITH OTHER PRODUCTION SYSTEMS IN CHIANG MAI, THAILAND**

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### **ABSTRACT**

The government of Thailand is promoting alternative vegetable production such as organic, chemical pesticide free, and safe use production systems. Most vegetable producers do not have confidence in transforming from their conventional system to organic farming, presumably due to technical difficulties and low production efficiency. Based on a questionnaire survey of 142 farmers under different production systems in Chiang Mai Province in 2008, this paper aims to clarify the common vegetable practices, cost and returns of major crops, profitability of organic farming in comparison with other production systems.

Over 15 kinds of vegetable were grown under different farming systems in Mae Rim District, Chiang Mai Province. Kinds of vegetable grown depended on market demand and growing time. In this district alone, vegetable production accounted for 0.57 million USD in 2007, of which 0.08 million USD was from organic vegetables. There were no differences in types of input used for major organic crops such as kale, pak choy, and yard long bean. Economic analysis revealed characteristics of four types of farming system: organic, chemical pesticide free, safe use, and conventional farming systems. The organic farming system was economically the most feasible due to high prices of produce; however, it would need further improvement in order to increase yields and production efficiency. Both safe use and pesticide free farming systems were also economically feasible. The conventional farming system faced the highest risk because of increased prices of synthetic chemical inputs, even though it was economically feasible. Under the Royal project foundation, most farmers sold their products at the project site, and price was determined by the project office. Organic vegetables reached consumers in Chiang Mai through supermarkets (63.3%), while other production systems had to sell their products through middlemen or local markets (over 80%). In this study, three kinds of analysis were done, namely cost and benefit analysis, production function analysis and marginal productivity analysis to compare four types of farming system. The benefit-cost ratio (B/C ratio) of organic farming system was greater than one, especially the B/C ratio of organic yard long bean was the highest. In organic kale, labor and seed were the most important factors in improvement of organic kale production, while the highest efficiency of resource use was seen for labor, indicating that the increased use of labor would lead to higher income for organic farms.

**Key words:** Royal project, input use, yield, profitability, marketing, alternative farming

### **INTRODUCTION**

While rice has been the traditional food crop in Thailand, the government started promoting commercial vegetable farming about two decades ago. Some parts of rice land were rapidly converted to vegetable production, which seemed to be preferred by farmers for faster cash flow, as well as the fact that the paddy price stagnated and fluctuated (Matsuda and Fujimoto, 1998). Since the emergence of commercial vegetable farming, several vegetable production systems have been developed. According to the Provincial Government (Chiang Mai Department of Agriculture, 2007), there were a number of vegetable production systems in Chiang Mai: conventional farming, safe use

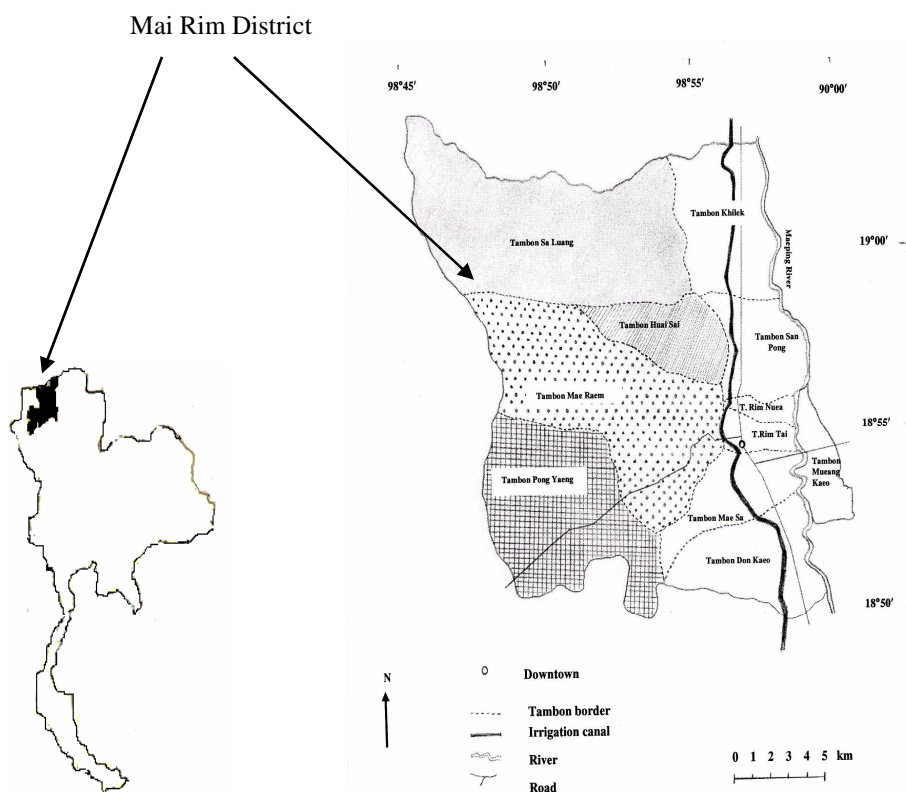
farming, natural farming, chemical pesticide free farming and organic farming. The conventional system depended heavily on synthetic chemical inputs such as pesticide, fertilizer and hormones. Seeds produced with the use of chemical inputs were used for the cultivation of conventional vegetables.

Both safe use and pesticide free systems referred to attempts to reduce dependency on synthetic chemical inputs. The safe use system has limited use of chemical fertilizer and pesticide, which was similar to what the government recommended as Good Agricultural Practice (GAP). The chemical pesticide free system excluded the use of synthetic chemical pesticide but still used chemical fertilizer. Only the organic system referred to true organic vegetable cultivation, in which no synthetic chemical inputs were applied and seeds were produced without the use of chemical inputs. Most organic vegetable growers, in the villages studied, utilized all of their land resources under the Royal Project Foundation or NGOs, and the whole organic farming area was certified in 1995 by the Department of Agriculture (DOA). Although most commercial vegetable farms are managed by companies, there are also small-scale vegetable farmers, most of whom are found in Chiang Mai Province (Kawasaki and Fujimoto, 2008). Total planted area of vegetables in Chiang Mai was approximately 37,997 ha or nearly 14% of total planted area in 2007; there were about 330 ha and 222 farmers practicing organic farming in 2005, with an average of 1.5 ha per household (Chiang Mai Department of Agriculture, 2008).

Organic Agriculture is not necessarily a new concept for Thai farmers because it resembles their traditional farming system. They rarely had high technologies, and always managed their farms well with simple skills in line with natural resources and environment. In fact, the area planted to organic vegetables in Thailand has greatly expanded since the 1980s. Many of the past studies on organic farming in Thailand focused on organic standard (Department of Agriculture, 2000; Saetang et al., 2003) and technical issues (Ruenglerpanyakul, 2004). Demand studies for organic vegetables showed clearly an increasing trend domestically and internationally, due to the increased awareness of the danger of chemical inputs. The average price of organic vegetables appeared to be higher than conventional vegetables by 15% (Jongworakitwattana, 2002), while the total number of retail stores dealing with organic vegetables was estimated to be 340 stores, of which 64% were in Bangkok (Vanit-Anunchai, 2006). However, some farm-level studies revealed that small organic farmers had inadequate capital, knowledge and labor for efficient management of their farms (Reunglerpanyakul, 2002). It is thus necessary to clarify the technical and economic performance of small organic vegetable farmers. We conducted a farm management questionnaire survey in Mae Rim District, Chiang Mai Province from January to March 2008. A total of 142 farmers were interviewed, of which 32, 32, 38 and 40 farmers were organic, chemical pesticide free, safe use, and conventional vegetable farmers, respectively. There are two specific objectives in this paper: (1) to identify and analyze production issues of the major vegetables under different farming systems by examining input use and yield, and (2) to determine the profitability of organic vegetable farming in comparison with other production systems and to suggest possible ways for improvement.

## **CHARACTERISTICS OF THE AREA AND FARMERS STUDIED**

This study was conducted in four subdistricts (Tambon) of Mae Rim District, Chiang Mai, namely; Mae Raem, Huai Sai, Pong Yaeng, and Sa Luang (**Fig. 1**). Mae Rim District is located in the central part of Chiang Mai Province and consists of 11 Tambons. It has a total area of 443.6 square kilometers with approximately 82,943 inhabitants, 35% of whom are engaged in farming. Temperature ranged from 20 to 32 °C, with the average annual rainfall being about 1,098 mm with 116 rainy days (Chiang Mai Meteorological Station, 2007). There are several tributaries and irrigation canals (such as Muang or Faay) from Mae Ping River (Wiroonsri, 1988). The typical soil type is clay loam with medium fertility. It seems that Mae Rim is a well established temperate vegetable area in Chiang Mai.



**Fig. 1.** Map of Mae Rim District, Chiang Mai Province

During the past 15 years, the total area planted in Mae Rim District increased by 132%. While the number of farms growing rice declined by 20% because of the decrease in price and yield of rice, fruit and vegetable growers increased by 331% (**Table 1**). Over 60% of the cultivated land area in Tambon Pong Yaeng, and Tambon Sa Luang was utilized in diversified commercial farming of fruits and vegetables, while rice was grown almost exclusively for home consumption (**Table 2**).

**Table 1.** Land resources in Mae Rim District, Chiang Mai Province.

Year	Rice		Field crop		Fruit and vegetables		Total	
	Area cultivated (rai)	No. of farms	Area cultivated (rai)	No. of farms	Area cultivated (rai)	No. of farms	Area cultivated (rai)	No. of farms
1992	17,887	2,960	334	105	4,917	777	23,138	3,842
2007	25,487	2,375	13,538	250	14,762	3,348	53,787	5,973
Growth ratio (%)	42	-20	3,953	138	200	331	132	55

Source: Chiang Mai Provincial Statistical Office, 2008

Note: One rai is equal to 0.16 ha.

**Table 2.** Land use in study area of Chiang Mai Province, 2007

Sub-District	Type of crops			Total
	Rice	Field crop	Fruit and vegetables	
Tambon Mae Raem	2,697	1,735	1,150	5,582
Tambon Huai Sai	1,731	527	1,026	3,284
Tambon Pong Yeang	42	2,426	5,252	7,720
Tambon Sa Luang	1,356	320	2,560	4,236

Source: Chiang Mai Provincial Statistical Office, 2008

Note: One rai is equal to 0.16 ha.

Land resources among the households studied under different production systems are presented in Table 3. The average area operated per household was 3.4, 3.9, 4.9 and 5.3 rai (one rai is equivalent to 0.16 ha) for organic, chemical pesticide free, safe use and conventional farming, respectively. The majority of organic farmers were owner farmers. Only a small proportion of organic farmers cultivated tenanted land, because conversion to organic farming system would require a minimum of 3 years, while there was the risk of sudden termination of tenancy contract.

Table 4 shows profiles of farm household heads studied. The average age of the heads in alternative farming was older than those in conventional farming. Generally, the average farm experience was more than 30 years, while the alternative farming experience ranged from 3 to 5 years. The majority of farmers graduated only from primary school, which was the basic formal education. There were some farmers of alternative farming system who graduated from university, indicating that alternative farmers had higher education backgrounds.

**Table 3.** Frequency distribution of farmers by tenurial status in the studied area, 2007.

Production systems	Owner farmers	Tenant farmers	Average farm size (rai)	SD
Organic	24	8	3.4	4.6
Chemical pesticide free	23	9	3.9	3.1
Safe use	20	18	4.9	4.3
Conventional	24	16	5.3	4.1
Overall	91	51	4.4	4.1

Source: Survey January-March, 2008

Note: One rai is equal to 0.16 ha

**Table 4.** Profile of farmers interviewed in Mae Rim District of Chiang Mai Province, 2007

Items	Organic	Chemical pesticide free	Safe use	Conventional
No. of farmers (HH)	32	32	38	40
Average age of household heads (years)	55	56	54	48
Formal education of HH (years)	4	4	4	4
Farming experience of HH (years)	44	39	40	30
Alternative farming experience of HH (years)	3	3	5	none
Distribution of the HH by occupation				
Farming	30	30	35	40
Non-farm labor	2	2	2	none

Source: Survey January-March, 2008

## MAJOR VEGETABLES GROWN AND CULTIVATION PRACTICE

### Major Vegetables

Kinds of vegetable grown depended on market demand and growing time. In the studied area alone, vegetable production was valued at about 19.6 million Baht in 2007, of which organic vegetables constituted 2.6 million Baht (one USD was equivalent to 34.35 Baht in 2007). Table 5-6 shows the distribution of planted area for a total of 9 major vegetables under different farming systems, including kale, pak choy, yard long bean, green eggplant, chili, spinach, baby carrot, cabbage, and green bean.

In relation to planting season, proportion of planted area was varied by different farm management capability. Most vegetable farms planted various kinds of vegetables from December to February in the winter season because of fewer insects and pests, while vegetable plots were used for cultivation for the whole year under crop rotation. In the middle of the dry season, planted area to vegetable was reduced because of the shortage of water. The majority of vegetables were harvested within 2-3 months.

Cropping intensity of vegetables was calculated by total planted area over the total physical area operated by four types of farming system. Total planted area under organic, chemical pesticide free, safe use, and conventional farming systems in 2007 were 155.9, 123.6, 247.0, and 416.8 rai, respectively, while the total physical area was 48.3, 55.9, 10.1 and 111.3 rai, respectively. The highest value of cropping intensity was 374.5% in conventional farming system, followed by 322.5%, 274.1%, and 221.1% under organic, safe use, and chemical pesticide free farming systems. It shows that frequency of vegetable planting was 3.7, 3.2, 2.7 and 2.2 times on one and the same plot in a year under the respective systems.

### Vegetable Cultivation Practice

Based on information obtained from interviews with the farmers, technical issues in organic vegetable cultivation are summarized in comparison with other production system, in this section. First, organic vegetable cultivation was carried out by various organic inputs, including seeds, manure, compost, Effective Microorganisms (EM), bio-pesticide, and labor. The seeds used should not be contaminated by chemical residue. All organic farmers under the NGOs and government bought organic seeds from nearby offices. Some seeds were produced domestically, but mostly imported from Japan, and EU at an expensive price. In individual organic farms, farmers grew local vegetables



and herbs mainly for household consumption by using seeds and seedlings from the previous crop, which were mostly resistant to pests and disease. The volume of organic vegetable seeds produced domestically was not adequate for the high demand and only a small proportion of domestically produced seeds could meet the International Federation of Organic Agriculture Movements (IFOAM) standard. Consequently, the improvement in quality and quantity of organic seeds is a very important factor for development of organic vegetable production in Thailand. Most seeds of other production systems were produced with the use of chemical inputs by domestic producers, and the quantity seemed adequate. In the case of chemical pesticide free and safe use farming systems, farmers purchased seeds from their farmer groups, while conventional farmers purchased their seeds from local shops.

Second, soil fertility on organic farms was maintained by crop combination and organic inputs, including manure, compost, and EM. There were six types of enterprise combination in the villages studied, including only vegetables, rice-vegetables, vegetables-livestock, vegetables-fruits, rice-vegetables-livestock and rice-vegetables-fruits under different farming systems. The most common cropping pattern was the planting of only vegetables for organic farming, while the majority of farmers under conventional, safe use and chemical pesticide free farming grew rice in combination with vegetables only during the rainy season. The organic farms applied only organic fertilizer by raising animals themselves such as cows and chickens. EM was produced by available ingredients in the fields but farmers did not clearly know effectiveness of EM. If soil was low in fertility, the farmers usually applied organic compost. Normally in organic farming, the manure and compost were applied during land preparation, while EM was applied twice: 2 weeks after transplanting and 2 weeks before harvesting. The proportion of fertilizer inputs was varied by physical properties of the soil. The three production systems, chemical pesticide free, safe use and conventional farming depended on synthetic chemical fertilizer. In particular, the conventional system heavily depended on external inputs such as synthetic chemical fertilizer and pesticides (Saengyot et al., 2005). Synthetic chemical fertilizers such as urea were readily available in local shops, while organic fertilizer was available only at the project office. However, the farmers faced high prices for chemical fertilizer.

Third, pest and disease control was often carried out by mechanical method and use of bio-pesticides in organic farms. The methods to control pests and diseases were as follows: physical method, use of bio-control agents such as natural enemies or pathogens including bacterial antagonists, micro parasites, parasitoids, and predator (Sudana et al., 2003). In the studied area, while small organic farmers used the mechanical methods including glue tray, light trap, and nets, the use of microbes and botanical pesticide was the most popular method (Table 7). There were more than 20 homemade botanical pesticide formulas in the study site, which were produced by available ingredients of the fields. Farmers in the studied area and other villages learned how to process botanical pesticide formulas from local NGOs and the learning center, which belonged to the government project. It seemed that farmer network was also expanded by using this learning center. Main herbs of homemade botanical pesticide included lemon grass (*Cymbopogon citrates*), tobacco (*Nicotiana tabacum*), and seed of neem tree (*Azadirachta indica*). For example, a typical bio-pesticide formula consisted of one kilogram of neem seeds, chili (*Capsicum spp.*), lemon grass, bo-raphet (*Tinospora crispa*) and galinga tuber (*Alpinia galanga*) chopped and finely pounded, mixed with 20 liters of water and left to ferment for 1-2 days. This bio-pesticide was applied once a week. However, these bio-pesticides were not so clearly effective for pest control. In addition to the use of bio-pesticide, microbial pesticides were also applied.

**Table 5.** Production of the 10 major vegetables under different farming systems by farmers studied in Chiang Mai Province, 2007.

	Types of farming system									
	Organic		Chemical pesticide free		Safe use		Conventional		Overall	
	Total area planted (rai)	Total production (tons)	Total area planted (rai)	Total production (tons)	Total area planted (rai)	Total production (tons)	Total area planted (rai)	Total production (tons)	Total area planted (rai)	Total production (tons)
Kale	33.3	27.2	29.1	37.7	57.5	58.1	85.6	108.2	205.4	231.1
Pak choy	22.5	19.0	25.3	38.9	49.6	60.6	136.8	177.6	234.1	299.8
Yard long bean	16.6	23.0	20.0	64.2	42.6	90.9	76.6	108.2	155.8	286.4
Chili	12.5	15.4	17.4	25.0	41.1	62.6	51.4	69.6	124.7	172.5
Green eggplant	13.9	23.2	17.8	32.7	35.9	82.2	45.8	100.6	113.2	238.7
Spinach	22.8	10.1	-	-	5.5	10.2	-	-	28.3	20.3
Baby carrot	22.5	15.5	-	-	-	-	2.0	6.3	24.5	21.8
Cabbage	6.3	9.8	-	-	8.0	0.4	1.0	3.4	15.3	13.6
Greenbean	-	-	14.0	7.0	-	-	-	-	14.0	7.0
Others	2.6	3.1	-	-	-	-	15.0	626.0	17.6	44.1
Total	155.9	146.6	123.6	205.4	247.0	388.7	416.8	632.3	943.3	1,374.5

Source: Survey January-March, 2008

Note: One rai is equal to 0.16 ha

*Economic and technical assessment of organic vegetable farming....*

**Table 6.** Sale of the 10 major vegetables under different farming systems.  
by farmers studied in Chiang Mai Province, 2007 **Unit: million Baht**

	<b>Types of farming systems</b>				<b>Overall</b>
	<b>Organic</b>	<b>Chemical pesticide free</b>	<b>Safe use</b>	<b>Conventional</b>	
Kale	0.5	0.7	0.9	2.4	4.5
Pak choy	0.3	0.6	0.7	1.6	3.2
Yard long bean	0.3	1.0	1.1	1.3	3.6
Chili	0.4	0.5	1.0	1.2	3.1
Green eggplant	0.2	0.4	0.9	1.1	2.6
Spinach	0.3	-	0.2	-	0.5
Baby carrot	0.5	-	-	1.0	0.6
Cabbage	0.1	-	0.01	0.2	0.2
Greenbean	-	0.1	-	-	0.1
Others	0.0	-	4.8	8.7	0.9
<b>Total</b>	<b>2.6</b>	<b>3.3</b>	<b>5.0</b>	<b>8.7</b>	<b>19.6</b>

Source: Survey January-March, 2008

Note: One USD is equal to 34.35 Baht

**Table 7.** Methods for controlling pests and diseases in Chiang Mai Province, 2007.

Methods	Processing	Target pest/insect	Application method
<b><u>1. Physical methods</u></b>			
1.1 Nets		insects, worm	
1.2 Light trap	This trap is about 1.5 meters above the ground, and 0.3 meters from the light	insects	2 sets per rai
1.3 Glue tray	Mix 600 cc of castor oil, 390 grams of rubber and 10 grams of carnuaba wax. Simmer for 45 minutes. After 1 hour, pour the cold glue in a tray.	insects	20 -60 sets per rai
<b><u>2. Biological methods</u></b>			
<i>2.1 Botanical Insecticides:</i>			
<i>2.1.1 Spray Mix : main herbs used :</i>			
Neem ( <i>Azadirachta indica</i> )	Chop all the materials into finely pounded mass.	Insects (Adults and larvae)	Spray once a week
Chili ( <i>Capsicum</i> spp.)	Mix all materials in 20 liters of water and		
Lemon grass ( <i>Cymbopogon citrates</i> )	leave to ferment for 1-2 days		
Bo-ra-phet ( <i>Tinospora crispa</i> )			
Galanga tuber ( <i>Alpinia galanga</i> )			
<i>2.1.2 Fungicide : main herbs used:</i>			
Lemon grass ( <i>Cymbopogon citrates</i> )	Chop all the materials into finely pounded mass.	<i>Colletotrichum</i>	Spray once a week
Siam weed ( <i>Eupatorium odortum</i> L.)	Mix all the materials with molasses in 20 liters	<i>gloeosporioides</i> fungi	
Galanga tuber ( <i>Alpinia galanga</i> )	of water and leave to ferment for 3 days		
<b><u>2.2 Microbial pesticideds</u></b>			
2.2.1 <i>Bacillus thuringiensis</i> (BT)	Mix 40-60 grams of BT per 20 liters of water	Insects (Adults and larvae)	Spray once a week
2.2.2 Nuclear Polyhedrosis Virus (NPV)	Mix 1 milligrams of NPV per 20 liters of water	Insects (Adults and larvae)	Spray once a week
2.2.3 <i>Trichoderma harzianum</i>	Mix 250 grams of <i>Trichoderma harzianum</i> (fungal biopesticide) per 20 liters of water	Fungal diseases	Spray once a week

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Source: Survey January-March, 2008

The main components of microbial pesticide were bacterium, fungus, and virus (Banpot, 2007), that particularly used to control common fungal diseases such as *Phytophthora infestans* in the rainy season and *Peronospora parasitica* during the growing time of young kale. For controlling these fungal diseases, farmers sprayed about 250 grams of *Trichoderma harzianum* (fungal biopesticide) per 20 liters of water (Office of the Permanent Secretary for Agricultural and Cooperatives, 2005). In fact, organic farmers bought the microbial pesticides at high price but they did not know the effectiveness of the microbial pesticides, which were not registered in the Ministry of Agriculture and Cooperatives. Recently the cost of production of the conventional farming system increased rapidly due to the increased price of synthetic chemical pesticides, resulting in the increase of the use of bio-pesticide in conventional farms.

Finally, most products under organic, chemical pesticide free, and safe use farming were sold directly to their farmer groups. For example, organic farmers harvested products by themselves, and the commodities were sorted and graded according to the quality standards as specified in the agreement. Price was determined by buyer as the standard price. It is also noted that organic produce was significantly more expensive than conventional produce. In the case of conventional production, farmers sold their produce to wholesalers or a local cooperative without sorting, grading and packaging. The price depended on the quality of the produce. In the case of both chemical pesticide free and safe use farmers, the products were sorted and graded, although no packaging was involved. Prices were determined by buyer and markets because there were no specific markets for chemical pesticide free and safe use vegetables.

### Input Use and Yield

Most organic vegetable growers studied produced their products under the Royal Project Foundation, and only 7 growers practiced organic system outside the organization, as individual farms. It seems that there were no differences in types of inputs used for major organic crops such as kale, pak choy, and yard long bean. **Table 8** shows input values and yield by different vegetable farming systems. Average yield levels of organic vegetables were slightly lower than other production systems. Organic farmers seemed to lack efficiency in management of their farms, while conventional farmers had more than 30 years of farming experience (**Table 4**). In chemical pesticide free farms, farmers got knowledge and technical support from the provincial government.

The average amount of seeds used seemed to make no difference. Manure and/or compost and bio-pesticide were the major inputs for organic and chemical pesticide free farming systems, while safe use and conventional farms heavily depended on synthetic chemical inputs such as chemical fertilizer and chemical pesticide. The amount of bio-pesticide for organic farm was 8-10 bottles per rai for major organic crops. According to the government's promotion of production of safe food, the conventional farmers were also advised to apply some amount of bio-pesticide for pak choy and yard long bean.

Vegetable cultivation in Chiang Mai heavily depended on family labor, and no hired labor was used in organic farming. It seemed that family labor worked intensively in their organic farms, resulting in the family labor input of 93 mandays per rai in pak choy. Other farming systems were dependent on both family labor and hired labor, and it is seen that conventional farming had the highest level of hired labor among all farming systems, accounting for 40% of total labor inputs. The conventional farmers usually employed landless villagers for land preparation, water management, and pest control.

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**Table 8.** Estimated yield and inputs per rai of major vegetables by different farming systems in Chiang Mai Province, 2007

Types of farming system and Major vegetables	Seed		Manure and/or Compost		Chemical fertilizer		Chemical pesticide		Bio- pesticide		Labor				Yield	
											Family	Hired				
	(kg)		(kg)		(kg)		(bottle)1/		(bottle)1/		(man-days)	(man-days)			(kg)	
<b>Kale</b>																
Organic	0.3	a	112	a	-	-	-	-	9	a	88	a	-	-	1,180	a
Chemical pesticide free	0.4	b	122	a	119	a	-	-	5	b	48	b	20	a	1,297	b
Safe use	0.3	b	49	b	157	b	1	a	1	c	33	c	23	a	1,103	a
Conventional	0.2	c	18	b	147	b	2	b	-	-	26	c	17	b	1,474	c
<b>Pak choy</b>																
Organic	0.3	a	195	a	-	-	-	-	10	a	93	a	-	-	1,559	a
Chemical pesticide free	0.4	b	153	a	77	a	-	-	6	b	60	b	23	a	1,609	b
Safe use	0.3	a	34	b	99	a	2	a	3	c	34	c	11	b	1,511	a
Conventional	0.3	a	13	b	128	b	2	a	1	d	29	d	19	c	1,781	c
<b>Yard long bean</b>																
Organic	0.3	a	213	a	-	-	-	-	8	a	90	a	-	-	2,167	a
Chemical pesticide free	0.4	b	169	a	107	a	-	-	6	b	67	a	20	a	2,536	b
Safe use	0.3	a	67	b	135	b	3	a	3	c	40	b	34	b	2,280	a
Conventional	0.4	b	31	b	195	b	4	b	5	d	43	c	26	c	2,706	b

Source: Survey January-March, 2008

Note: Values in each column followed by the same letters indicate insignificant differences at  $P < 0.05$ .

1/ One bottle contained 500 cc.

One rai is equal to 0.16 ha

## **Problems of Vegetable Cultivation**

According to the farmers interviewed, there were no differences in kinds and extent of management problems among four vegetable farming systems, the common problems being inadequate water supply in the dry season, inadequate labor during harvesting and transplanting, high pest and disease occurrence, low soil fertility, high chemical residues, inadequacy of farm equipments, inadequate product supply for market demand, and increasing investment cost. The most important problems in organic farming were inadequate seeds, and labor. Most seeds were usually imported from foreign countries at high price. Under organic farming, the farmers grew vegetables in an open system without a net. The pest and diseases frequently found were leaf worm and damping-off of seedlings. The techniques used for pests and diseases management were crop rotation and mechanical control by manually picking pests. Therefore, organic farming was more labor-intensive, and the farmers need to pay more attention to disease and pest control and soil improvement. During harvesting period, the farmers followed the harvest guidelines under organic standard. There were four main types of accreditation institutions in Chiang Mai, providing organic certification services: Organic Agricultural Certification Thailand (ACT), Organic Crops Institute of the DOA, foreign companies, and Northern NGOs (Ellis et al., 2006). Organic vegetables in villages studied area were certified for quality level by organic standard of the DOA, while the good agricultural practice (GAP) was used for production of pesticide free and safe use vegetables.

The DOA encouraged farmers with respect to acquiring knowledge, farmland inspection, and the standard method for efficient management of alternative farming such as organic, chemical pesticide free and safe use production systems. The Department of Agricultural Extension established learning centers in villages to promote production of alternative farming. Recently, the conventional farmers encountered serious economic problem in producing vegetables, due to the increased prices of synthetic chemical pesticides and fertilizers. They also started using manure and compost to reduce chemical fertilizer cost, but still depended heavily on chemical pesticides.

## **ECONOMIC ANALYSIS**

### **Costs and Returns**

The data collected from the questionnaire survey were used to estimate costs and returns per rai for major vegetable crops under four types of farming system. Costs have been classified into variable costs such as seeds, fertilizers, and labor, and fixed costs such as depreciation, interest on capital and rental payment of land. Total cost was divided into cash cost and non cash cost. Total revenue was measured by price and yield for each crop. Net profit was obtained by deducting total cost from total revenue, while profit above cash cost was calculated by deducting only cash cost from total revenue.

Average costs per rai for three major vegetables, kale, pak choy and yard long bean are presented in **Table 9**. In organic farming, yard long bean had the highest total production cost of 24,016 Baht (nearly 699 USD), followed by pak choy (23,524 Baht) and kale (21,625 Baht). It should be noted that production cost of yard long bean included the extra costs of beanpole. Among input costs, labor constituted the largest expense, amounting to 14,004, 14,847, and 14,326 Baht in kale, pak choy and yard long bean respectively for organic farming. Labor and seed costs for organic farming were the highest among all farming systems. However, the use of synthetic material inputs such as pesticide and fertilizer were greatly higher than other material costs in conventional farms. Results show that pesticide cost was the highest in kale (2,229 Baht) and yard long bean (4,952 Baht) for conventional farming, and pak choy (2,391 Baht) for safe use system. Most operated lands of conventional farms were located close to main roads and irrigation canals, and land value was therefore high, leading the average rental to 1,296, 1,246, and 1,274 Baht in kale, pak choy and yard long bean respectively for conventional farms.



**Table 9** also shows the average revenue and profit for major vegetables per rai and per kg. Although organic farming had higher cost because of labor, they had the highest revenue of all farming systems, with higher prices contributing to its higher profits. Normally, vegetable prices depended on the demand and growing time, but organic vegetable prices were fixed for the whole year because there were specific markets such as supermarkets. Average price per kg of three organic vegetables were 21, 18, and 21 Baht for kale, pak choy, and yard long bean respectively. Average revenue per rai of yard long bean was the highest at 45,210 Baht, followed by pak choy (28,075 Baht) and kale (25,328 Baht) for organic farming. Concerning other production systems, chemical pesticide free farms also received a high revenue, the average total revenue being 22,960 Baht for kale, 22,894 Baht for pak choy, and 38,713 Baht for yard long bean.

Regarding the average total cost per kg under different farming systems, organic farms had the highest cost, while average cash costs per kg were the lowest for pak choy (3.7 Baht) and yard long bean (2.9 Baht). It is clear that the organic farms had the higher non cash cost than other production systems because of family labor costs, while there were higher hired labor costs to be accounted in cash cost for safe use and conventional farms. Consequently, the highest profits over cash cost per kg were 13.0 Baht for kale, 14.3 Baht for pak choy, and 18.0 Baht for yard long bean for organic farms. The profitability of all farming systems was also evaluated by the ratio of benefit to cost of farm. If the ratio is greater than unity, it indicates that the return was larger than the cost. If the ratio is less than unity, the cost was higher than the return. The benefit-cost ratio (B/C ratio) of all farming system was greater than one, especially the highest B/C ratio of organic yard long bean was 1.9.

### **Production Function Analysis**

In order to examine mechanism of vegetable production in Chiang Mai, the production function of the Cobb-Douglas type was estimated for the farmers studied. Because kale appeared to be a dominant crop and data were available for four production systems, we estimated the production function of kale. The variables used are as follows. The dependent variable (Y) is production of kale per farm per crop (kg) in a whole year, and five independent variables were used:  $X_1$  refers to kale's planted area (rai),  $X_2$  is total labor inputs of family labor and hired labor (man-days),  $X_3$  refers to total amount of seed used (Baht),  $X_4$  is amount of Nitrogen element in fertilizer (kg), and  $X_5$  refers to cost of pest control (Baht).

**Table 10** presents the results of the estimation of production function for different farming systems in Chiang Mai. In organic kale production, there were three significant regression coefficients: labor and seed at the 1% level and pest control cost at the 5% level. The coefficient of determination ( $R^2$ ) was 51%, indicating a reasonable explanatory power of the variables included in the estimation. The results imply that family labor and quality of seed were the most important factors in improvement of organic kale production. If the number of labor and seed increased by 10%, organic kale production would increase by 2.97% and 2.69%, respectively. Our study revealed that the planted area was not a significant contributor to the determination of organic kale production, presumably because the expected influence of planted area was somehow affected by land fertility management during the transition period from conventional to organic production.

In the case of chemical pesticide free farming, the regression coefficients for labor and pest control cost were significant at the 1% level. It implied that a 10% increased in labor and pest control cost would increase the production of chemical pesticide free kale by 2.42% and 2.28%, respectively. However, the seed variable was not significant in chemical pesticide free farming, implying that kale seeds produced locally with the use of chemical inputs were probably of low standard. The coefficient of determination ( $R^2$ ) was 62.3%.

The regression coefficient for farm size was significant at the 1% level for safe use and conventional farming system, indicating that a 10% increased in farm size would increase kale production by 1.76% and 2.86% for safe use and conventional farms, respectively. Farmers often used the mechanical methods including glue tray and light trap, which reduced the production cost, and then the pest control cost was not significant for safe use farming. Conventional farmers heavily depended on chemical fertilizer and pesticide to increase their productivity, and its regression coefficient was significant at the 5% of level. Labor was not significant for conventional farming because the farmers widely adopted in the labor-saving technology such as tractor, truck, sprayer, and pump. The coefficients of determination were 58% and 56% for safe use farming and conventional farming.

### **Marginal Productivity Analysis**

Based on the production function estimates (**Table 10**), the marginal products of inputs can be estimated in order to evaluate the efficiency of input use. First, the marginal physical products of labor, seed, fertilizer and pest control under organic farming were 15.41 kg/man-day, 0.10 kg/can, 103 kg/kg of fertilizer and 0.19 kg/bottle, respectively. Since the average price of organic kale was 21 Baht/kg, marginal value products would become 330.81 Baht/man-day, 2.09 Baht/can, 2,210.85 Baht/kg and 4.06 Baht/bottle, respectively (**Table 11**). Second, the marginal physical products of land, labor, fertilizer and pest control under chemical pesticide free farming were 370.76 kg/rai, 10.02 kg/man-day, 46.13 kg/kg of fertilizer and 0.21 kg/bottle respectively, and the marginal value products became 6,563.59 Baht/rai, 177.41 Baht/man-day, 816.73 Baht/kg and 3.67 Baht/bottle respectively at an average price of chemical pesticide free kale of 18 Baht/kg. Third, the marginal physical products of land, labor, seed and fertilizer under safe use farming systems were 291.17 kg/rai, 3.33 kg/man-day, 0.09 kg/pack and 137.99 kg/kg of fertilizer, respectively, while the marginal value products were 4,527.50 Baht/rai, 51.81 Baht/man-day, 1.47 Baht/pack and 2,145.62 Baht/kg at an average price of safe use kale of 16 Baht/kg. Lastly, the marginal physical products of land, seed, fertilizer and pest control under conventional farming were 484.97 kg/rai, 0.10 kg/pack, 22.88 kg/kg of fertilizer and 0.09 kg/bottle, respectively, and the marginal value products would become 6,571.41 Baht/rai, 1.41 Baht/pack, 310.01 Baht/kg and 1.17 Baht/bottle at an average price of conventional kale of 14 Baht/kg.

The opportunity cost of land was the fixed rent in the village studied. The tenant farmers paid approximately 2,000 Baht/rai/year by cash, so that an opportunity cost of land for kale production was estimated to be 667 Baht for the period of four months. The opportunity cost of labor was assumed to be the on-going wage rate; 150-155 Baht per day. The opportunity cost of organic seeds was the highest among all farming systems at 1,000 Baht per can, while the opportunity cost of organic manure was at 8 Baht/kg. The efficiency of resource use was evaluated by the ratio of marginal value product to opportunity cost of the input. As shown in **Table 11**, the ratio of land and fertilizer were higher than unity for all vegetable farming systems in Chiang Mai, indicating that the increased use of land and fertilizer would lead to higher income. On the other hand, the ratio of seed and pest control was lower than unity, indicating the use of seed and pest control was beyond the optimum level. Under organic farming, the ratio of seed and pest control was also lower than unity, implying the use of organic seed and pest control methods were still inefficient.

*Economic and technical assessment of organic vegetable farming.....*

**Table 9.** Costs and returns per rai of major vegetables in Chiang Mai Province, 2007.

	Kale				Pak choy				Yard long bean			
	Organic	Chem. pesticide free	Safe use	Conventional	Organic	Chem. pesticide free	Safe use	Conventional	Organic	Chem pesticide free	Safe use	Conventional
<u>Costs</u>												
<u>Variable Costs (Baht):</u>	20,973	17,907	15,386	14,192	22,940	19,393	14,347	13,891	23,121	24,440	21,072	21,357
Seed	690	547	392	210	635	564	426	195	873	588	493	578
Fertilizer (Manure, Compost, EM)	3,326	2,896	2,124	1,012	4,926	2,109	2,025	1,178	4,891	5,954	2,827	924
Chemical fertilizer	-	1,610	2,122	1,991	-	1,045	1,334	1,731	-	1,438	1,824	2,633
Pesticide	-	-	1,297	2,229	-	-	2,391	2,256	-	-	2,815	4,952
Bio pesticide	1,788	969	249	-	1,950	1,290	562	259	1,517	1,236	573	958
Labor	14,004	10,841	8,915	6,876	14,847	13,390	7,202	7,556	14,326	13,863	11,801	10,977
Opportunity cost of investment (1.7% per year)	76	109	117	91	74	116	117	90	80	124	158	94
Others	1,090	936	170	1,784	508	880	291	626	1,434	1,237	580	240
<u>Fixed Costs (Baht):</u>	652	351	284	1,311	583	706	200	1,255	895	867	545	1,288
Land tax and land rent	640	337	271	1,296	574	695	191	1,246	882	850	532	1,274
Depreciation of farm machinery	12	14	14	14	10	11	9	10	13.2	17.0	13.1	14.6
Total cost per rai	21,625	18,258	15,670	15,503	23,524	20,099	14,548	15,147	24,016	25,307	21,617	22,646

**Table 9.** Costs and returns per rai of major vegetables in Chiang Mai Province, 2007.

	Kale				Pak choy				Yard long bean			
	Organic	Chem. pesticide free	Safe use	Conventional	Organic	Chem. pesticide free	Safe use	Conventional	Organic	Chem pesticide free	Safe use	Conventional
<u>Returns</u>												
<u>Baht per rai</u>												
(1) Total revenue	25,328	22,960	17,157	19,969	28,074	22,894	17,785	16,336	45,210	38,713	26,377	33,265
(2) Total costs	21,625	18,258	15,670	15,503	23,524	20,099	14,548	15,147	24,016	25,307	21,617	22,646
Benefit-cost ratio (1)/(2)	1.2	1.3	1.1	1.3	1.2	1.1	1.2	1.1	1.9	1.5	1.2	1.5
<u>Baht per kg</u>												
(3) Selling price	21	18	16	14	18	14	12	9	21	15	12	12
(4) Total costs	18.3	14.1	14.2	10.5	15.1	12.5	9.6	8.5	11.1	10.0	9.5	8.4
(5) Total variable cost	17.8	13.8	13.9	10.4	14.7	12.1	9.5	7.8	10.7	9.6	9.2	7.9
(6) Total fixed cost	0.6	0.3	0.3	0.1	0.4	0.4	0.1	0.7	0.4	0.3	0.2	0.5
(7) Total cash cost	8.5	7.6	9.2	7.6	3.7	6.1	5.9	5.9	2.9	5.5	6.5	5.8
(8) Total non-cash cost	9.9	6.4	5.0	2.9	11.4	6.4	3.7	2.6	8.2	4.5	2.9	2.6
Net profit (3) - (4)	3.1	3.6	1.3	3.0	2.9	1.7	2.1	0.7	9.8	5.3	2.1	3.9
Profit over cash cost (3) -(7)	13.0	10.1	6.3	5.9	14.3	8.2	5.9	3.3	18.0	9.8	5.0	6.5

Source: Survey January-March, 2008

Note: One rai is equal to 0.16 ha

One USD is equal to 34.35 Baht

**Table 10.** Estimate of kale production function under different farming systems in Chiang Mai Province, 2007.

	Type of vegetable farming											
	Organic			Chemical pesticide free			Safe use			Conventional		
	Reg coeff.		t value	Reg coeff.		t value	Reg coeff.		t value	Reg coeff.		t value
Constant	1.637	*	1.761	2.404	***	4.411	3.161	***	7.78	2.871	***	5.564
Area (rai)	0.114	ns	1.386	0.167	**	2.632	0.176	***	2.38	0.286	***	3.745
Labor (man-day)	0.297	***	2.703	0.242	***	2.905	0.122	*	1.66	0.035	ns	0.540
Seed (Baht)	0.269	***	3.521	0.058	ns	1.181	0.097	**	2.29	0.106	*	1.759
Nitrogen element in fertilizer (kg)	0.118	*	1.922	0.096	**	2.532	0.141	*	1.67	0.073	**	2.135
Pest control cost (Baht)	0.177	**	2.557	0.228	***	2.134	0.075	ns	1.27	0.089	**	2.025
R square	0.512			0.623			0.580			0.564		
F value	11.324			16.170			18.220			20.958		
Durbin-watson value	1.992			1.773			2.138			2.411		
N	60			55			72			87		

Source: Survey January-March, 2008

Note: \*\*\*Denotes significance at 1% level

\*\* Denotes significance at 5% level

\* Denotes significance at 10% level

ns Denotes non significance at 10% level

**Table 11.** Marginal products and opportunity costs of selected variables under different farming system in Chiang Mai Province, 2007.

	Type of farming system											
	Organic			Chemical pesticide free			Safe use			Conventional		
	Marginal value products (MVP)	Opportunity costs (OC)	MVP/OC ratio	Marginal value products (MVP)	Opportunity costs (OC)	MVP/OC ratio	Marginal value products (MVP)	Opportunity costs (OC)	MVP/OC ratio	Marginal value products (MVP)	Opportunity costs (OC)	MVP/OC ratio
Area (Baht/rai)				6,563.6	667	9.8	4,527.5	667	6.8	6,571.4	667	9.8
Labor (Baht/man-day)	330.81	150	2.21	177.4	155	1.1	51.8	155	0.3			
Seed (Baht/can or pack)	2.09	1,000	0.002				1.5	15	0.1	1.4	15	0.09
Fertilizer (Baht/kg)	2,210.8	8	276.4	816.7	14	58.3	2,145.6	14	153.3	310.0	14	22.1
Pest control (Bath/bottle)	4.06	20	0.20	3.7	15	0.2				1.2	15	0.08

Source: Survey January-March, 2008

Note: A fixed rate of rental land was 2,000 Baht/year, while kale was planted 3 crops per year.

The opportunity cost of land was estimated to be 667 Baht per crop

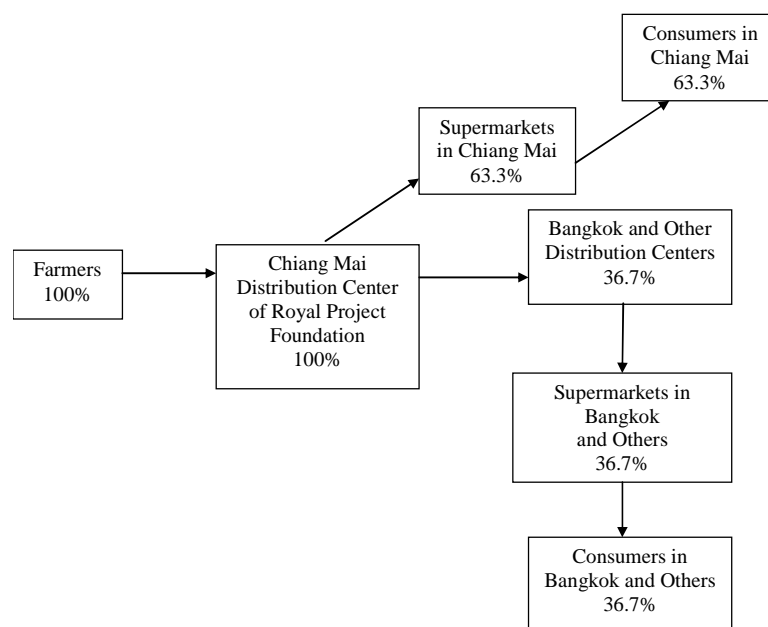
One rai is equal to 0.16 ha

One USD is equal to 34.35 Baht

## VEGETABLE MARKETING PRACTICES

Economic efficiency of organic farming appeared to depend on the level of vegetable price under the unique marketing system. The prices of major vegetables under different farming systems, are shown in Table 12. The selling prices of vegetable under different farming systems differed significantly, and organic vegetables were sold at the highest prices both at the farm and market levels. The price difference from farm to hypermarket of organic vegetables was 257% for yard long bean and 495% for kale, while the conventional vegetable prices seemed to be the lowest. It indicates that organic vegetables prices were mostly higher than conventional vegetables prices by 25% for water spinach and 471% for Chinese parsley and tomato. The price difference between farm price and supermarket price was also high, ranging from 100% for Chinese parsley and okra to 367% for yard long bean and winged bean under chemical pesticide free farming, and 226% for okra and lettuce to 500% for pak choy in safe use farming.

Organic farmers of the Royal Project Foundation were all encouraged to use organic inputs due to high prices of organic vegetables under the contract marketing system of the Royal Project. The prices of organic vegetables were estimated by the marketing cost and vegetable prices of other farming system, while vegetable prices of other farming systems still depended on market demand. His Majesty the King had supported expenditure of the project for the organic vegetable production and marketing activities. The marketing channels of vegetables produced by different farming systems in Chiang Mai are shown in Figures 2 to 5. In organic marketing, farmers sold all of their vegetables to the Royal Project Foundation's sites, located nearby their farms. The organic vegetables of the Royal project were distributed domestically under the brand name "Doi Kham". In terms of quantity, 63% of the Royal project's organic vegetables were bought by consumers in Chiang Mai, and 37% shipped to supermarkets and retail shops of the Royal Project Foundation in Bangkok and other large provinces such as Hat Yai, Phitsanuloke, and Khon Kaen (Fig.2).



Source: Survey January-March, 2008

**Fig. 2.** Marketing channels of organic vegetables under the Royal Project Foundation in Chiang Mai Province

**Table12.** Farm and market prices of major vegetables under different farming systems in Chiang Mai Province, July-August 2007

Kinds of vegetable	Type of farming system													Unit: Baht per kg	
	Organic			Chemical pesticide free				Safe use			Conventional			Farm price differences (Organic-Conventional)	
	Farm (1)	1/ Hyper market	% Price difference	Farm (1)	2/ Safe food market in weekend	3/ Super market	% Price difference	Farm (1)	3/ Super market	% Price difference	Farm (2)	4/ Local market	% Price difference	Baht (1)-(2)	Percent
Kale	21	125	495	15-20	20-25	40	122	15-23	75	369	7-15	14-23	64	6	40
Pak choy	20	95	375	10	17	25	150	10-15	90	500	7-9	11-13	44	11	122
Yard long bean	35	125	257	15	20-25	65-70	367	11-16	65	306	10-14	21-26	86	21	150
Green egg plant	20	100	400	10	15	33	230	11-15	75	400	5-7	13	86	13	186
Chinese parsley	40	150	275	15-20	25-40	40	100	-	-	-	5-7	12	71	33	471
Tomato	40	150	275	8	15	25	213	-	-	-	5-7	13	86	33	471
Winged bean	-	-	-	15	40	70	367	-	-	-	-	-	-	-	-
Water spinach	15	75	400	10	17	25	150	7-10	40	300	6-12	12-16	33	3	25
Okra	20	100	400	10	40	20	100	15-23	75	226	-	-	-	-	-
Lettuce	40	150	275	15-20	25-30	50	150	15-23	75	226	-	-	-	-	-

Source: Survey January-March, 2008

1/Office of Marketing, The Royal Project Foundation, 2008

2/MCC, Chiang Mai University, 2008

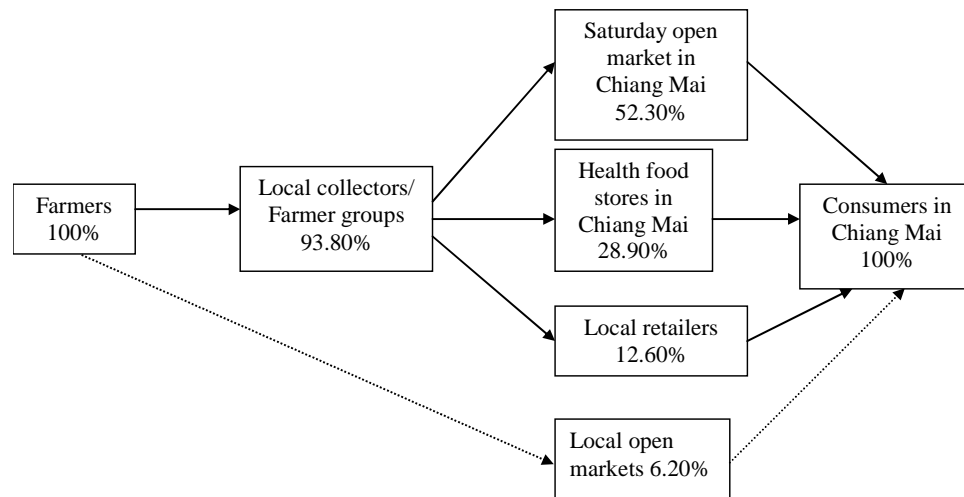
3/Rim Ping Supermarket, 2008

4/ Chiang Mai Agriculture office, 2008

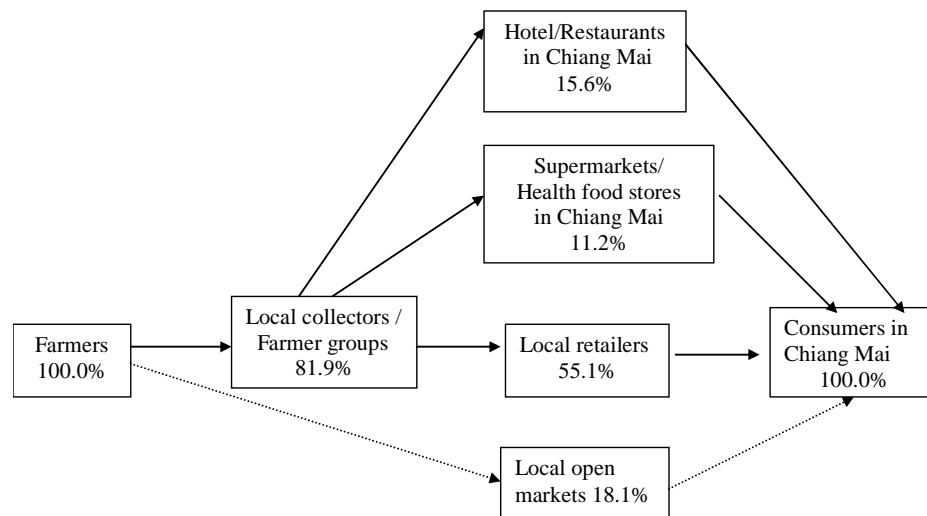
Note: One USD is equal to 34.35 Baht



Both safe use and chemical pesticide free vegetables have a similar system of marketing, because they were produced by Good Agricultural Practice (GAP) through grouping of farms which were also involved in joint marketing. As much as 94% of the chemical pesticide free vegetables were bought by local collectors and/or their farmer groups, of which 52% were sold at their Saturday market (Fig. 3). The Saturday market was established by a network of chemical pesticide free vegetable growers, and only farmer members were allowed to trade in this market. In other words, the local collectors and/or their farmer groups sold 55% of safe use vegetables to the local retailers, and 18% sold at the local open markets by farmers (Fig. 4). In fact, there was no formal marketing arrangement for both safe use and chemical pesticide free vegetables. Therefore, some farmers had no trading post, and they sold their vegetables within village and local open markets.



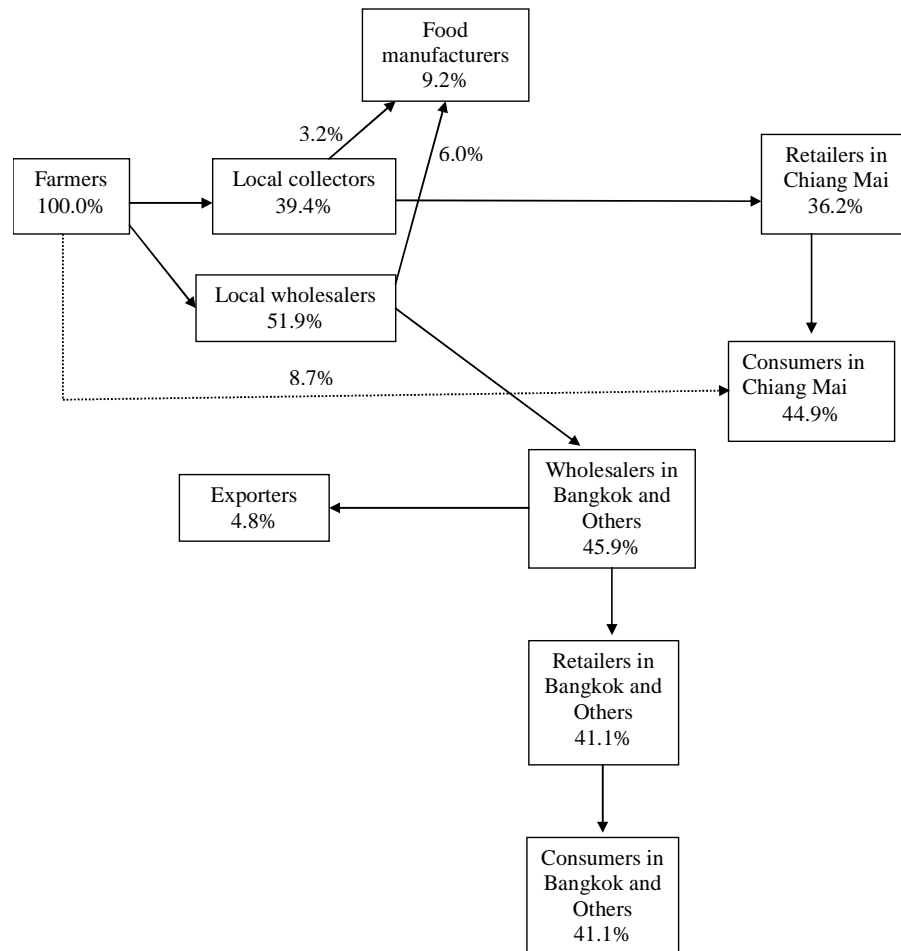
**Fig. 3.** Marketing channels of chemical pesticide free vegetables in Chiang Mai Province



**Fig. 4.** Marketing channels of safe use vegetables in Chiang Mai Province

The shelf space for alternative vegetables in supermarkets in Chiang Mai such as Carrefour and Rim Ping supermarkets had increased rapidly during the past few years, but the number of varieties of alternative vegetables available did not increase (Kramol et al., 2006). Due to the lack of marketing information on quantities and prices, which usually fluctuated all the time, alternative vegetable growers needed time to learn and get experience, and to increase efficiency in their business. This may be one type of entry barrier for the alternative vegetable growers in the supermarket. However, there were some advantages of selling in the supermarkets, including the stable number of consumers, exact payment time, and preservation of the freshness of vegetables in air-conditioned rooms.

Most of conventional vegetables were distributed through various middlemen: 52% by local wholesalers, and 39% by local collectors (**Fig. 5**). Prices were determined by demand and supply. In Muang Mai market of Chiang Mai, vegetable prices were determined by the negotiation between buyers and sellers, but level of prices depended on seasonality, quality of products and marketing costs. It became clear that nearly 46% of conventional vegetables were sold to wholesalers in Bangkok and other provinces by local wholesalers, while the remaining 54% were traded in Chiang Mai and the neighboring provinces.



**Fig. 5.** Marketing channels of conventional vegetables in Chiang Mai Province.

Currently, marketing system for alternative vegetables in Chiang Mai was in the early stage of the development process. The number of consumers was still small, while most of the consumers were in Bangkok and other big cities. Consumers were often confused by different brands when buying alternative vegetables. However, alternative vegetables appeared to have a good chance of marketing due to an increasing demand from supermarkets. For instance, Carrefour supermarket launched a healthy vegetables project under the name “organic vegetables” from the alternative vegetables growers in Chiang Mai to export to Singapore (Wibbonpongse and Sriboonchitta, 2004). In villages studied, there was a small number of alternative vegetable growers whose quality of vegetables met the supermarket requirement, but most of them were still inadequate. Therefore, the government should help them with marketing management and promote alternative vegetables for local people.

## **CONCLUSION**

Based on data obtained from the questionnaire survey of 142 farmers in Mae Rim District, Chiang Mai, this paper analyzed the major vegetables cultivated under different farming systems, and discussed production efficiency and profitability of organic farming in comparison with other production systems: chemical pesticide free, safe use and conventional farming systems. Kinds of vegetables grown depended on market demand and growing time. The common problems found in organic farming were inadequate seeds and labor, while conventional farmers faced the increased prices of synthetic chemical pesticides and fertilizers. The yield of organic vegetables was the lowest among all farming systems due to the lack of experience in organic vegetable production and inadequate knowledge of management, while the benefit-cost ratio of organic farms were greater than one, indicating that organic farming was also the profitable farming for small farmers.

Through the estimation of the production function of kale under different farming systems, this paper showed that labor was the most important factor for organic and chemical pesticide free farming systems, while production depended on farm size for safe use and conventional farming systems. These results raised important issues for the development of each vegetable farming system, as follows: 1) Improvement in the availability of high quality but reasonably priced seeds for organic farming; 2) Clear and easy demonstration of know-how and standard method for efficient management of the chemical pesticide free and safe use farming systems; and 3) the guaranteed farm gate price for conventional vegetables.

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***AGRICULTURE FOR THE 3s: Economy, Environment and Energy***

**ABSTRACTS OF PAPERS**

**PLENARY SESSION**

**EXAMINING ENERGY – ECONOMY – ENVIRONMENT LINKAGES TO SUPPORT  
RURAL DEVELOPMENT INTRODUCING ENVIRONMENTALLY FRIENDLY  
AGRO-INDUSTRIAL CLUSTER BASED ON LOCAL SPECIALTY**

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As the global climatic change is arisen, many are beginning to see that there is a unity of the single system of energy, environment, and economics. Many questions arose, what is the state of global climatic change and the country dependency on fossil fuels? What effort should the country do on conservation and renewable energy resources? What is the CER trading? Who will get the benefits? Do we need to make tradeoffs in balancing these values along with the imperatives of energy supply, economic growth, environmental sustainability? The answers to these questions require new tools of analysis and a model of energy-environment-economy linkages is a tool, may be useful for policy in formulating the development focused on sustainability.

This paper presents one possible framework for describing energy-economy-environment linkages to support rural development. The model will be based on some considerations: 1) all economic activity requires materials and energy drawn directly and indirectly from the environment and, these materials and energy are returned to the environment as waste materials, 2) the economy consists of the activities : as production, distribution and consumption undertaken by humans, and 3) there is a dependent relationship of sustainable development and the requirement of improving living standards of rural people. Having the target of improving standard of living of rural people without ignoring the linkages to the environment, then the idea of introducing environmentally friendly agro-industrial cluster based on local specialty may be one alternative to promote rural development in Indonesia.

The development of the agro-industrial cluster based on local specialty will attract a group of businesses concentrating on the same economic activity in one region, consolidating this social and productive network and strengthening it to develop a suitable economy of scale in the region which will adopt environmentally friendly technology in the production process both on-farm and off-farm. And further, re-grouping major local agribusiness/agro-industries, research institutions and all other support organizations will foster an efficient sharing of resources, information and know-how and at the same time maintaining the specificity of the region. Such a mechanism, through an integrated national effort, will impart a better competitive advantage to local entrepreneurs to access bigger market shares. The implication of such movement is for better rural growth and minimizing environmental impact.

## **SUSTAINABLE DEVELOPMENT FOR PADDY INDUSTRY IN MALAYSIA**

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Two of Malaysian major policy challenges are to feed its increasing population and to increase the income of farmers in order to eradicate poverty. This is in addition to the growing population, urbanization and higher living standards and the associated increase in demand for land exert great pressure on food production (Roetter and Van Keulen, 2007). These challenges are faced against the background of decreasing availability of natural resources for agriculture such as water and arable land, and declining labour availability, as a result of rapidly increasing competition from other sectors. Moreover, the policies aimed at conservation of environmentally vulnerable areas also decrease the availability of farmland resources.

As a result of the Green Revolution, Malaysia has increased the level of self-sufficiency in rice, but the associated use of fertilizers and biocides causes increasing public concern. The high inputs of fertilizers and biocides increase production costs, and cause serious environmental, occupational and public health problems, which all bear significant social costs. Loss of N and P from farmland is one of the major causes of eutrophication of rivers and pollution of groundwater. Another possible consequence of the intensive use of biocides is that pest organisms develop resistance to insecticides, reducing their efficiency in protecting crops. To stimulate paddy production, increase farmers' income and alleviate the adverse effects of agrochemicals on the environment and human health, the Malaysian government has implemented various policy measures in recent years. Priority has been given to agricultural research and price support to increase yields and mitigate the adverse effects on the environment and human health caused by the use of agrochemicals. Therefore, the effectiveness needs to be assessed of different crop and livestock production technologies in attaining rural development goals, i.e. increasing paddy production, increasing farmer's income and reducing negative environmental impact. The recent price increase in rice, which was mainly due to limited supply and energy crisis, were a reason for great concern for the Malaysian government. As self-sufficiency in rice is a long-term national policy objective of Malaysia, favourable policies, i.e. a tax reduction, direct subsidy on seed, subsidy on purchase and a minimum farm gate price for rice, were implemented in 2006 (DOA,2007). Another, equally important goal is to increase farmers' income. In addition to rice self-sufficiency, Malaysian policy also pays attention to protection of the environment through research on and extension of input-saving technologies such as improved nutrient management and integrated pest management. Therefore, the sustainable agriculture involved production methods of paddy that are healthy, do not harm the environment, respect workers, provide fair wages to farmers, and support farming communities. Sustainable agricultural practices can both feed people and protect the environment include the land that use to plant the paddy, source of water and other ecosystems that harbour biological divers, sustainable agriculture can be measured also in two main concepts that include economic and healthy environment .

However, in order to practice this sustainable agriculture in paddy production, there are some challenges that must be faced such as limitation of land, low yield, pest and disease, suitable variety of paddy, encourage the corporate sector to invest in sustainable agriculture, high cost of production and application of mechanization, automation and technology and low involvement of young generation in this sector. To achieve sustainability, the constraints that threaten it must be alleviated, and major efforts must be made in increasing productivity to meet immediate demands of growing global population. 10 Matrix Tone Paddy Production Project is one of the projects that has been established by the government in order to promote sustainable paddy production in Malaysia.

**PHILIPPINE AGRICULTURAL EDUCATION FOR THE 3E'S: ECONOMY,  
ENVIRONMENT AND ENERGY**

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After World War II concerted efforts have been exerted by countries in search for an approach to increase yield and boost agricultural production to end global hunger. One ground breaking approach is the development of genetically modified crops and high yielding varieties. A package of technology that includes improved seeds, fertilizers, pesticides and new-farm technologies which rely on heavily irrigated system was promoted especially to the so-called third world countries. This approach indeed has increased crop yield; however, environmentalists realized that it is not economically and environmentally sustainable. In the Philippines, agriculture is one sector of the national economy that is strategically important for the developing countries. It accounts for 20% or one-fifth of the gross national product (GNP) and supplies the major source of raw materials on which the whole economy of the country depends. It is also the second biggest contributor to employment with 37% of the country's labor force engaged in it. However, the phenomena that pose threats to agriculture itself and to the natural environment are the existing agricultural ill-practices and climate change. These phenomena must be addressed by responsive agricultural education. Agricultural education is a critical tool for social transformation wherein agricultural production must consider the context of sustainable development. Unfortunately however, there has been a progressive decline in enrollment in agricultural colleges and universities in the Philippines wherein the environment stewards- the agricultural educationists are dwindling in number. Its one hundred seventy (170) agricultural colleges and universities have been experiencing declining enrollment with young high school graduates going for business courses as number one choice and new interest in medical and allied courses especially nursing as second choice.

Another phenomenon that must be addressed by agricultural education is climate change, the country being at the receiving end of its effects like sea level rise, strong rains and typhoons of calamity proportion. Greater consciousness on climate change is pushing more countries to look for alternative fuel such that those that can be contributed by biofuel. The Philippines' carbon footprint is minimal but much is required to adapt to this phenomenon. Given these challenges, the paper shall then discuss the initiatives of Bicol University and other state colleges and universities in the Philippines to address the declining enrollment in agriculture, forestry and natural resources in order to sustain the vital manpower resource for agriculture as well as to redirect agricultural education interest toward agribusiness and sustainable development.



**DIVERSIFICATION AND VALUE CREATION OF AGRICULTURE IN THAILAND  
SUGARCANE: A CASE STUDY 3ES**

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Thailand is a major exporter of agricultural commodities like rice and sugar. Thailand's agriculture based economy with an area of 21 million hectares contributing to the GDP and generating employment to majority of the population (approx. 5.8 Million households; OAE 2006). Through government policies and investment in research and development there has been a major emphasis on the increased productivity and value creation in major crops in Thailand. Though increased use of farm chemicals are consequences for increased agricultural growth, steps to move towards use of bio control agents, IPM and mechanization to reduce the use of chemicals have made the agriculture sustainable and environment friendly.

The depletion of fossil fuel and the rising cost of imported fuel necessitated the utilization of alternative sources of energy with agricultural based bio- energy as the ideal choice. Thailand has been the major player in this sector. Though the controversy of food crops against the energy crops came into light, sugarcane, cassava and oil palm and sugar industry is a fore runner in meeting the demands of the 3Es economy, environment and energy. Sugar cane and sugar industry has seen a great growth through a number factors *viz.*, technological advances and diversification in situ.

Thai sugar industry (46 sugar mills) with core business is sugar, where capacity expansion to high productions, improvement in cane area and cane productivity was brought about by initiation of research and development for "sustenance" and "development"

Diversification of core business of sugar into various by products has paid dividends to the Thai economy. With major players like Mitr Phol group where the diversification has been into particle boards (utilization of fiber, bagasse) which can replace wood for furniture, cogeneration (the use of bagasse or fiber to generate electricity) supplying electricity to the government, and ethanol (using molasses through fermentation). The ethanol is the green energy for a clean world. The environmental impacts are clearly seen in the particle board and ethanol plants by reducing felling of trees and reduced carbon dioxide and green house gases. The future contribution of sugarcane to the economy of the country is envisaged through value creation by diversification into functional foods and nutritional food.

*In a nut shell, sugarcane plays an important role in Thailand agriculture in sustenance and development of the economy through sugar and bio-energy in a safer environment.*

**EFFECT OF ENVIRONMENTAL FACTORS ON BIOLOGICAL CHARACTERS AND  
GRAIN QUALITY OF VIETNAMESE FOXTAIL MILLET (*SETARIA ITALICA* L.)**

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Foxtail millet (CM), a plant with high nutrient and higher heavy metal content in grain, is suitable under drought conditions. Using millet grain to produce food nutrient for human is necessary. In this study, we collected foxtail millet germplasm and selected variety with high grain yield and grain quality in each ecological region as well as build up cultivation technique in Vietnam. Total of 11 varieties of foxtail millet collected in Vietnam were described and distinguished their botanical characters. Among them, 4 varieties (CM1, CM9, CM10 and CM11) were selected to estimate the correlations among photosynthetic rate, stomatal conductance, transpiration rate and dry matter accumulation under irrigated, drought and recovering condition in a pot experiment.

A field experiment was conducted to estimate the affection of three ecological regions such as Gialam (Red River Delta with at altitude of 5 – 20 meters), Bacha (Northern mountainous region with at altitude of 600 - 1000 meters) and Sapa (Northern mountainous region with at altitude of 1500 – 1800 meters) on several agronomic characters *viz.*, growth duration, dry matter accumulation, grain yield and grain quality in four varieties. The average growth duration of all millet varieties were longer in Sapa (136 days) than in Bacha (130 days) and Gialam (108 days). The average grain yield of all millet varieties was the highest in Sapa (2.7 ton ha<sup>-1</sup>) than in Bacha (2.0 ton ha<sup>-1</sup>) and Gialam (1.1 ton ha<sup>-1</sup>), contributed to both the larger number of spikelets per panicle and the higher 1000-grain weight. The highest grain yield was observed in CM1 in Gialam, whereas it was found in CM9 in Bacha and Sapa. This was due the different varietal response to temperature, water supply and/or radiation. It was found that ecological regions affected protein, lipid and amylose content in millet grain.

Another field experiment was conducted to study the effect of nitrogen (N) fertilizer on grain yield and grain quality of two foxtail millet varieties (CM1 and CM9) in Gialam. As application four levels of N fertilizer (0, 30, 45 and 60 kgN per ha), grain yield was the highest in CM1 at 60 kgN level (2.78 ton per ha), but highest in CM9 at 45N level (3.02 ton per ha). This was due to the higher chlorophyll content at vegetative growth stage and dry matter accumulation at heading stage. However, at high N fertilizer the grain quality decreased.

Further technology would be studied on using millet grain for commercial food nutrient product.

## SCIENTIFIC SESSIONS

### PERFORMANCE OF THE DIFFERENT VARIETIES OF CUCUMBER (*CUCUMIS SATIVUS*) USING KAKAWATE LEAVES AS MULCHING MATERIAL

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Cucumber is known for its edible fruits because it is delicious, crispy, high in nutrients, low in calories and excellent source of fiber needed for a healthy digestive system. Since this is a warm temperature vine vegetable, it is then imperative to produce carefully the crop in order to maintain better quality for maximum production. This could be possibly achieved by using kakawate leaves as mulching material because of the multiple benefits derived from it. Evidently, it could be utilized as botanical pesticides, as green manure, notwithstanding its regular usage as firewood and could be used as post due to its durability. The study was conducted from September to December 2007 in Naglaao-an, Sto. Domingo, Ilocos Sur, Philippines. It aimed to compare the response of the different varieties of cucumber using kakawate as mulching material and to determine the yield performance of promising varieties of cucumber. The variety trials were laid out in a Randomly Complete Block Design (RCBD) with four replications as follows: *Variety 1–Ilocos White*, *Variety 2–Batangas White*, *Variety 3–Poinsett 76* and *Variety 4–Governor (Hybrid)*. Based on the four varieties of cucumber harvested, there were no significant differences on the yield. *Governor (hybrid)* yielded the best result with a total harvest of 36,195.23 kg/ha, followed by *Batangas white* and *Poinsett 76* with total harvests of 32,680.95 and 18,428.58 kg/ha respectively. *Ilocos white* had the lowest yield, 16,390.17kg/ha. Yield differences were attributed to varietal differences and potentials.

### PHENOLOGY AND YIELD OF FENNEL (*FOENICULUM VULGARE* L.) AT DIFFERENT PLANTING PATTERNS

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Fennel (*Foeniculum vulgare* L.) is a plant from Apiaceae family, and its essential oil is used for soothing, cleansing and toning effects on the skin, while at the same time improving circulation and fighting water retention and puffiness. Effects of different planting patterns on phenology and yield of fennel was evaluated at Islamic Azad University of Tabriz, Iran, in 2007. Studied factors were row spacing (80, 90, 100 cm) and intra-row spacing (5, 10, 15, 20 cm). The treatments were arranged factorially based on randomized complete block design in three replications. Seed essence was extracted by steam water distillation method. Data were analyzed by MSTAT-C software and means were compared with Duncan's multiple range test. Results revealed that plant phenology were delayed, when density increased, and time to 50% flowering stage and harvesting time in planting pattern of 80\*5 cm were happened 5 and 11 days later than 100\*20 cm, respectively. Number of umbrellas per plant was influenced by plant spacings, and was greater in 90 cm row spacing treatments. Thousand seed weight increased in spaced treatments, that was expected. Seed yield of fennel ranged from 989 kg ha<sup>-1</sup> to 849 kg ha<sup>-1</sup> (14% reduction), which was related to higher side branches per plant of fennel, with increasing of intra-row spacing. Essence yield of fennel reduced 33% in 100\*5 cm compared with 90\*20 cm planting pattern. It is recommended for fennel growers in region with planting pattern of 90\*20 cm they will obtain higher grain and essence yield.

## **RESPONSE OF RICE YIELD TO CONTROLLED RELEASE UREA**

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High nitrogen (N) loss is one of the key problems faced by rice farmers. Nitrogen use efficiency in rice is often low due to high N loss through volatilization, leaching and denitrification. One of the approaches to improve N efficiency is by using Controlled Release Urea (CRU). The CRU generally out-performed the granular urea fertilizer in reducing N losses, stimulating plant growth, releases nutrients during the entire growing-season, increases N concentrations and yield. The performance of different types of CRU was therefore compared with granular urea in a field experiment with rice variety MR220. This study compared the effect of six different types of CRU fertilizers on rice yield with urea (control). Bakau series (Typic Tropaquept) was used in this study. Rice plants were grown in cylindrical culverts measuring 90 cm in diameter x 60 cm in height. The soil was filled up to 40 cm height and 20 cm space from the top of the culvert was to hold water. Flow regulators were attached to the culvert for adjusting required water level. The soil was flooded and pre-incubated for three weeks to stabilize their physio-chemical properties before sowing. The experiment was conducted using a completely randomized design (CRD) and replicated three times. Six different types of CRU evaluated for two planting seasons on the same plot. Fertilizer was applied once throughout the study. For both seasons, CRU treated plants had a significantly higher rice yield, 6 t/ha and 6.2 t/ha, than urea-treated plants 3.7 t/ha and 2.2 t/ha, for first and second planting harvest, respectively. It can be inferred that CRU performs significantly better than granular urea. This is important, considering the usually high N losses in rice growing area. From this study, Meister-20, Meister-27, CDU Uber-10 and CRU Duration Type-V can be used as single application for 2 seasons in rice planting. There is a prospect of using CRU to increase rice yield and N efficiency and can be used for two season planting with single application of CRU fertilizers.

## **EFFECTS OF ETHYLENE STIMULATION ON RUBBER BIOSYNTHESIS GENES EXPRESSION IN *HEVEA BRASILIENSIS* LATICIFERS**

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Ethrel<sup>®</sup>, an ethylene releaser, is widely used in rubber estates to enhance latex yield production. However, stimulation induces a decrease in the latex dry rubber content (DRC). Our research focused on how ethylene might affect the expression of the genes involved in the rubber biosynthesis pathways. Kinetic effects of ethylene on untapped and 4 months-tapped trees of the PB217 rubber clone were studied, using 1/2S d2. Seven batches of 3 trees were set up: two batches for control (no stimulation) and 5 batches with 5% Ethrel<sup>®</sup> treated for 4, 8, 16, 24 and 40 hours before the first tapping. The second tapping was performed 2 days later. The same experiment was performed on the same trees 4 months later. Latex total RNA were extracted and the cDNA were synthesized. Randomized Complete Block Design with 3 replications was set up for gene expression analysis by real time RT-PCR. Results showed that the genes involved in the isoprene unit synthesis through the mevalonate rubber biosynthesis pathway, were markedly down-regulated by ethylene from both the 1<sup>st</sup> and 2<sup>nd</sup> tapping of virgin and tapped trees. Only HMGR3 was up-regulated. The genes involved in

polymerization of isoprene units into rubber molecules showed down-regulation by ethylene. In addition, the genes involved in isoprene unit synthesis through the DXP/MEP isoprenoids pathway such as DXPS and DXPR were also down-regulated by ethylene in both the 1<sup>st</sup> and 2<sup>nd</sup> tapping of virgin and tapped trees. Conversely, the invertase gene encoding the enzyme involved in the entry of glycolysis, which produces the carbon skeleton for the whole cell anabolism and rubber biosynthesis, was up-regulated by ethylene in both virgin and tapped trees. Ethylene stimulation might favor the whole latex cell cytoplasm regeneration through increase in primary metabolism, at the expense of rubber synthesis.

#### **EFFICIENT AMPLIFICATION OF HEAVY AND LIGHT CHAIN VARIABLE REGIONS FOR THE CONSTRUCTION OF NON-IMMUNE PHAGE SCFV LIBRARY**

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The system of non-immune phage scFv library is one of the most attractive technologies currently available for therapeutics, diagnostics and basic scientific research. It offers rapid isolation of the antibodies of interest that could be applied directly to drug delivery systems, antibody therapy and disease diagnostics. However, the success in construction of this library has limitation due to the inefficient cloning of antibody genes from non-immune donors. One problem is caused by inability to design RT-PCR primer sets to cover all of the antibody diversity. In order to overcome this problem, we described two-step amplification of VH and VL by PCR method. First, we generated total cDNA by using Oligo dT primer, then VH and VL genes were amplified from the signal sequence to joining region. Second, the VH and VL products from the first step were amplified by using degenerate primer sets which could amplify the VH and VL genes from framework region 1 (FWR1) to joining region (J). Finally the scFvs were obtained from PCR overlapping extension method. Fifteen transformants were submitted to sequencing and the diversity of full-length scFv sequences belonged to 36-60.2pg51, 61-1P, 7183.9, D6.96 and J558.32, J558.81.87, J558.32 of heavy chain families and Vκ 4-57, 19-13, 19-15, 19-17, 19-32, 21-12, at4 and kk4 of light chain families were obtained. Colony hybridization assay showed that eighty percents could be expressed which confirmed the efficiency of this strategy and primer sets for construction and expression of antibody library.

#### **MODELING OF *PSEUDOMONAS* SP. GROWTH IN COOKED DICED CHICKEN MEAT FROM POULTRY INDUSTRY**

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Ready to eat chicken is easily to spoil when it was stored under unsuitable temperature. A specific model for assessing shelf-life of cooked chicken meat at difference temperature could be useful decision-making tool. Experiments were conducted to validate a predictive model for describing the growth of spoilage microorganism in ready to eat chicken. The cooked diced chicken meat samples from poultry industry were used in the study. *Pseudomonas* sp. was determined to be

specific spoilage microorganism (SSO) of cooked diced chicken meat. Growth rate measurements of isolated *Pseudomonas* sp. on cooked chicken meat at 9 temperatures ranging from 5 to 25 °C were collected to compare to *Pseudomonas* spp. growth rate at difference temperatures extracted from published data. Initial concentration of *Pseudomonas* sp. used was 3 Log CFU/g. The square-root or Ratkowsky equation was used to model the data. The accuracy and bias factors between the growth rates on cooked diced chicken meat and the model relating published *Pseudomonas* spp. growth rates and temperature were 1.097 and 0.91, respectively. The validation parameters showed close agreement between the model and observation. However, the bias factor indicated model under-predicts growth rate. Plots of observation vs. predictions revealed the higher experimental growth rate of *Pseudomonas* sp. on cooked diced chicken meat, as points above the equivalence line. The residual plot for predictions vs. observations had almost positive residuals. Therefore, when the predictive model will be used to predict shelf- life of cooked diced chicken meat, other factors beside temperature should be taken into account.

### EXPRESSION OF RECOMBINANT COAT PROTEIN (CP) OF *CITRUS TRISTEZA VIRUS*

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*Citrus tristeza virus* (CTV) is one of the major threats for the production of citrus worldwide. Polyclonal antibodies either produced from the recombinant coat protein (CP) of CTV or purified viral particles from infected midrib used for the detection of virus. In comparison, the purified virion was a laborious procedure and with contamination from plant proteins, when use of recombinant CP antigen resulted in highly specific polyclonal antibodies without cross reaction with plant protein. A CTV *cp* gene clone contained 666bp long from Thailand MSh-141 isolate collection was used for expression of recombinant protein. A forward primer CTV-CP1 and reverse primer CTV-CP2 was designed to amplify and clone and express the *cp* gene into pET160/GW/D-TOPO vector and transformed to  $\alpha$ DH5 *E. coli* competent cell. Two clones harboring the correct orientation insertion were selected for transformation into BLD21 star (DE3) expression *E. coli* cell and their recombinant protein expressions capacity and optimum length of time were studied after inducing with 1mM IPTG. The optimum time for recombinant protein production was investigated. The large scale production of recombinant CP and produced protein was purified using Ni-NTA resin. Result on sequence analysis of extracted plasmid used for mass protein was similar to MSh-141 isolate. Moreover the expression of recombinant CP was very high for the cloned CP with pET160/GW/D-TOPO vector expressed in BLD21 star (DE3) *E. coli* cell compared with the initial clone induced. Inducing protein for 4 hour after addition of 1mM IPTG gave optimum amount of recombinant protein expression with molecular weight approximately 25 kDa which is similar to previous research works. The purified protein from this experiment will be used to immunize rabbit or chicken for production of polyclonal antibodies for detection of CTV using ELISA or immunochromatography.

### FINITE ELEMENT MODELING OF STAINLESS STEEL FIN PLATE FOR MICROWAVE-VACUUM DRYING OVEN

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The objective of this research was to study, design and determine the stainless steel fin plate that is used to support the microwave domestic oven structure to apply for microwave-vacuum drying

chamber in laboratory level by using finite element method (FEM). A detailed three-dimensional finite element model has been created using the Solidwork software and simulated using the COSMOS software. The fin plate size base on the best simulated result has been selected for testing in the strength experiment. Then, the simulated result was compared with the experimental result. The compared results showed a good agreement between both methods. From analysis results, the stainless fin plate size 254x330x3 mm is the best size to apply for microwave-vacuum drying chamber in laboratory level.

#### **ACHIEVEMENTS IN COST REDUCTION AND EFFICIENT OPERATION OF THE THAI SUGARCANE SUPPLY CHAIN VIA OPTIMIZATION MODELING**

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More effective cost reduction and efficiency improvement in sugarcane harvesting and transportation are needed to maintain current status of the Thai sugar industry in a competitive international market. A mechanized resources allocation plan provides one such opportunity. This study found that the allocation of mechanical harvesters and trucks to reduce the cost in sugarcane harvest influenced the profit distribution among the three groups involved: sugarcane farmers, the owners of the trucks and mechanical harvesters, and sugar factories. These groups usually do not have common interests. A mechanized resources allocation plan should be considered together with acceptance of the plan gained from the engaged groups. Therefore, multi-objective optimization (MOO) was applied in this study to find a compromise solution. The parameters used in the MOO model were evaluated by using a simple sugarcane harvesting and transportation simulation derived from the field study in Udon Thani province, northeastern Thailand. An area of 10 km by 10 km, covering 248 sugarcane fields, was used in our computational experiment. The compromise solution obtained from MOO was more acceptable than the solutions obtained from single-objective optimization. The main factors influencing cost were the distance to a sugar factory, field size, and their interaction. In addition, cost reduction and efficient operation in mechanical harvesting and transportation were achieved. The percentage of reduction in operating cost was 4 to 9% while the percentage of decrease in the number of working days per unit area was 4 to 43%.

#### **PRODUCTIVITY AND EFFICIENCY OF SUGARCANE PRODUCTION IN NORTHERN THAILAND**

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Sugarcane, one of Thai major export crops has recently received great attention as an important bio-energy. Since demand for cane increases so as to meet sugar and ethanol demand, the rise in total production of cane is expected from higher productivity rather than expansion of cultivated land. This paper aims at investigating yield of sugarcane in response to fertilizer, technical efficiency and factors determining efficiency levels. Production data of crop year 2004/05 were collected from interviewing 98 sugarcane growers in Sukhothai Province, the major cane producing area of Northern Thailand. The yield of cane was nonlinearly responsive to nitrogen (N), and

phosphorus (P). The average efficiency at 87% indicates substantial room for efficiency improvement. Whilst production size caused diseconomy and thus reduced efficiency, use of farm machinery, education and experience levels boosted efficiency significantly.

### EFFECTS OF IRRIGATION INTERVALS, NITROGEN RATE AND SPLITTING ON ESSENCE YIELD OF GERMAN CHAMOMILE (*MATRICARIA CHAMOMILLA* L.)

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German chamomile (*Matricaria chamomilla*), is a very important medicinal plant. In order to study the effect of irrigation intervals and nitrogen on the yield and essential oil content of German chamomile, split plot factorial experiments were established in the university of Tabriz, Iran. Treatments were irrigation intervals ( $I_1=6$ ;  $I_2=12$ ,  $I_3=18$  days), nitrogen rate ( $N_1=23$ ;  $N_2=46$ ,  $N_3=70$  kg ha<sup>-1</sup>) and nitrogen splitting ( $T_1=100\%$  at planting time;  $T_2=50\%:50\%$  at planting and stem elongation stages,  $T_3=25\%:50\%:25\%$  at planting, stem elongation and early flowering stages, respectively). The highest heads per plant observed in  $I_2T_2$ , but reduced 53%, when irrigation intervals increased up to 18 days and total amount of nitrogen was applied at planting or at planting (25%), stem elongation (50%) and early flowering (25%) stages. Equally application of nitrogen at planting and stem elongation stages increased dry flower yield up to 351 kg ha<sup>-1</sup>. Flower essence increasing value in  $I_2N_2$  was calculated 75%, in comparison with three limited irrigation treatments. Essence yield ranged from 1.56 l ha<sup>-1</sup> up to 3.63 l ha<sup>-1</sup>. Addition of nitrogen from 23 to 46 kg ha<sup>-1</sup> increased essential oil yield from 2.3 to 2.9 l ha<sup>-1</sup>. Nitrogen splitting had significant effect on essence yield. Irrigation interval of 12 days and equally application of 46 kg nitrogen/ha at planting and stem elongation stages of German chamomile would insure higher essential oil yield.

### PERFORMANCE OF SIX CHICKPEA ACCESSIONS UNDER BENGUET AND MT PROVINCE CONDITION

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Chickpea (*Cicer arietinum* L.) is a new introduced crop in the Cordillera and has one of the highest nutritional compositions of any edible legume. The study sought to introduce, evaluate yield performance of chickpea accessions in Benguet and Mt. Province condition. These six accessions had been evaluated in nine sites under different elevations (720 to 1,525 meters) above sea level. The percentage pod setting ranged from 54-57%. Kabuli type had 54% pod setting while desi type had 57% pod setting. Occurrence of fog with long cloudy condition and very close planting distance tend to lower pod setting and average seed yield/plant. Kabuli type varieties had higher seed yield than desi type varieties because of its bigger seed size. Total seed yield showed that desi type varieties had lower yield with 800 to 900 kg/ha than kabuli type with 1,000 to 1,200 kg/ha. Cutworm (*Agrotis ipsilon*) had 20% infestation during the vegetative stage while pod borer (*Helicoverpa armigera*) had 30% infestation during the pod development and at harvest. Chickpea stunt caused by virus had 10% infection, while collar rot (*Sclerotium rolfsii*) and Sclerotinia stem rot (*Sclerotium sclerotiorum*) showed 5% infection during the vegetative and early reproductive growth stage. Chickpea was found to be adaptable under Benguet and Mt Province conditions.



## ECONOMY PARTICIPATORY EVALUATION OF SWEETPOTATO FOR WINE AND JUICE PROCESSING IN THE CORDILLERA

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Sweetpotato is a plant with diverse features, such as: its skin and flesh color vary from white, cream, yellow, orange, red, purple, dark pigmentation with anthocyanins. Sweetpotato was described based on these characters to come up with a good quality processing type cultivar for wine and juice making. This study was done to collect sweetpotato cultivars in sweetpotato growing areas of the Cordillera, characterize, evaluate yield and select the cultivar suitable for wine and juice processing. This has been conducted in Sagada, Mt. Province; Banaue, Ifugao and La Trinidad, Benguet. Forty-seven (47) sweetpotato cultivars were collected and evaluated. The collections from Mt. Province cv. *Ayotan* had the highest yield of 13.85 tons/ha. In order to add more varied colors, cvs. *Bengueta*, *JK 27*, *JK 2001*, and *Tinipay* were included because of their dark-orange, yellow flesh colors, a carotene-rich source, and are high yielding cultivars. These cultivars were selected for wine and juice processing and found acceptable. However, cv. *Haponita* had the highest acceptability ratings for wine and juice making. The acceptability rating was influenced by the color, appearance, taste and flavor. Sweetpotato wine had higher ROI as compared to sweetpotato flavored juice. Sweetpotato juice had an ROI of 4.49% - 7.60%, while 29.45% to 51.28% for sweetpotato wines. The alcohol and sugar content of wines evaluated ranged from 7.04 - 9.36% and 15.3 to 17.0 brix<sup>0</sup>, respectively. These wines were found acceptable by the consumers.

## CHANGES IN THE PHYSICO-CHEMICAL PROPERTIES AND ASSIMILATE PRODUCTION OF DEVELOPING YOUNG *ZINGIBER OFFICINALE* RHIZOME INTRODUCED TO SOILLESS CULTURE

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Recent study to exploit an alternative method for year round and sustainable production of young or green *Zingiber officinale* had adopted the soilless-fertigation culture under controlled environment system. Initial finding had shown enhanced early growth at 14 week after planting, increased fresh rhizome weight at 47~87%, abundant, good quality sized rhizomes and possibility of year-round production. The finding on the quality of rhizome was, however, not conclusive and hence requires immediate attention. Rhizome quality having high content of flavonoids, is an important determinant of the final use and the economics of rhizome. Quality rhizome is also measured as having good physico-chemical such as fiber-free rhizome as in high quality young or green *Z. officinale*, a designated choice grade that fetches a premium price. Rhizome growth and quality are, however, easily influenced by growing micro-environment especially moisture. However, information bridging the micro-environmental factors with physico-chemical qualities, assimilate production and flavonoid contents, especially in soilless culture of *Z. officinale*, are still lacking for proliferation of commercial value and interest. The paper discusses the changes in the quality of developing young *Zingiber officinale* rhizome in terms of the physico-chemical properties and assimilates production, when introduced to soilless-fertigation culture. The finding serves as basic information for continued study to establish precise cultivation technique for sustainable production of quality young *Z. officinale* production under soilless-fertigation culture in the tropical lowlands, particularly for anticancer activity.

**WILL ELECTRIC FIELD ENHANCE GERMINATION RATES AND SEEDLINGS GROWTH OF SOYBEAN (*GLYCINE MAX* L.), RADISH (*RAPHANUS SATIVUS* L.) AND PAPAYA (*CARICA PAPAYA* L.)?**

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Electromagnetic field (EMF), a non-ionizing radiation exists in abundant in the vicinity of high voltage power lines, which covers a large area of the agricultural land. The study on the effects of EMF on biological system has been rare in Malaysia. Therefore, the study on high voltage effect on seed germination would provide new and important knowledge to the agricultural industry. The effect of high electric field as a seed treatment on soybean, radish and papaya was simulated at the High Voltage Lab, Universiti Teknologi Malaysia. The high electric field strength used in the study was 0, 10, 20, 40, 60, 80, 100 and 120 kVm<sup>-1</sup>. The results on germinating soybean seeds showed increased germination rates at 10, 60 and 100 kV/m, while increased germination rates for radish and papaya were obtained from the treatments at 100 and 60 kVm<sup>-1</sup>, respectively. High electric field (60 kVm<sup>-1</sup>) treatment on germinating seeds also resulted in increased seedling growth of soybean, radish and papaya.

**EFFECT OF PIG MANURE EXTRACT AS FOLIAR APPLICATION ON PLANT GROWTH, CHLOROPHYLL CONTENTS, LEAF EXPANSION AND YIELD OF CASSAVA (*MANIHOT ESCULENTA* CRANZ) CV. HAUYBONG 60**

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Pig manure is a problematic farm waste but containing all nutrients required by plants. This study sought to utilize pig manure extract (PME) as source of nutrient for cassava production. The plants were subjected for five treatments as follows; 1. No fertilizer, 2. Chemical fertilizer 21-10-10 at 40 kg/rai applied at 45 days after planting, 3. Foliar application of PME, 4. Soil application of PME, and 5. Foliar and soil application of PME. PME as foliar or soil application was done every month from 45 until 245 days after planting and harvested after 10 months. The plants with foliar and soil application of PME had the highest yield of 12.73 ton/rai. Chlorophyll contents in all fertilizer applications decreased in the first 4 months, increased until 6 months and decreased again at 8 months after planting. There were significant differences in chlorophyll a, chlorophyll b and total chlorophyll content at 4 months after planting where foliar and soil application of PME showed the highest chlorophyll contents. Leaf expansion (LAI) gradually increased from 3 to 6 months after planting but was reduced after 6 months due to the reduction of leaf canopy except those on chemical fertilizer application. There were no significant difference in plant height and stem diameter of the plants. Soil and foliar applications of PME provided higher starch content of roots. The difference in soil strength was 39%. The higher yield always found in the low soil strength plots. The application of PME as a soil and foliar fertilizer could provide higher roots yield than chemical fertilizer application.

**EFFECT OF TEMPERATURE ON MASS DIFFUSIVITIES IN DRAGON FRUIT  
(*Hylocereus undatus*)**

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Mass diffusion of water and solids during osmotic dehydration of dragon fruit flesh was studied. Dragon fruits with commercial maturity that had average total soluble solids to titratable acidity ratio equal to 46.65 were used in the experiment. Dragon fruit flesh were cut into a rectangular shape with a dimension of 5×5×1 cm, then osmotically dehydrated in the solution of sucrose, sodium chloride, calcium chloride, potassium sorbate, and potassium metabisulphite in the amount of 55, 2, 0.15, 0.25, and 0.25 grams, respectively in 100 grams of water for 5 hours at the temperature of 30, 40 and 50°C. It was found that the moisture contents of dragon fruit flesh decreased rapidly at the first 30 minutes and slowly decreased when the time increased. The solution temperature significantly had an effect on the moisture content ( $p < 0.05$ ). Water diffusivity increased with increased temperature and had a value of  $6.45 \times 10^{-10} \pm 0.48 \times 10^{-10}$ ,  $7.17 \times 10^{-10} \pm 0.32 \times 10^{-10}$  and  $10.02 \times 10^{-10} \pm 1.88 \times 10^{-10}$  m<sup>2</sup>/s for 30, 40 and 50°C respectively. Arrhenius model could be used to describe the effect of temperature on the diffusivities. The results showed that the temperature of the osmotic solution significantly increased solids gain percentage, and water loss percentage ( $p < 0.05$ ).

**EFFECT OF FOLIAR APPLICATION OF SUGARS AND PLANT GROWTH  
REGULATORS ON FLOWER QUALITY OF JASMINE (*JASMINUM SAMBAC* AIT) IN  
COOL SEASON**

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Flower carbohydrate contents had effects on flower quality of jasmine. NAA and GA<sub>3</sub> can promote elongation of plant organ. The objective of this study was to determine the concentration of glucose fructose and sucrose on flower quality and additive effect of NAA and GA<sub>3</sub> on enhancement jasmine flower size. The experiment was divided into two parts. In part I, the concentration of sugars on flower quality were examined. One percent aqueous solution of glucose, fructose and sucrose and the mixture of glucose and fructose at 0.5% each were sprayed to the jasmine trees when the flower was 2 mm. during cool period in November. The result showed that foliar spray of sugars increased flower width and length when harvested at fully mature unopened stage. However, flower weight and petal length of the treated plants were not improved by such treatment. In part II, aqueous solution of 1% sucrose and 1% fructose, mixture of 1% sucrose and 0.1 ppm NAA, 1% sucrose and 0.1% ppm GA<sub>3</sub>, 1% fructose and 0.1 ppm NAA, 1% fructose and 0.1% ppm GA<sub>3</sub> were sprayed to jasmine trees for 3 days intervals within 3 weeks when the flowers had the same stage as in part I. In the 1<sup>st</sup> week after the last application (WALA), sugars and plant growth regulator applications increased the quality of flowers especially increased flower fresh weight, flower width, petal length when compared to the untreated plants. The mixture of sugars and NAA or GA<sub>3</sub> gave better results than spraying each sugar alone. In the 2<sup>nd</sup> WALA, sugar and plant growth regulator applications increased only flower width. In the 3<sup>rd</sup> WALA, there was no difference between chemical treated plants and untreated plants. The results indicated that additive effects of plant growth regulators and sugars could improve flower quality of jasmine better than only sugar application.

## EFFECT OF CHEMICAL SUBSTANCES ON INDUCING BUD BRAKE AND IMPROVE FLOWER QUALITY OF JASMINE (*JASMINUM SAMBAC* AIT) IN COOL SEASON.

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The main problem during growing jasmine (*Jasminum sambac* Ait) is inhibition of growth during cool season, which a few blooming and decreasing in flowers size. This problem affected diminishment of yield and caused high price during this season. The purpose of this experiment was to control flower bud dormancy using different types of dormancy regulating chemicals (DRCs) and study the role of sorbitol and gibberellic acid (GA<sub>3</sub>) on improvement flower quality in cool season. The effect of potassium chlorate (KClO<sub>3</sub>), thiourea and potassium nitrate (KNO<sub>3</sub>) on hastening flower bud break were studied. Foliar application of 1% thiourea, 2.5% KNO<sub>3</sub>, and 2000 ppm KClO<sub>3</sub> when the flower was 2 mm. during cool period in November were more effective in inducing flowering than untreated plants. Although thiourea could induce 100 % flowering but it gave the lowest flower weight, flower length, flower width and petal length. The effects of sorbitol and GA<sub>3</sub> on improvement flower quality were also studied. Before treatment, thiourea was sprayed to induce abundant flower in cool season. When flower reached 2 mm. in length, 0.25 % and 0.50 % sorbitol and 0.1, 0.5 and 1.0 ppm GA<sub>3</sub> were sprayed to jasmine tree for 3 days intervals in 4 times. Factorial in completely randomized design was used in this experiment. Interaction of sorbitol and GA<sub>3</sub> was not found in this experiment. However, sorbitol alone increased flower length and flower width and GA<sub>3</sub> alone increased flower length, increased petal length and flower width. In the cool season, DRCs particularly thiourea may be used to regulate flower bud break, after flower buds reach 2 mm., spray of sorbitol and sugar increase flower size. This method can overcome the problem of reduced flowering and flower quality of jasmine in cool season.

## EFFECT OF SELENIUM AND IODINE ON GROWTH PERFORMANCE AND SOME CARCASS CHARACTERISTICS OF MEAT GOATS

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Trace elements are minerals that in small quantities are essential for the normal health and function of humans and animals. Iodine is important in the synthesis of thyroid hormone that plays an important role in regulating growth. Selenium is important as an antioxidant and promotes health and immune status of animals. This study sought to determine the effect of supplementation of iodine and selenium at levels higher than the NRC requirement for growing goats on their growth performance and carcass characteristics. Twenty four male local crossbreed goat, 6-9 months of age and placed in individual pens, were randomly assigned to four dietary treatments namely, Treat C, control (60% guinea grass, 40% concentrate), Treat 2 (control + 0.6 mg/kg DM selenium), Treat 3 (control + 0.6 mg iodine) and Diet 4 (0.6 mg selenium and 0.6 mg iodine/kg DM), respectively. The concentrate contained 43% palm kernel cake, 30% rice bran, 25% corn, 1% CaCO<sub>3</sub>, 0.5% NaCl, 0.5% mineral-vitamins mix. At the end of the 100 day feeding trial, there were no significant differences in final weights among the treatments. However, the live-weights of goats fed Treat 3 (26.3 kg) and Treat 4 (26.7 kg) appeared to be higher than those of the control (25.7 kg) and Treat (25.7 kg). There were no

significant differences in the dressing percentages and hot carcass weights. The iodine supplementation, and iodine in combination with selenium may have a positive effect on the growth performance of meat goats.

### **PRELIMINARY STUDY OF PARTICLE BOARD PRODUCTION FROM RICE HUSK USING ALKALI PULPING PROCESS**

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Rice husk is an abundant waste material from agriculture in Thailand and utilization will be beneficial to both economy and environment. As a lignocellulosic material, rice husk should be able to be treated by alkali pulping process to produce rice husk pulp which can be used to form sheets. This research is intended to be preliminary study of using rice husk for particle board production. Rice husk pulp was produced by boiling rice husk with sodium hydroxide for 4 hours. The ratio of NaOH to rice husk is 1:10 dry weight. Rice husk pulp samples were refined with kitchen blender for 2, 5 and 7 minutes. The samples were spread on screen to form a sheet of about 3 mm. thickness to dry under sunlight for 5 days. The 7 minute sample was selected because of its most suitable appearances to form sheet. The sheet was cut, two sheets were pressed together using metallic pres and heated to 140, 160, 180, 200 and 220°C an electric oven for 3 hours. The strongest particle board was formed from heating at 220°C. So far, no bonding agent was used. There are also potential uses of pulping wastewater to obtain valuable by products. After neutralized by using carbon dioxide, a gel-like material precipitated from the wastewater. Using baker's yeast for fermentation test, a small amount of gas was collected from the remaining wastewater flask.

### **INFLUENCE OF THE ANISOTROPY OF PLANT TISSUE AND THE ORIENTATION OF APPLIED ELECTRIC FIELDS ON ELECTROPERMEABILIZATION**

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The phenomenon called electroporeabilization of cell membranes has been known for several decades, and has recently received increasing attention for the manipulation of cells and tissue. The influence of the anisotropy of plant tissue and the orientation of applied electric fields on electroporeabilization was investigated. Apple parenchyma was selected as a model tissue since it contained a high degree of cell size distribution. Different tissue regions were viewed under the microscope to study cell size, shape and orientation. In a parallel experiment, cylindrical samples of tissue were subjected to pulsed electric fields and the change in electrical resistance was measured by the voltage-current method. The measured electrical resistance during pulsing was then converted into a permeability index which defined the relative change in electrical resistance compared to the electrical resistance of frozen/thawed tissue that served as a reference of completely damaged tissue. Electrical impedance was also measured to monitor the tissue changes as affected by pulsed electric fields. The results showed that elongated cells taken from the inner region of the apple parenchyma, responded to the electric fields in different ways. Fields of lower intensity were required to permeabilize these cells when the fields were applied parallel to the longest axis of the cells. Other field orientations resulted in greater applied electric fields being required to permeabilize the cells. No field orientation dependence was observed for round cells that belonged to the outer region of the apple parenchyma. A condition in which a high degree of permeabilization during pulsing and very

small change after pulsing were observed could be obtained at a low applied field intensity of about 200 V/cm.

### OPTIMIZATION OF IMMATURE EMBRYO TISSUE CULTURE IN IRANIAN BREAD WHEAT CULTIVARS

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Improvement of wheat (*Triticum aestivum*) by biotechnological approaches is currently limited by a lack of efficient and reliable tissue culture methodology. In this report, immature embryos of seven Iranian bread wheat cultivars were used to evaluate their ability of callus induction, green spot formation, shooting and regeneration frequency. Seven wheat cultivars were evaluated using four embryogenic callus induction medium and three regeneration medium in a split-split plot based on completely randomized design with 4 replications. Analysis of variance showed a significant difference between cultivars for all the *in vitro* traits studied except percentage of callus induction after 30 days from culture. Significant difference was found among callus induction media for all the studied traits. The cultivar X callus induction medium interaction was significant for percentage of callus induction, volume of callus, percentage of green spot, number of green spot per callus, percentage of shoot formation, and regeneration frequency. The effects of regeneration media and its interaction with cultivar and callus induction medium were significant for percentage of green spot, number of green spot per, percentage of shoot formation, regeneration frequency. The results showed that Atilla-50Y followed by Alvand were the best cultivars for callus and embryogenic callus induction. Mean comparison of callus induction mediums showed that medium B2 was not suitable for callus induction but this medium performed well for embryogenic callus induction. The medium containing MS (Macro+Micro) + Thiamine-HCl + L-Asparagine + 2,4-D + Maltose + Agar was best for callus induction as well as embryogenic callus production. Regeneration medium containing MS (Macro+Micro+vitamins) + myoinositol + IAA + BAP + Sucrose + Agar acted better than the others. Interaction of B\*C expressed that combination of B2C1, B2C3 and B3C3 medium were the best for callus induction, green spot and shooting in Atilla50Y, Atrak and Alvand/Tajan cv., respectively. *In toto* Atilla50Y and Alvand cultivars were better than others for callus formation and regeneration. The results suggest that by selecting only calluses producing early green spots the experimental efficiency will be increased.

### THE DESIGN AND FABRICATION OF A DUAL-POWERED FOLIAGE CHOPPER FOR BOTANOPESTICIDES PREPARATIONS

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In the Philippines, the search for environment friendly natural products from plants like kakawate (*Gliricidia sepium*) and other plants has conquered many farmers in the countryside through organic farming practices. But preparations of botanopesticides are hampered by the lack of equipment. Thus, a dual powered foliage chopper (DPFC) was designed and fabricated using a rotating shaft mounted with four (4) rotary chopping blades wrapped around the 16 inch long cylinder on its surface. It contains also eight (8) fixed chopping board plates mounted in the inner surface of

the assembly. It is powered by foot pedal and an electric motor. The machine chopped 1 kg leaves kakawate by foot and electric motor in 8 min. and 5.55 min. respectively while seaweeds (*Sargassum sp.*) by foot and electric motor in 10 min. and 8 min., respectively. The chopped materials can pass through a 0.02 cm mesh. One unit of the newly-designed DPFC costs P 30,465.00.

#### **THE EFFECTS OF SEED COATING SUBSTANCES ON CHEMICAL AND BIOCHEMICAL PROPERTIES OF RICE SEEDS CV. KDML 105**

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Fungicides may cause phytotoxicity induced seeds deterioration. Thereafter, during storage a number of biochemical and physiological changes occur. Loss of viability is associated with disturbances of the cell membranes, nutrients losses and losses of enzyme activities. This study sought to investigate the effects of various seed coating substances; chemical fungicide (captan; CA), and biological fungicide polymers [chitosan-lignosulphonate polymer (CL) and eugenol incorporated into chitosan-lignosulphonate polymer (E+CL)] on chemical and biochemical properties of rice seeds cv. KDML 105, which have been stored for 12 months. CA significantly affected the rice seed viability and the associated deterioration. Total protein content decreased accompanied by decline of lipid content, increase of free fatty acids and activation of lipoxygenase enzyme. In the case of biological fungicide coated seeds, the antioxidative scavenging enzymes were ascorbate peroxidase and superoxide dismutase and a high antioxidant activity protected them. The biological coated seeds were found to maintain high sugar contents inside the seeds which resulted in high seed storability significantly. In contrast, under fungicide stress (CA), those compounds were lost that directly affected seed vigor during storage. This results suggest that sucrose may serve as the principal agent of stress tolerance in the seeds, whereby the larger oligosaccharides serve to keep sucrose from crystallizing. The application of biological seed coating substances by CL and E+CL may be a promising strategy to improve the direct-seed rice production system.

#### **THE EFFECTS OF SOME PLANT GROWTH REGULATORS ON THE ROOTING OF NARIG (*VATICA MANGGACHAPOI BLANCO*) AND MAYAPIS (*SHOREA PALOSAPIS BLANCO*; MERR.) JUVENILE CUTTINGS USING NON-MIST PROPAGATION**

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Dipterocarps have erratic flowering and fruiting characteristics. To ensure continuous supply of quality planting materials of these economically important trees, a non-mist propagation study was conducted to assess the rooting responses of juvenile cuttings of two dipterocarp species - mayapis [*Shorea palosapis* (Blanco) Merr.] and Narig (*Vatica manggachapoi* (Blanco) - to various concentrations of indole butyric acid (IBA), naphthalene acetic Acid (NAA), and Superthrive Vitamin Hormone (StVH). It also aimed to develop rooting protocols for such species intended for mass

propagation. IBA induced the highest rooting percentage of mayapis and narig as compared with NAA and StVH. IBA 100 ppm and 150 PPM induced a high rooting percentage by 82.29 and 87.45%, respectively which was not statistically significant. In terms of the number of roots developed, no significant differences were observed among varying IBA concentrations tested (50ppm, 100ppm and 150ppm) but was significantly different from the control and StVH. Root lengths did not significantly differ among treatments. The rooting of narig, on the other hand, was 92.50%, 88.33% and 75.83% at 500 ppm, 250 ppm IBA and StVH, respectively. The lowest rooting percentage was obtained under 500 ppm NAA.

## **A REMOTE SENSING APPROACH TO ESTIMATE STAND DENSITY IN OIL PALM**

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The conventional method used to determine oil palm stand density is to perform tree census using manual labor. Typically, oil palm tree census is performed annually to quantify i) productive palms, ii) non-productive palms, iii) supply palms and iv) unplantable palm points. Information derived from tree census is used to determine allocation of crop inputs. In Malaysia, the cost of performing tree census manually ranges between RM1 and RM5 per hectare. Apart from the sizeable cost, this method is also prone to human error. This paper demonstrates the potential use of satellite imagery as a means to perform tree census in oil palm. This work was carried out in a commercial oil palm plantation located in Sagil, Johor, Malaysia. Archived satellite imagery (2005) of the plantation was obtained via Google Earth with a spatial resolution of 4 m, without any cost. Five study plots (polygons) were demarcated on the imagery based on planting year and soil type. Each polygon was geo-referenced and to aid ground truthing operations. Image processing was performed using MapInfo Professional Version 8. Tree counting on the imagery was done using the MapInfo 'mark' tool based on tree canopy pattern at nadir viewing. Ground truthing was done using a global positioning system (model: Trimble Geo Explorer XH). Results showed a high correlation between the number of trees counted on Google Earth imagery and that counted on the ground. This finding suggests that satellite remote sensing can offer an alternative means of estimating oil palm stand density. This technique is not only cost-effective but also reasonably accurate.

## **TREE TRUNK INJECTION TECHNIQUE: ENVIRONMENTAL AND COST EFFECTIVE METHOD OF CONTROLLING PINE SHOOT MOTH (*DIORYCTRIA RUBELLA* AND *PETROVA CRISTATA*) ON CARIBBEAN PINE (*PINUS CARIBAEA* VAR. *CARIBAEA*)**

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Every plant needs its own, specially-adapted method of pest protection. Caribbean pines (*Pinus caribaea* var. *caribaea*) are fast growing tropical pine species not native to the Philippines, mostly cultivated for its timber. At present, it has great potential as a landscape tree. Unfortunately, Caribbean pines in the Philippines are being destroyed by insects, notably pine shoot moths (*Dioryctria rubella* and *Petrova cristata*). These problems indicate the need for alternative pest control technique/procedure because these pests often occur sporadically. Conventional spraying of insecticides is seldom an appropriate means of pest control, either from an economic or environmental point of view. A pest control technique has been adapted involving injection the systemic insecticide directly into the trunk. An ArborJet Tree I.V. Kit Injection system was acquired and ArborJet "stinger



method” was used to treat the estimated five thousand 3 to 4 year old Caribbean pine trees planted as primary landscape trees at a high-end Swiss-inspired residential development project site. Infected pine trees were injected with acephate systemic insecticide solution at 5 milliliter per inch at DBH (diameter at breast height). Average DBH of pine trees is between 4 to 10 inches. Four treatments were performed during the study trial namely: control; trunk injection (Acephate); basal application (Furadan 3G); and conventional spraying (Cymbush). The trial showed that the tree trunk injection technique of delivering chemical pesticide is the most cost effective and environmentally sound method of controlling pine shoot moth infesting Caribbean pines in the Philippines.

## **TESTING FOR INTEGRATION IN BENGUET VEGETABLE MARKETS**

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The general objective of the paper is to determine whether the vegetable market for cabbage, potatoes and carrots is spatially efficient. It is efficient if prices are fully transmitted between farm-to-wholesale or farm-to-retail levels or if prices changes in geographically separated markets move in unison between market levels that prohibit traders from obtaining abnormal profit. Two approaches are used to test for market integration: (1) the Ravallion model, and (2) the cointegration analysis. Two sets of prices are used: the wholesale prices collected in La Trinidad, Baguio Hangar, Urdaneta, Pangasinan, Balintawak and Divisoria markets in November 2003 for testing cointegration and farm, wholesale and retail prices from January 1998 to March 2008 for the Ravallion model. The results of the cointegration analysis revealed that all original price series for the three vegetables are confirmed to have a unit root. Generally all price series are significant which implies that they are directly related to each other. The outcome of the Ravallion analysis confirmed the abovementioned findings. There is market integration between Benguet vegetable trading centers and their market destinations. Wholesale prices from reference markets were immediately transmitted to wholesale markets in Benguet. Local price history has a significant contribution to the formation of current wholesale prices albeit in low amounts. The market information system and communication facilities contributed to vegetable market integration in vegetable trading in Benguet and its market destinations. An efficient marketing information system is important to maintain and enhance the connectedness of Benguet markets with its various market destinations. The following recommendations can improve the connectedness between markets: (1) establishment of communication facilities in production areas; (2) adequate budget to be given to the Bureau of Agricultural Statistics (BAS) to ensure the collection and timeliness of needed market information; (3) market reporters to be trained on quality monitoring of prices and other relevant market information; and, (5) farmers and traders to be trained on proper postharvest practices and grading. A strict enforcement of a good grading system for vegetables increases the meaningfulness of price quotations reported in market news.

## **INCREASING THE PRODUCTION AND REPRODUCTIVE EFFICIENCY OF NATIVE GOATS**

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The project emphasis was to increase the production and reproductive efficiency of native goats as one of the options of increasing food production and agriculture development. The conception rate of native does mated with purebred buck like *Toggenburg* had increased; the gain and weaning weight of kids sired by purebred buck were also improved, compared to those mated with

native buck. Raising systems like the range, confinement, semi-confinement and tethering had the same effects in the final weight, gain in weight, dressing percentage and carcass quality of goats. However, goats raised in the range were most profitable. The mixing of 25% rice bran and 75% hog grower mash had effected the highest final weight, gain in weight, heart girth, dressing percentage, net profit and return of investment to grade goats given as feed supplements. The feeding of ground corn given as feed supplement in combination of tamarind leaves had improved the gain in weight, feed intake, dressing percentage and reduced cost of feed required per kilogram gain in weight. Furthermore, feeding of tamarind leaves combined to the basic diet effected highest Return of Investment. Napier was better soilage supplement than *Auri* leaves giving heavier final weight and higher dressing percentage of fattening goats. However, the 75% Napier + 25% *auri* leaves was the best mixing level and most economical. The mixture of 50% para grass and 50% peanut stover was the best forage combination for higher dressing percentage and more economical than giving native grasses. The mixture of 75% *Napier* and 25% *Lombay* leaves yielded higher final weight, gain in weight, feed consumption, dressing percentage, and require less cost per kilogram gain in weight, hence, more economical than giving native grasses.

#### **DETECTION OF HUANGLONGBING DISEASE OF CITRUS IN THAILAND BY MOLECULAR AND SEROLOGICAL TECHNIQUES**

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Huanglongbing (HLB) disease, previously known as citrus greening disease, is one of serious disease of citrus cultivars in Thailand. The disease causes by *Candidatus Liberibacter asiaticus* (CLA), the uncultured on synthetic media, and phloem sieve tube restricted bacterium. Disease symptoms are resemble Zn-deficiency symptom, yellowing of new leaves, and molting with blotchy of fully expanded leaves and usually associated with corky veins which make difficulty to diagnose. HLB in Thailand was found in pomelo, tangerine, kaffir lime, sweet orange and lime. Three detection methods were developed and compared for specific detection of HLB from several *Citrus* spp. in Thailand. The detection techniques were polymerase chain reaction (PCR), DNA dot blot hybridization (DBH) and enzyme-linked immunosorbent assay (ELISA). Two specific primers and probe were used for PCR and DHB techniques whereas antiserum against RPLJ protein of HLB was produced for ELISA technique. Results demonstrated that all three developed methods were highly specific only to HLB disease of *Citrus* spp. throughout Thailand. Therefore, all three developed methods could be used to detect and diagnose of HLB infected citrus samples, that is more accurate and reliable than symptom observation. However, further development of lateral flow serological method should provide an easy to use and accurate detection of HLB.

#### **DETECTION OF *ACIDOVORAX AVENAE* SUBSP. CITRULLI IN PLANT SAMPLES USING ENZYME-LINKED IMMUNOSORBENT ASSAY**

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The seed-borne bacterium *Acidovorax avenae* subsp. *citrulli* (Aac) causes fruit blotch in watermelons. The precise diagnostic techniques are essential to epidemiological studies, disease management and quality control for exporting disease-free seeds. In this study, we produced mouse monoclonal antibodies (MAb) against the sonicated cell suspension of Aac. MAb, designated 11E5, was selected for further immunoassay development since it reacted specifically with only Aac and did not cross-react with other bacteria including closely-related bacteria in the Family *Comamonadaceae*, other phytopathogenic bacteria, bacteria isolated from diseased cucurbits and saprophytic bacteria from watermelon seed. MAb 11E5 detected an Aac protein band at a molecular weight of approximately 170 kDa in western blot analysis. Plate-trapped antigen ELISA (PTA-ELISA) and sandwich ELISA were compared for detection of Aac in plant samples using MAb 11E5. The results from this study showed that plant sap somehow interfere the detection of Aac in PTA-ELISA. Sandwich ELISA could improve sensitivity to Aac detection in plant sap. The sensitivity of sandwich ELISA was at least 1000 times higher than that of PTA-ELISA in detection of Aac in plant sap. We successfully differentiated between Aac-infected and healthy plant samples using sandwich ELISA. Ultimately, we will apply this method to detect this bacterial disease in seed samples for export industries.

#### ESTIMATION OF HEAVY METALS LOADING OF ANAEROBIC DIGESTED ANIMAL MANURE SLURRY

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Closed-system anaerobic digestion has the potential to eliminate most of the lagoon emissions while conserving more nutrients and producing a renewable energy source as an additional benefit. In addition, the anaerobic digestion process creates potentially valuable by-products with available nutrients and animal manure is a significant source of heavy metal input such as copper (Cu) and zinc (Zn) which have been used as feed additives. This study aims to estimate the heavy metal balances in anaerobic digested slurry (ADS), grass and forage crops, and grassland soil accumulation based on the loads of heavy metal from animal digested slurry to grassland and forage cropping area, and the uptake of these elements by grass and forage crops. Three feed crops; *Lolium perenne* L. (PRG), *Phleum pratense* L. (TY) and *Lolium multiflorum* Lam. (IRG) were grown. Feed crop field plots (1a turf-type) had been treated 2 years with dairy manure ADS, swine manure ADS, and chemical fertilizer included no added fertilizer as a control for each crop. Fertilizer application amounts  $200 \text{ kgN ha}^{-1}\text{y}^{-1}$  was determined by equalizing the ammonium nitrogen contained within the recommended commercial fertilizer with the ADS for each. Potassium (K)  $320 \text{ kg K}_2\text{O ha}^{-1}\text{y}^{-1}$  and phosphorus (P)  $240 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}\text{y}^{-1}$  were applied followed regional recommended rate; however in ADS, K was exceeded the application rate because of the high contents in ADS. Fertilizers were applied three times per year, 1/2 in spring and 1/4 in the summer and fall after harvesting. The loads of Cu and Zn from ADS to grassland and forage cropping area were 1474 and 2033 g/ha/y from dairy manure ADS, 11,344 and 12,972 g/ha/y from swine manure ADS, respectively. The Cu and Zn uptake in IRG and TY applied swine manure ADS were greater than that of PRG; applied dairy manure ADS, swine manure ADS and TY applied dairy manure ADS. The upper layer soil contained 58.5 kg/ha Cu and 40.0kg/ha Zn. To keep the environmental quality standards for soil pollution, dairy manure ADS could be applied around 43 years, and swine manure ADS could be applied 6 years to grass land soil.

## EFFICIENCY OF N<sub>15</sub> LABELED UREA APPLIED TO RICE AT REDUCING WATER REGIME

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Water shortage could be a threat to increasing rice production. This study was conducted to determine the effect of reducing flood water in rice production on fertilizer N balance and rice yield rice using N<sub>15</sub> labeled Urea. Five water treatments with four replications were arranged in Completely Randomized Design (CRD) as follows: W1 (flooding at 5 cm); W2 (flooding at 1 cm); W3 (flooding at 5 cm then 1 cm after 3 weeks); W4 (flooding at 5 cm then 1 cm after 6 weeks) and W5 (flooding at 5 cm then 1 cm after 9 weeks). The Bakau Series soil was filled in each cylindrical concrete culvert. The MR 220 rice variety were sown at the rate of 150 kg/ha. Urea labeled with N-<sub>15</sub> were applied at 120 kg N/ha in three splits, 60 kg P<sub>2</sub>O<sub>5</sub>/ha as Triple Super Phosphate and 60 kg K<sub>2</sub>O/ha as Muriate of Potash as basal dressings. The standard agronomic practices were applied and rice was harvested after 110 days. The N<sub>15</sub> atom excess in plant parts and in soil at different depth was determined by using an emission spectrophotometer. The NDFE (nitrogen derived from fertilizer) were calculated using isotopic dilution technique. The fertilizer N uptake ranged between 48.2 to 57.2 kg/ha fertilizer N recovered in soils ranged between 39.4 to 58.5 kg/ha. The reduction of water input did not have any significant effects on rice yield and fertilizer N balance as in earlier study. Reducing flooding water did not cause detrimental effect on rice yield, fertilizer N efficiency and N uptake. Thus there is a potential to produce rice under low water input to increase water use efficiency.

## PRODUCTION OF AN ATTENUATED STRAIN OF KYURI GREEN MOTTLE MOSAIC VIRUS BY LOW TEMPERATURE TREATMENT

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Cultivation of cucurbits is often hampered by virus diseases and at least 50 species of cucurbit-infecting viruses are known in the world (Fauquet et al., 2005). Among them, cucurbit-infecting viruses species in the genus *Tobamovirus* are well-studied for their biological or molecular characters. They have wide host range and geographical distribution, and include many strains or isolates. They can spread through seed, contact and soil, and become serious plant quarantine issue. To control *Kyuri green mottle mosaic virus* (KGMMV), one of the *Tobamoviruses*, the use of attenuated virus seems promising. Among several techniques to produce attenuated virus strains, low temperature treatment has not yet tried in KGMMV. Moreover, the method is advantageous than high temperature treatment which is prone to cucurbit plantlets. With KGMMV-C1 isolated in Japan, we treated KGMMV-C1 local lesions formed on *Chenopodium amaranticolor* at 15°C for 20 days and then inoculated them individually to zucchini (*Cucurbita pepo* cv. Diner) to detect mild symptom development. After continuous inoculation and selection using zucchini, an isolate (e73) that showed only very mild mosaic on zucchini was obtained. To examine whether e73 has cross protection ability against wild type or not, we challenge inoculated the wild type of KGMMV-C1 3 or 5 days after pre-inoculation of e73 on zucchini. The zucchini plants pre-inoculated by e73 at 5 days prior to challenge inoculation showed only very mild mosaic due to cross protection whereas zucchini plants showed mosaic when challenge inoculation was conducted only 3 days after pre-inoculation. Although further selection of more stable single clone of e73 is necessary, this study showed for the first time that low temperature treatment is useful in production of attenuated KGMMV.

## INFLUENCES OF TUBE CONTAINER VOLUMES AND STORAGE DURATION PRIOR PLANTING ON GROWTH OF EUCALYPTUS LINERS AFTER TRANSPLANTING INTO THE FIELD FOR ONE YEAR

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Eucalyptus clone CT76 plantlets from tissue culture were grown in 3 different sizes of opaque plastic tube containers; small (40 cm<sup>3</sup>), medium (75 cm<sup>3</sup>) and large (120 cm<sup>3</sup>) for 75 days during nursery production. After reaching a standard size for out planting, plants were taken off from containers and packed in a 12 x 24 cm plastic bag, 30 plants per bag, according to a standard procedure of the nursery and transported to the site. Plants were transplanted into the field on the same day or stored in the same plastic bags under shade and watered daily before transplanting to simulate the conditions of long distance transport or labor shortage. Effect of different container volumes and storage duration on growth of eucalyptus liners after transplanting was monitored for 13 months under rain-fed conditions. The results showed that liners from large containers had better initial growth during the first 4 months than those from smaller containers. Liners stored for 10 days had more growth restriction after transplanting. After transplanting for 8 months, liners from large containers were still larger in sizes than those from smaller containers but the effect of different storage duration on plant growth declined. Effect of container volumes and storage duration on canopy width, dry mass of leaves, branches and main trunk and dry mass of medium roots and small roots were not statistically significant. The results suggested that liners from smaller containers can catch up with those from large containers under rain-fed conditions after transplanting into the field for 1 year and thereafter. Growth restriction can be minimized if liners are properly stored not longer than 5 days before transplanting.

## INTEGRATION OF ANTAGONISTIC BACTERIA AND SILICON TO CONTROL BACTERIAL WILT OF TOMATO UNDER GREENHOUSE CONDITION

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Control of bacterial wilt of tomato caused by *Ralstonia solanacearum* strain To-Ud3 (RS) in tomato cv. Seeda was investigated in greenhouse by using antagonistic bacteria *Bacillus subtilis* strain CH4 (BS) and silicon as salicylic acid (Si1) and sodium silicate (Si2) forms with a single or a combination with BS application. Treatment BS powder plus Si2 gave the most effective disease reduction at 8 weeks post inoculation which showed 88% tomato survival and yield by 240 gm/plant whereas the treatment BS powder alone or a combination with Si1 gave 66% tomato survival and yield by 180-200 gm/plant. All treatments were significantly different from non-treatment control. Population of RS reduced from initial inoculum of  $3.4 \times 10^8$  cfu/ml to the lowest of  $1.16 \times 10^3$  cfu/ml in treatment BS+Si2 at 8 weeks post inoculation which was significantly different from the non-treatment control. The BS population increased in all treatments at 8 weeks post inoculation. Treatment BS with sodium silicate was the most effective control providing the highest survival, yield and reduction of RS population. This is the first report of a

combined use of bacterial antagonist with silicon for effective control RS in tomato under greenhouse condition until harvesting.

### **THE MONITORING OF SPECTRUM RESPONSIVITY ON APPLES AND PEARS DECAY THROUGH VIS-NIR REFLECTANCE SPECTROSCOPY**

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Visible and Near Infra Red (VIS-NIR) spectroscopy have been widely used in agriculture industry in determining the fruits' post harvest quality. This research focused on the measurement of surface reflectance from fruits in determining the best wavelength that can be used to monitor fruits decay using red apple, green apple, yellow (snow) pear and green pear. The measurement is done through fiber optic cable using ASD spectroradiometer with range of VIS-NIR wavelength from 325nm to 1075nm. The fiber probe was allocated on top of the fruit flesh after the fruits have been cut to halve. The measurement was taken every hour for 9 hours. The experiment has shown that NIR wavelengths within range of 960nm to 980nm able to produce a good responsivity in the form of its linear correlation coefficient,  $R^2$  between reflectance and time of measurement. VIS wavelength does show deviation between 0 hour and 9 hours of measurement, but does not produce good linear correlation through 9 hours of measurement.

### **SINGLE NUCLEOTIDE POLYMORPHISM GENOTYPING OF CALPASTATIN GENE USING THE ARMS COMPARED WITH THE RFLP.**

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Calpastatin is an endogenous inhibitor of calpain which is responsible for breakdown of myofibrillar proteins. The association of single nucleotide polymorphism (SNP) in the calpastatin gene with meat tenderness is an important topic in meat production. The efficient procedure to investigate the SNP is necessary. This study sought to detect the SNP of calpastatin gene at domain L marker (G/C transversion) of the Kamphaeng Saen beef breed (KPS; n=26) by the amplification refractory mutation system (ARMS) compared with the restriction fragment length polymorphism (RFLP) methods and to determine the genotypes of KPS at that marker. Genomic DNA of calpastatin gene extracted from blood of KPS was detected using ARMS and RFLP methods. The ARMS approach has utilized two primer pairs to amplify the two different alleles of a polymorphism in single PCR reaction to detected single base mutation. In this method, the alleles-specific primers had a mismatch at 3' terminal base and a second deliberate mismatch at position-2 from 3' terminus. While the RFLP method detected a polymorphism by PCR-base technique follow by *RsaI* restriction enzyme. Amplification of the ARMS method revealed that the results were not different from the conventional method of RFLP. Analysis of genotypes revealed that the KPS cattle inherited the CC, CG and GG genotypes at domain L marker. There were reliable when verified by nucleotide sequence

analysis of PCR products. The animals were genotyped and determined tenderness phenotype for this marker that predicted variation an intronic polymorphism at domain L of the calpastatin gene. Therefore, the ARMS method was simple, efficient technique, and suitable for detecting SNP at domain L marker of the calpastatin gene.

#### **CONTROL OF DIRTY PANICLE DISEASE OF RICE WITH ANTAGONIST MICROBES UNDER FIELD CONDITION**

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Dirty panicle disease caused by multiple fungus species is severe for economic loss of rice production areas in Thailand that the effective control measure is critical limitation. Biological control using microorganism may be necessary for alternative method of sustainable rice production. The two-bacterial biocontrol agents *Pseudomonas fluorescens* SP007s and *Bacillus amyloliquefaciens* KPS46 have been proven effective in controlling several diseases of various crops, but their effects on dirty panicle infection of rice are not known. Field experiment was conducted in March-July, 2008 at Angthong growing region to develop control strategies for this disease with seven treatments (T1 to T7) including 4-different antagonist formulations (T1 to T4) compared with 2-chemical programs (T5 and T6) and nontreated control (T7). They were arranged in CRD that evaluated under natural inocula. The results showed that 2-treatment program: 6-month shelf life formulation of  $1 \times 10^6$  cfu/ml SP007s (T1: seed treatment and 5-foliar spray intervals) and synthetic fungicide (T6: copper hydroxide seed treatment and 6-carbendazim foliar spray intervals) were significant greatest ( $P=0.05$ ) for reduced development of dirty panicle infection. Regarding the efficacy of pathogen inhibition, SP007s formulation was significantly higher in suppression of causal species of dirty panicle pathogens. However, all antagonist microbe treatments including SP007s and KPS46 formulations and *Trichoderma* cell culture except *Bacillus subtilis* formulation (Laminar<sup>(R)</sup>) significantly provided higher yields than chemicals T5 and T6 ( $P=0.05$ ). These antagonist microbes tested seem to enhance biocontrol activity not only with decreased disease severity but also promoted plant growth of rice clump, panicle, and kernel that result in highest yield obtained.

#### **APPROPRIATE TECHNOLOGY FOR USING ETHYLENE GAS TO FLOWER INDUCING OF SMOOTH CAYENE PINEAPPLE IN ORGANIC FARMING SYSTEM**

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Thailand is the top world producer of pineapple in 2002. Prices usually go down in May-July and November-December with peak of production. This price reduction has not hit the organic market yet which is 100% higher than conventional pineapple. It therefore serves as the alternative market for farmers who want higher price. However, organic pineapple production has the important problem about natural flowering which cause serious yield losses. Ethyphon and calcium carbide are used for flower inducing but are prohibited materials in organic standards. Only ethylene gas is allowed to regulate pineapple flowering in European and Japanese organic standards. This study aimed to determine the appropriate technology for using ethylene gas as flower inducer of Smooth Cayene pineapple and to develop an ethylene gas sprayer suitable for small organic pineapple farms. The ethylene gas sprayer was developed from backpack sprayer. Ethylene gas spraying with 0.5 % activated charcoal was applied when the plant had optimum weight for forced flower induction. The

ethylene gas sprayer in this research had high efficiency. The application of ethylene gas at 800 , 1000 and 1200 g. / 6000 l. of water induced flowering 95.8, 97.8 and 96.8 % respectively which did not show significantly difference while untreated pineapple did not flower . In addition, ethylene applications did not show differences in fruit weight, yield and fruit quality.

## **QUALITY: THE CASE STUDY IN PHATTHALUNG PROVINCE**

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The problem of producing organic fertilizer so far could not meet the standard of department of agriculture. Therefore this project aimed to survey the material, methodology and quality of organic fertilizer in Phatthalung as well as give the recommendation/advice to organic fertilizer producers. The project surveyed 18 groups of organic fertilizer producers in Phatthalung. The samples of organic fertilizer before and after recommendation were taken and analyzed in laboratory. There were 3 kinds of organic fertilizer classified by texture i.e. powder, pellet and granule. Mainly they produced powder organic fertilizer followed by granule and pellet by 61.11%, 22.22% and 16.67% respectively. The base materials to produce organic fertilizer were animal manure such as cow manure, layer poultry manure and pig manure which they used as a single or mixed material together with sawdust, rice husk, rice husk charcoal, rice hull, rock phosphate, bio-extract and urea. Based on the organic fertilizer standard of department of Agriculture 2008, the over all evaluation in terms of electrical conductivity (EC), organic matter (OM), C:N ratio, moisture content, N, P and K, all groups of organic fertilizer producers did not pass. However the individual evaluation showed that C:N ratio and K were 100% satisfied followed by moisture content, P, N, EC and OM by 94%, 75%, 69%, 56% and 12% respectively. TISTR advised and recommended the ratio of material and methodology of composting to producer during mid 2006, the quality of organic fertilizer after that improved i.e. the overall evaluation was 69% passed. Meanwhile individual evaluation showed more percentage passed as well. The parameter that seldom met the standard was OM, however the percentage passing increased from 12% to 69% after advise was given. Moreover, it was found that the quality of powder organic matter was superior than pellet and granule organic fertilizer.

## **ECONOMIC AND TECHNICAL ASSESSMENT OF ORGANIC VEGETABLE FARMING IN CHIANG MAI, THAILAND**

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Government of Thailand is promoting alternative vegetable production systems such as organic, chemical pesticide free, and safe use production systems. Most of vegetable producers are not confident to transform from their conventional system to organic farming, presumably due to technical difficulties and low production efficiency. Based on a questionnaire survey of 142 farmers under different production systems in Chiang Mai province in 2008, this paper aims to clarify the common vegetable practices, cost and return of major crops, and profitability of organic farming in comparison with other production system. Over 15 kinds of vegetable were grown under different farming systems in Mae Rim district, Chiang Mai province. Kinds of vegetable grown depended on market demand and growing time. In the this district alone, vegetable production accounted to 19.6 million Baht in 2007, of which 2.6 million Baht was from organic vegetables. There were no differences in types of input used by major organic crops such as kale, pak choy, and yard long bean. Economic analysis revealed characteristics of four types of farming system; organic, chemical pesticide free, safe use, and conventional farming system. The organic farming system was



economically most feasible by high prices of produce; however, it would need further improvement in order to increase their yields and production efficiency. Both safe use and pesticide free farming systems were economically feasible. The conventional farming system was economically feasible, but faced the highest risk in the increased price of synthetic chemical inputs.

### **FARM OF THE PAST AND FUTURE: MEANS TOWARD ECOLOGICAL RECONSTRUCTION**

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The world is now facing problems which seem uncontrollable ranging from inequitable income and resource distribution and environmental degradation to social maladjustments. Due to indiscriminate collection and consumption, many species of plants and animals are slowly disappearing. Agricultural ecosystems suffer most of these ecological backlash because of the imbalances caused by loss of some important components of the food web found therein. Rural communities located within agricultural ecosystems suffer most. The unabated hunting and collection of endemic species consist most of their daily food intake and needs for survival are now depleting. The exploitation of local habitats by introduced ones caused near extinction of the important flora and fauna which once served farming communities. The Occidental Mindoro National College implemented the "Farm of the Past and Future" project. The farm envisions to bring back agricultural ecosystems to what they were in the past by retrieving and perpetuating the native species of snails that are disappearing due to introduction of agricultural chemicals and foreign species of snails. A fishpond was constructed where endemic species of fishes which were commonly found in the rice fields are being cultured and reproduced. Vacant spaces are planted with indigenous vegetables. A garden for herbal medicines was also put up to provide source of planting materials to the nearby residential lots. A native chicken production was also established inside the farm. Ultimately, the farm will be able to provide genetic material for improvement of local species of crops and animals. The future farms in the whole province will be like this once fully advocated by farmers unlike today's farms most of which are suffering ecological damage.

### **EFFECT OF SPEED AND SPREAD OF SCREW PRESS ON QUALITY OF STABILIZED AND UNSTABILIZED RICE BRAN**

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Recently, the petroleum crisis affected the whole world. Biodiesel was an alternative energy which is produced from agricultural products such as palm and cassava. The excess amount of rice bran in Thailand was high enough for producing biodiesel. The production methods of rice bran oil used in Thailand are distillation and screw press, which is suitable for biodiesel production. Therefore, screw press technique was applied into this research. However, not any report was demonstrated about the effect of speed and spread of screw press on quality of stabilization and unstabilization rice bran yet. The main objective of this study is to evaluate the effect of speed and spread of screw press on rice bran oil quality and quantity. Samples were divided into two groups; one from parboiled rice bran and another from normal rice bran. Samples were stabilized at 100°C for 5 minute. The comparison of stabilized and unstabilized samples was, then, determined. The results showed that

speed and spread of screw press were effect on rice bran oil quantity whereas it was not effect on quality. Stabilization process influenced rice bran oil quantity of normal rice bran whist it not significantly different in parboiled rice bran.

## **THE POTENTIAL OF SWEET POTATO AS AN ALTERNATIVE FEEDSTOCK FOR BIOFUELS**

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This paper discusses the learning insights in exploring livelihood options for upland farmers in a watershed area in the foothills of Sierra Madre Mountains in Tanay Rizal. Of interest and focus is the potential of sweet potato (*Ipomea batatas*) as an alternative feedstock for biofuels. The potential of sweet potato as an alternative feedstock for biofuels is seen in the perspective of farmers' acceptability to be part of their present farming systems. Apparently, sweet potato is readily accepted by farmers as it does not threaten their sense of food security. Its potential use for industrial purposes as in biofuels would simply require increasing the volume of production without necessarily depriving the farming family of its possible use for food. The idea of commercial scale production of sweet potato inspired in them some hopes of a possible increase in their farm productivity, thus, an increase in farm income and an improvement in their quality of life. Further, this paper discusses some learning insights in the initial efforts for commercial scale production of sweet potato to produce the required volume of a feedstock for an ethanol plant that was envisioned to be. The learning insights are organized into the following themes: 1) The yield performance of sweet potato as affected by climate, soil types and fertility and its cultural practices. 2) The preparedness of farmers both technically and financially in a project idea of commercial farming of this crop. 3) Possible transition strategy for farmers to shift from subsistence farming to commercial farming of sweet potato.

## **CONSUMER WILLINGNESS-TO-PAY FOR FARM-PRODUCED ETHANOL: THE VIEW FROM CANADA**

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Adequate consumer demand and willingness to pay for farm-produced bio-fuels is a necessary condition for the adoption on the supply side of environmentally friendly, employment-intensive technologies at the farm level. As taxpayers as well, consumers must be willing, through their preferences for electoral platforms, to fund public policies to ensure that farmers have stable and profitable conditions for the production of bio-fuels. These include subsidies for farm-land conversion, taxes on regular gasoline, subsidies to entrepreneurs starting up bio-fuel processing plants, and restrictions on imports of feed-stocks or finished bio-fuel from other nations, to this research, based on a survey of 1002 Canadian automobile-owning households, used Chi-squared, OLS and Logit regression analyses to measure and explain the willingness to pay for bio-fuels for each province and socio-demographic segment of the population. The average willingness to pay varies significantly by population density, age of the car most often driven, gender, age, and education; suggesting that carefully targeted public information programs could stimulate voluntary increases in ethanol purchase. The average voluntary willingness to pay remains low, however, at approximately five cents Canadian per litre. This implies that complementary tax, subsidy, and trade policies will be

necessary. Those policies most favoured by consumers as a whole are a) the restriction of ethanol imports, provided Canadian farmers are able to produce ethanol crops domestically, and b) government subsidies to start up ethanol processing plants. Here again, the level and ordering of policy receptivity differs by socioeconomic subgroup and province, suggesting that a province-by-province program to support farm production of sustainable energy crops would be more effective than a blanket national policy.

## **FEASIBILITY OF PRODUCING BIOETHANOL FROM CASSAVA IN THE PHILIPPINES**

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This paper discusses the feasibility of producing cassava for ethanol production in the Philippines under the following arrangements: 1) corporate and joint venture cassava plantation; 2) ethanol processing (primary and secondary processing), and; 3) integrated cassava plantation and ethanol processing. The results show that production under these three different arrangements will be feasible. Given the base assumptions for plantations of 10,000 has. and average yield of 20,000 kgs./ha., the corporate farming arrangement is financially more attractive with an IRR of 18%, ROI of 22.2% and payback period of 5 years compared to the joint venture arrangement with an IRR of 14.7%, ROI of 14.7% and payback period of 5.6% although the investment cost for corporate arrangement is higher. The concern under corporate farming is the prices of farm inputs and labor. The post-harvest and ethanol processing is also financially attractive with a total project cost of PhP1,411,431,529. Assuming a selling price of PhP 54/liter and raw material price of PhP14/kg cassava chips, the internal rate of return is 13.1%, ROI of 16% and payback period of 6.6 years. About 90.77% of income of ethanol plant comes from the sale of the anhydrous ethanol, and 6.50% from sale of carbon dioxide. About 71.39% of the total cost is for raw materials and 15.81% for processing utilities. The third case considers a corporate-run cassava plantation and ethanol processing with a total project cost of PhP1,933,538,857. Assuming dried chips cost of PhP14.00 and suggested ethanol selling price of PhP50/liter, the internal rate of return is 14.58%, ROI of 12.8% and payback period of about 6.8 years. The concerns here are the sustainability of feedstock supply and high utility cost.

## **PERFORMANCE EVALUATION OF SWEET SORGHUM LINES FOR BIO-ETHANOL AND GRAINS UNDER PANGASINAN CONDITION**

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This study was conducted to evaluate the performance of five sweet sorghum lines in terms of agronomic characteristics in relation to grain yield and the total fermentable sugar. Analysis of variance showed that there were significant differences among varieties observed for plant height, stalk yield, stripped stalk yield, stalk diameter, stalk juice volume, stalk juice yield, Brix, stillage

yield, grain yield and seed size. The mean agronomic characteristics of the 5 varieties evaluated showed that ICSV 700 performed better in terms of plant height. ICSV 700 and ICSV 93046 were the top performers in terms of stalk yield, stripped stalk yield, stalk diameter, stalk juice volume, stalk juice yield, and \*Brix. The varieties SPV422 and ICSR 93034 performed better in terms of stillage yield. SPV422, ICSR93034 and NTJ2 were among the top yielders, whereas, ICSR 93034, SPV422, ICSV93046 and ICSV 700 varieties were statistically similar in terms of seed size.

## **A STUDY OF SWINE RAISING UNDER CONTRACT FARMING IN THAILAND**

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This investigation sought to determine the system of production and marketing in swine raising under contract farming system, examine strengths and weaknesses, constraints, and recommendations in order to improve production aspects and marketing channels under contract farming system, and formulate swine raising development models for contract farming system. Information was gathered from in-depth interviews with stakeholders including private company, swine raising cooperative and independent farming in 6 regions of Thailand. There were 2 patterns of swine production system including subsistence farming or semi-commercial farming and commercial farming. Swine raising under contract farming system, included breeding and fattening pigs towards pattern of price guarantee, marketing guarantee, and hired feed. Breeding pigs towards price guarantee, marketing guarantee, and hired feed, were operated by companies (47%), and 53% were hired feed. All fattening pigs were operated towards price guarantee and hired feed. Appropriate price for the parties was 53.60 baht per kg. There were 2 types of swine cooperative raising under contract farming towards marketing guarantee including their own operation and member operation. Cooperatives operated breeding pigs (60%) and fattening pigs (30%) while contract farmers operated breeding pigs (40%) and fattening pigs (70%). Appropriate price guarantee was 59.60 baht per kilogram. Independent farming operated all breeding pigs and 40% of fattening pigs while contract farmers operated only fattening pigs (60-100%) towards pattern of price guarantee, marketing guarantee, and hired feed. Appropriate price guarantee was 55.60 baht/kg. Most benefit for contract farmers were less risk responsibilities in price and marketing and had more opportunity to develop raising management towards learning process. On the other hand, weak points included less autonomy in input procurement leading to face risks in higher cost and lower quality of input affecting less standard products. Most benefit for a party to the contract was accessed to expected output and cost saving. On the other hand, most weak points were dishonest and less practice in standardization of contract farmers.

## **INNOVATION ADOPTION OF BEEF CATTLE FARMING IN RURAL AREA OF INDONESIA**

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The objectives of this research were to analyze the rate of innovation adoption, to discover the farmer's characteristics factors influencing adoption of technology of cattle farming, and to describe the structure of adoption. This research was conducted by survey method in Karanganyar Regency (Central Java) and Bantul Regency (Yogyakarta Province). One hundred twenty cattle farmers as respondents were selected by purposive sampling method, quota sampling method, and convenience sampling method. The data were analyzed by using Pearson's Product Moment Correlation and Multiple Linear Regression. Experience in cattle raising and number of cattle own influence to the rate of technology adoption. The structure of adoption in cattle farming measured using communication model. Source of technology information, dominantly came from academic and government sectors, while private and non-governmental organization still a few in percent. Some recommendations were set based on the methods and mode that farmers preferred.

## **REGIONAL ECONOMIC DEVELOPMENT BY UTILIZING FOOD-INDUSTRIAL CLUSTER: A CASE OF BENI-IMO PROCESSING IN YOMITAN VILLAGE, OKINAWA**

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Sweet potato was imported to Japan approximately 400 years ago. Since then, sweet potato production and consumption have been widely extended. Recently the demand of sweet potato has declined due to the influence of diversification of consumption habits. However sweet potato is still considered as a significant crop in the upland farming in Southwest Japan. Moreover, the demand of sweet potato should be expanded to activate the production of both the development of various sweet potato products and coping with consumer needs. The purpose of this paper is to examine the development of regional economic by utilizing food industrial cluster, the case of Yomitan village, Okinawa Prefecture. In Yomitan, food industrial cluster system of 'Beni-imo' has been established. The Yomitan 'beni-imo' is a purple sweet potato that has purple flesh. Currently, purple sweet potato is widely used for primary and secondary processes. In order to promote such interaction and collaboration by crossing sectors, the flame of food industrial cluster system is required. The finding shows the importance of interactive relation towards harmonious coexistence between sectors on the promotion of commodities and services. In Yomitan village, since the beginning of 90s, local chamber of commerce and industry, agricultural cooperative and the local government have promoted 'beni-imo' production as a local revitalization project. They also requested confectionaries to conduct an experiment on 'beni-imo' products. In addition, 'beni-imo' products became popular as gifts and souvenirs of Okinawa. Furthermore, Yomitan 'beni-imo' consultant was established to certify the quality from different potato materials. The consultant certifies production records and handling by unification that gives advantages to 'beni-imo' producers. The important aspect of this experience is the establishment of certification system and the share of common values by agriculture, manufacturing and commercial sectors. Finally, the coordinator is also an important function to consider for a successful implementation systems.

## **SEA URCHIN (*TRIPNEUSTES GRATILLA*) FARMING IN NALVO STA. MARIA, ILOCOS SUR, PHILIPPINES: PROSPECT FOR COOPERATIVE ENTREPRENEURSHIP**

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This descriptive research found out that sea urchin farming can uplift the socio-economic condition of the fishermen in Nalvo, Sta. Maria, Ilocos Sur, Philippines, as evidenced by the increase in their monthly income. This study, therefore, relates to the sub-theme HEI Research Capability Building for Socio-Economic Growth. Majority of the fishermen are males who belong to the age group of 20-29; most of them are married; have gone as far as high school; have been engaged in sea urchin farming from 4-20 years. The sea urchin fishermen in Nalvo can become entrepreneurs. Successful entrepreneurship, according to the Austrian School of Economics, provides an avenue of *social advancement that is particularly attractive to people who are denied opportunities elsewhere like higher education*. With in-depth, not superficial, implementation by the academe and the local government concerned, this Austrian thought coupled with Deming's Project Plan to Quality (PPQ) works for the fishermen because it focuses on embedding continuous improvement and innovation throughout the project; realistic expectations, self-auditing, self-inspection and setting goals on what specific areas of the sea urchin enterprise are targeted for improvement. This Austrian thought can make the enterprise flourish if the fishermen are made to realize government's sensitivity to the socio-economic implications of their existence as organized entrepreneurs and their impact on the rest of the society. The researchers would like to alert the Philippine government through the academe and the local officials to organize the sea urchin farmers into a cooperative enterprise because it can be a vehicle for socio-economic growth.

## **AGROFORESTRY AS A STRATEGY TOWARDS SUSTAINABLE DEVELOPMENT OF AN INDIGENOUS PEOPLE COMMUNITY IN OCCIDENTAL MINDORO, PHILIPPINES**

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Occidental Mindoro National College, in partnership with Plan International conducted the Sustainable Upland Development Program in Sitio Salafay, Barangay Monte Claro, San Jose, Occidental Mindoro, site to about 50 Buhid Mangyans, one of the seven tribes in the island of Mindoro. The project was implemented to increase productivity of the community and help conserve upland resources. Community people were organized and worked collectively in the project. Thus, ownership is communal. Their interest towards establishment of the project was further aroused by carefully and clearly explaining to them its importance in improving their living conditions and their environment. Other activities conducted were the "Lakbay Turo"; showcasing 0.5 hectares on-farm soil and water conservation techniques; showcasing 1,000 m<sup>2</sup>; community nursery and showcasing community fish pond. The project contributed greatly to the continuous schooling of the minority school children because it was able to augment the food that their own farms supply which are most often insufficient. Prior to the establishment of the project, dropping out of classes was very rampant and it was found out that it was due to insufficiency of food. School children practically just drop out and either stay at home or search for food in their surroundings. The project also augmented table needs of the families by the food crops produced which are divided among the owners according to their degree of participation in the project through the guidance of the elders. Working together in the project improved social relations such as cooperation, camaraderie and belongingness. The agroforestry project will bring about increased literacy rate thereby liberating them from ignorance thus, empowering them and making them more capable of charting their own destiny. As to its long

term effect, it is envisioned that the community will truly be developed into one that is living in harmony with nature.

**PROCESS DEVELOPMENT FOR STANDARD OF FOOD PRODUCT AND VALUE ADDED  
IN MARKET SECTOR OF FARMER GROUP AT TAMBOL BAN PRAN, AMPHUR  
SAWAENGHA, ANGTHONG PROVINCE**

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This research sought to survey background information of agricultural communities in order to evaluate their potential, improve the indigenous product into new product and achieve standard, and promote learning process, management of product, human resource and marketing to link between producers and market sector. Target farmer group for this study live in Tambol Ban Pran, Amphur Sawaengha, Angthong province. Methodology for study is documentary method and mock audit for product standard certification, knowledge transfer through group participatory process. Tool and technique for collecting data were questionnaire setting, observation form, public hearing. The qualitative data and information was transfer into quantitative figure using content analysis. It was found that 1) farmer in Tambol Ban Pran are rice grower which produce 7 crops in 2 years period according to the good irrigation system at the 1<sup>st</sup> level. After harvesting, rice will be transported to rice mill immediately. The second rank of crops is sugarcane plantation. This crop can be harvested once a year within the period 4-5 years after first planted in field. Produce from farm are sold to factory which price are not satisfied by the growers. In the past, government sector will support by transferring and training the processing technology for some products i.e., Noni juice. However, the processing and technology still lack standard and not able to purchase. This cause negative impact to the small food producer in food processing while the persons who worked with the non-food product i.e., handcrafted product, basket. In addition, villager pay attention on increasing the investment fund in community as they believe the benefits will be gained more for agriculture sector. 2) Suitable raw material for food processing are sugarcane and rice while the promoted product such as Noni juice was not in consideration neither improvement for achieving standard. Researcher attempted to show process of un-refinery sugar production and disseminate knowledge by exchanging the lessons and learns under the scope of production technology, marketing and management among producer group from Singburi province and provincial of industry from Singburi Province. By this exchanging experience, producers were gathered and form group of farmers (producers) and sale product in the local community and nearby. The packaging of products was also studied to find the most suitable for the products.

**MANAGEMENT OF COMMERCIAL CHICKEN MARKETING: OPPORTUNITIES AND  
CHALLENGES FOR MARKET ACTORS OF CHICKEN PRODUCTS**

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Poultry business in Indonesia is growing faster than other livestock commodities. This business has become the industry that has component completely from pre-production up to post-production. This development of business gave significant contribution in the agricultural development. This paper will explain the opportunity and challenges for market actors that involves in this industry especially in the small and medium levels in Yogyakarta, Indonesia. The method of this study was field research. Key informants were use to gather the data: farmers, middlemen, owner

of chicken slaughter house, and head of livestock office of Yogyakarta province. The data were analyze using descriptive statistics. Results showed that poultry business in Indonesia still concentrate in small scale, consequently, the business efficiency and profit feasibly difficult to reach. Many opportunities in this business can be taken by the market actors. Some problems also existing in this business such low quality of chicken meats and eggs, and price fluctuation. Cost fluctuation was effected by fluctuation in the production level caused to contraction in the supply level.

## **INCOME DISPARITY IN TWO RICE FARMING VILLAGES IN MALAYSIA**

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Malaysia has achieved dramatic economic growth since the late 1980s, largely due to multi national companies investing foreign capital in industrial zones on the west coast. GDP share of the manufacturing sector increased from 16.8 % in 1980 to 31.4 % in 2005. As this industrialization has been concentrated on the west coast, we may expect to see a situation of economic imbalance between the west and east coasts of the Malaysian peninsula. It is therefore necessary to study the reality of income disparity and indicate the nature of inequality in relation to the regional, household and individual levels. Also by clarifying inequality in two villages among rice farm households, we can specify the factors which have influenced inequality between the two villages and within each. Interview surveys were conducted in 2006 and 2007 in Sebrang Prai and Kelantan. A total of 42 and 39 farm households were studied respectively. This paper aims (1) to identify economic standing on the east and west coast under different geographical conditions; (2) to clarify the current situation of income distribution at the household and individual levels in both villages; and (3) to examine factors responsible for determining total income among farm households.

## **FARM PRODUCTIVITY AND FARMER EMPOWERMENT: A CASE OF SUSTAINABLE AGRICULTURAL PRACTICE IN MALAYSIA**

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Advent of Industrial agriculture, led to considerable environmental harms such as depletion of biodiversity, soil degradation, pollution and global warming. Furthermore concentration and vertical integration of corporate undermines farmer's participation in agrifood system. Farmers merely act as technology adopters and passive producers. In this system, farmers knowledge and innovations is impeded. In addition to this, heavy depended on agrochemical and fuel increases production cost, thus reducing the farmer's profit. The sustainable agriculture practices which rely more on the ecological process with exclusion of agrochemicals and high energy inputs, that can lead to healthy ecosystem and productive farm. Besides this, sustainable agriculture practices actively engage farmers themselves into agrifood system in terms of production, marketing, management, research and innovation. Objective of this case study was to explore the impact of sustainable agriculture practices among selected Malaysian farms on farm's productivity and farmers empowerment. In order to address these objective, we chose qualitative case study method, in which semi- structured interviews, participatory observation, secondary data collection and transect walks were carried out with farmers, extension officers and Non Governmental Organization workers. The study showed that in selected farms, sustainable agriculture practices such as composting, biological nitrogen fixation, crop rotations, application of biological pest control and herbal plant growth



promoter had created healthy soil, increased pest and disease resistant in crops, resulting in improved farm productivity in terms of diversified, healthy and high shelf life farm produce. Farmers earned more profit with reduction of agrochemical, machineries and direct access to local market and as well as with downstream products. Farmers become more decisive, creative, innovative and knowledgeable by involving in management, marketing, development of new products, advocating, public seminars, conferences and research. In conclusion, the sustainable agriculture practices could improve farm productivity and empower farmers to take control of their own development process.

### **AN ECONOMIC STUDY OF MAJOR FARMING COMPONENTS IN MID-HILLS OF NEPAL: CASES OF NUWAKOT, KAVRE AND LALITPUR DISTRICTS**

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Nepal is ecologically divided into three regions: mountain, hill and terai. These three regions are characterized by different types of land structure, climate and temperature, resulting in varying farming systems. This paper focuses on major farming components in the hills where farming is performed on slope and terrace. It is a distinct characteristic that farming in mid hills is based on three major components: crops, livestock and forestry. Crops provide feed and fodder, while in return animals supply draught power and manure, and forests give nutrients and support lands. In the past, upland hill farmers had used sloping land for subsistence farming, but the focus has been shifted to improve productivity and sustainability of the sloping upland farming in recent years, so as to meet the increasing needs of food security and livelihoods of an expanded upland population. In order to achieve the goal, the first task is to raise the level of the farm income. This paper tries to identify the economic role of each farming components, as these three components are playing the important role in the agriculture production. Based on data obtained from a questionnaire survey, conducted in December 2007- February 2008 and another in September 2008 in three villages located in the mid-hills, this paper attempts (1) to clarify the physical degree of interactions among the three components, (2) to examine the strength and weakness of the interactions, (3) to analyze economic contribution of each component to total farm income, and (4) to suggest a sustainable system on the basis of the three components

### **JOINT MARKETING OF AGRICULTURAL PRODUCTS: LESSONS LEARNED FROM THE IMPLEMENTATION OF RURAL AGRO-ENTERPRISE DEVELOPMENT IN INDONESIA**

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Agriculture is the leading sector in Indonesian economy. The production has increased but it does not accordingly always increase farmers' income. Farmers still face the lowest bargaining power in selling their produces in which they become the price taker at farm gate. Thus marketing practice that may influence the selling price and accordingly will lead to an increase in farmers' income is being important. CRS Indonesia, particularly the Agriculture Program, has implemented Rural Agro-enterprise Development (RAeD) Project (2004-2008) in collaboration with 9 local NGOs in 6 provinces in Indonesia. RAeD project put emphasis in marketing where farmers can sell their

produces and accordingly will increase their access to market and cash income. During the implementation of the project, CRS Indonesia conducted monitoring and evaluation in which questionnaire survey was conducted every year. This paper aims to (1) document the implementation of RAeD project and (2) analyze the impact of joint marketing in increasing farmers' income. Joint (collective) marketing through farmer groups and associations has been introduced. Farmers sold their agricultural products together through farmer groups or associations that conducted agreements with their business partners or buyers. The principles of the joint marketing are: (1) direct selling to final consumers or manufactures, avoiding dealing with the middlemen, (2) shortening the marketing channels, and (3) selling the products collectively, especially in the same territory (territorial approach). The selling price of the products is the same as the on-going price in the market, but farmers were able to receive higher prices compared to the conventional marketing practices due to the marketing margin by conducting direct selling and shortening the marketing channels. Farmer groups or associations protected farmers from receiving price lower than the market price, thus market survey was conducted regularly by the farmer groups or associations. Farmers have earned higher income through the joint marketing and hopefully it can be implemented in other areas.

**FACTORS AFFECTING STRENGTH DEVELOPMENT IN COMMUNITY ENTERPRISE,  
JORAKAE SAMPHAN SUB DISTRICT, U-THONG DISTRICT, SUPHAN BURI PROVINCE**

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This study sought to investigate some general background of leader farmers, status and potential of community in rice production, strength development task in community rice enterprise, relationship between some general background of leader farmers with their opinions in factors affecting strength development of rice enterprise in community, and constraints and recommendations in strength development of rice enterprise. Data collection was obtained through interview schedule from 78 leader farmers towards multistage sampling technique. Inferential statistics to testing hypothesis was Pearson product moment correlation coefficient. The findings revealed that major occupation was rice cultivation, and at least 1 minor occupation was found. Average total land was 26 rai (3.36 hectares). Average total income was 168,474 baht (USD 5,105, 1 USD = 33 bt.) per year. Rice cultivation twice a year was done by 80.8 percent of leader farmers. Major rice was cultivated in late July, 2-harvested in late Nov, 2005. Most popular variety was PATOOM THANEE No.1. Rice cultivation three times a year were done by only 16.7 percent of leader farmers. Major rice was cultivated in late July, 2005-harvested in late Nov, 2005. Most popular varieties were SUPHAN BURI No.60 and SUPHAN BURI No.1. Most popular second time for second rice was CHAINAT. More than half of leader farmers bought rice input from store in community. A few of them could use their own seed for coming crop year. Factor affecting strength development task in community rice enterprise that majority of leader farmers agreed at stronger level were type of leadership, type of group members, group atmosphere, pattern of group enterprise, and outside external support. More than half of leader farmers were needed to cooperate any times in all items of strength development management in rice enterprise. Most constraints in strength development of community rice enterprise were labor shortage and recommendation seed shortage. Most needed methods in strength development of community rice enterprise were training in vertical rice enterprise in the village and field study in rice enterprise. Testing hypothesis were found that there were non significant statistical between some general background of leader farmers with their opinions in factors affecting strength development of rice enterprise in community.

**TOWARDS AN INTEGRATIVE SOCIAL LEARNING APPROACH:  
ENHANCING COMMUNITY EMPOWERMENT FOR SUSTAINABLE AGRICULTURE  
DEVELOPMENT IN NORTHERN THAILAND**

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Enhancing community empowerment through capacity development to enable more farmers to play and active role in the decisions that affect their communities requires integrative and interactive approaches of social learning. There is also an increasing recognition that technological and social innovations are complex processes, which require knowledge domains from a variety of actors. The introduction and integration of external and local knowledge are created through a process of facilitation in various platforms of learning. Various critiques have been raised on effectiveness of facilitation in social learning particularly on its impacts on sustainable agriculture development and natural resource management, whether the process helps foster changes to maintain agro-ecological dynamics and environmental integrity. The premise to manage changes in complex environment requires systems and integrated approach to guide facilitating social learning. This paper presents different approaches in social learning that help promote technological and social innovation. It summarizes lessons learnt for achieving capacity development which resulted in different dimensions of community empowerment. A set of four case studies is presented to illustrate the critical importance of each learning approach and its impact on capacity development in practice. The paper also highlights farmers' adaptive strategies of managing changes and the roles of key actors in transforming production systems and practices. The four cases include: community rice seed development, conversion into pesticide free vegetable production, farmer-private partnership in organic rice farming and community farming enterprise development. The paper concludes with the discussion of implications for institutional arrangement and partnerships that may best enable the application of social learning in agriculture transformation for small farm holders.

**A STUDY OF FOOD CONSUMPTION PATTERNS AND CONSUMERS' RICE PURCHASE  
BEHAVIOR IN ASIA: FOR A FARMING STRATEGY REFLECTING CONSUMER NEEDS**

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The objective of this study is to reveal the relationships between food consumption patterns and consumer values as well as rice attributes that affect on rice purchasing behavior. It will give an implication to farmers to avoid risks that their products do not satisfy consumer needs and preferences. Rice is one of the most important foods for Asian farmers and consumers. In general, rice consumption increases first as the economy grows, then it decreases eventually as the economy grows further. Therefore, it is very important for rice farmer to be careful with the shift of consumer needs and to adjust their farming strategies to the shift. For the objectives, 1) food consumption patterns of several Asian nations, such as Japan, Korea, Thailand, Taiwan, and Vietnam, were clarified based on food balance sheets data (secondary). Then, 2) a comparative analysis of consumer values and rice attributes (variety, price, aroma, production method, etc.) were implemented by using CHAID analysis (Chi-squared Automatic Interaction Detector) based on the data collected by a questionnaire survey given to consumers in 2007 in above mentioned nations. The results of this analysis shows: 1) as the economies grew, food consumption patterns of Japanese and Taiwanese have shifted to the

diets that include higher percentage of fat and less rice. This shift is followed by Korean, and then Vietnamese and Thai consumers whose diets are still heavily rely on rice. 2) The results of CHAID analysis shows that Japanese, Korean and Taiwanese consumers' values are very much diversified; however, there are fewer "saving persons" on rice purchase in these nations. 3) Consumer values become more safety and health conscious as the economy grows. The values of safety and health conscious are found in multiple consumer demographics in this analysis, and the values are achieved through various attributes of rice. However, the relationship between the values and the attributes are not significant.

#### **EXTRACTION OF CHITOSAN-GLUCAN COMPLEX FROM FUNGUS AND YEAST FOR IN-VITRO STUDY ON THEIR CHEMOTHERAPEUTIC POTENTIALS**

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$\beta$ -glucan is a common component of yeast and fungal cell walls, and it is known as biological response modifiers, which stimulate the immune system of the host and exert an amazing range of immunopharmacological activities. In the cell wall of yeast and fungus,  $\beta$ -glucan is covantly associated with chitin and these two biologically active polysaccharides in the complex may enhance its pharmacological effect. The chitosan-glucan complex was isolated from the cell wall of baker's yeast (*Saccharomyces cerevisiae*) and fungus (*Aspergillus niger*) which was grown on sweet potato pieces supplemented with mineral solution. Mycelia were harvested after 7 days of cultivation. The extracted water-insoluble complexes were solubilized in water by means of carboxymethylation. The isolated complexes were characterized by UV, IR and NMR spectroscopy. Mineral contents of the complex were also determined. Chitosan which were obtained from chitosan-glucan complex treated with 2% Acetic acid solution have antimicrobial activities against two gram-negative (*Escherichia coli*, *Salmonella typhimurium*) and gram-positive bacteria (*Staphylococcus aureus*). The resulting carboxymethylated complex were detected their anticancer activities with human fibroblast cell lines in comparison.

#### **ISOLATION OF SESQUITERPENE SYNTHASE FROM PEPPERMINT THAT CATALYZES THE PRODUCTION OF APHID ALARM PHEROMONE B-FARNESENE AND ITS EXPRESSION IN *E. COLI***

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The trans- $\beta$  farnesene in peppermint was synthesized by sesquiterpene synthase which encoded by *tspa11* locus that mimics the aphid alarm pheromone. The specific primers were designed by alignment the three accessions of *tspa11* retrieved from the GenBank named *Lumi Far5* forward [5' CACCTCTAGAATGGCTACAA ACGGCGTCGTA3'] and *Far 2B* reverse [5' GGATCCTCAAAAG ACTATGGCATCAACAAAGAG3'] which included the *Xba* I and *Bam*HI recognition sequences to the 5' ends, respectively. The total RNAs were extracted from peppermint leaf and subjected to cDNA synthesis and PCR in the coupled one step RT-PCR reaction. The PCR fragment was cloned into PCR<sup>®</sup>8/GW/TOPO<sup>®</sup> and selected the clone harboring the insert fragment of this gene for sequencing. The 1662 base pair of DNA sequence and 552 deduced amino acid were obtained from the inserted clone. Subsequently, the *tspa11* fragment was re-amplify from the cloning vector using

the proof reading DNA polymerase *Deep Vent* and ligated into Campion™ pET160 Directional TOPO® expression vector. The positive clone was further introduced into *E. coli* BL21Star™ (DS3) for protein expression. The optimum time for protein production was 6 hours after induction that produced discrete band of approximately 55KD. The purification protocol may apply the Ni<sup>+</sup>NTA affinity column to obtain the purified protein for immunization and for further detection the level of sesquiterpene synthase in transgenic papaya after introducing of this gene by means of genetic transformation.

**INSECTICIDAL ACTIVITY AND CHEMICAL COMPOSITIONS OF *STEMONA BURKILLI* AGAINST *SPODOPTERA EXIGUA* AND *SPODOPTERA LITURA***

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The increasing awareness about the environmental and health impact of pesticide use including the increasing demand for food safety and quality led to a higher degree of interest in integrated pest management utilizing biopesticides as one of the tools. *Stemona* sp.(Stemonaceae), a potential plant, have been widely used for vegetable crops pests control in Thailand especially crucifers. Initial investigations on *Stemona burkilli* root extracts were shown to possess insecticidal activity<sup>1,2</sup>. In this research, *Stemona burkilli* roots were sequentially extracted with hexane, dichloromethane and methanol and bioassayed. The result showed that dichloromethane crude extract (DCE) exhibited the highest toxicity against *Spodoptera exigua* and *Spodoptera litura* by leaf dipping method. with LC<sub>50</sub> values of 6,204 and 9,589 ppm at 24 hr, respectively. The DCE was further isolated on silica gel column chromatography and successively purified by preparative HPLC with 100% EtOH elution to give two active fractions. Among the two, fraction 2 showed stronger influence on antifeedant activity in no-choice leaf dip test by giving 80.0 ± 1.07 and 87.9 ± 2.05 % feeding reduction against *Spodoptera exigua* at 17.70 and 44.25 µg/cm<sup>2</sup>, respectively. Against *Spodoptera litura*, at 15.00 and 30.00 µg/cm<sup>2</sup>, fraction 2 could reduce feeding activity by 80.14 and 83.12 %, respectively. Results informed that *Spodoptera exigua* was more susceptible to the active compound than *Spodoptera litura*. On the basis of IR, GC-MS, <sup>1</sup>H NMR and <sup>13</sup>C NMR spectral data, the active compound responsible for the insect activity was identified as stemofoline. In addition, we found that the purified fraction 1, which was effective in causing larvae mortality even less toxicity than compound stemofoline, had EI- mass spectrum identical with stemofoline. Consequently, fraction 1 was suggested to be an isomer of stemofoline. These findings indicated that *Stemona burkilli* root extract could be applicable as an alternative agent for controlling larvae of *Spodoptera exigua*, as well as larvae of *Spodoptera litura*.

**INSECTICIDAL EFFECTIVENESS OF *PIPER RETROFRACTUM* AND *TEPHROSIA VOGELII* EXTRACTS AGAINST *CROCIDOLOMIA PAVONANA* AND *PLUTELLA XYLOSTELLA* AND THE SAFETY OF THE EXTRACTS TO *DIADEGMA SEMICLAUSUM***

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Most farmers rely heavily on the use of synthetic insecticides to control crucifer pests. Excessive use of insecticides may lead to some undesirable side effects to the environment and human

health. In order to alleviate this problem, botanical insecticides could be used as alternative to conventional insecticides. The active fractions of ethyl acetate extract of *Piper retrofractum* (Pr) fruits and hexane extract of *Tephrosia vogelii* (Tv) leaves and their mixtures were evaluated for their insecticidal activity on second-instar larvae of *Crocidolomia pavonana* and *Plutella xylostella* as well as for their safety to the adults of *Diadegma semiclausum* parasitoid. Fraction (fr) 2 of Pr from vacuum liquid chromatography (VLC) and fr 2-4 of Tv from column chromatography (CC) had strong insecticidal activity on *C. pavonana* and *P. xylostella*. In the test with *C. pavonana*, the two fractions were more active by feeding than by contact. Based on LC<sub>50</sub> at 72 hours since treatment (HST), fr 2 VLC Pr was 3.8 times more toxic than fr 6 VLC Pr to *C. pavonana*. Besides, fr 2 VLC Pr was 2.4 times more toxic to *C. pavonana* than to *P. xylostella*. On the contrary, fr 2-4 CC Tv was 1.8 times more toxic to *P. xylostella* than to *C. pavonana*. The mixture of fr 2 VLC Pr and fr 2-4 CC Tv at concentration ratios of 8:5 and 5:1 was antagonistic to *C. pavonana* and *P. xylostella*, respectively. The mixture of fr 6 VLC Pr and fr 2-4 CC Tv, however, had additive to weak synergistic joint action against *C. pavonana*. At equal test concentrations, the treatment with fr 2-4 CC Tv and its mixture with fr. 2 KVC Pr caused much lower mortality in *D. semiclausum* parasitoid adults than in its host larvae, *P. xylostella*. This suggests the selectivity of the test extracts in favour of the parasitoid. In contrast, an organophosphate profenofos, included in this study as a positive control, was much more detrimental to *D. semiclausum* than to *P. xylostella*. In a semifield experiment, fr 2-4 CC Tv had comparable effect to profenofos and bioinsecticide *Bacillus thuringiensis* in reducing the population of *C. pavonana* larvae on broccoli plants. Thus, *T. vogelii* extract preparation and, to a limited extent, its mixture with *P. retrofractum* extract hold the potential as alternatives to conventional insecticides for the control of crucifer pests.

**INSECTICIDAL ACTIVITY OF *AGLAIA ODORATA* (MELIACEAE) COLLECTED FROM SEVERAL LOCATIONS AGAINST *CROCIDOLOMIA PAVONANA* (LEPIDOPTERA: PYRALIDAE) LARVAE**

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Extract of *Aglaia odorata* (Meliaceae) has been known to possess insecticidal activity to several insect pests. As an insect pest control agents for field application, the preparation of mass extract product is necessary, therefore a large number of plant raw material sources is needed. On the other hand, content of plant active compound is greatly influenced by climate condition and location where those plants are growing. So, the objective of this study is to evaluate the insecticidal activity of *A. odorata* taken from several locations against *Crocidolomia pavonana* (Lepidoptera: Pyralidae) larvae. Plant materials were collected from Bogor (Cimanggu, Ciapus, and Bogor Botanical Garden), Bekasi, both are located in West Java, and Tegal of Central Java. Plant materials were extracted with methanol and then extracts were bioassayed by using leaf residual method. Based on the LC<sub>50</sub> and LC<sub>95</sub> values, the results showed that there were differences on LC<sub>50</sub> and LC<sub>95</sub> values of each extract. This result suggests that difference locations of plant growth may cause the differences in insecticidal activity of plant extracts.

**INSECTICIDAL ACTIVITY OF *PIPER CUBEBA* FRUIT AND *TEPHROSIA VOGELII* LEAF EXTRACTS ON THE CABBAGE HEAD CATERPILLAR, *CROCIDOLOMIA PAVONANA***

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Most farmers rely heavily on the use of synthetic insecticides to control crucifer pests. Excessive use of insecticides may lead to some undesirable side effects to the environment and human health (Stenersen 2004). In order to alleviate this problem, botanical insecticides could be used as alternatives to conventional insecticides (Prakash & Rao 1997; Isman 2006). This study was conducted to evaluate the insecticidal activity of hexane extract of *Piper cubeba* fruits and *Tephrosia vogelii* leaves and their mixture on the cabbage head caterpillar, *Crociodolomia pavonana*, in the laboratory and greenhouse. Commercial insecticide formulations containing *Bacillus thuringiensis* (Bt) and profenofos were included in this study as positive controls. *P. cubeba* extract consisted of oily and solid phase, in which only the solid phase was active. Hereafter, for the sake of brevity, the solid phase of *P. cubeba* extract is shortened to *P. cubeba* extract. In the treatment with *P. cubeba* and *T. vogelii* extracts as well as with Bt, the mortality of the test larvae was still low at 24 hours since the beginning of the treatment (HBT) and increased after 48 HBT. Based on LC<sub>50</sub> at 72 HBT, the order of toxicity of the test materials against *C. pavonana* larvae was as follows (in a decreasing order): *B. thuringiensis* = profenofos > *P. cubeba* + *T. vogelii* extract mixture ≥ *T. vogelii* extract > *P. cubeba* extract, with LC<sub>50</sub> of 0.010%, 0.013%, 0.112%, 0.14%, and 0.341%, respectively. The mixture of *P. cubeba* and *T. vogelii* extract had weak synergistic joint action at the LC<sub>50</sub> level for the assessment time at 48 and 72 HBT, whereas at the LC<sub>95</sub> level, the mixture was additive at 48 HBT and weak synergistic at 72 HBT. In the a persistence study in the greenhouse, the treatment with Bt residue caused fairly high mortality of *C. pavonana* larvae (>85%) until 7 days after application (DAA), whereas *T. vogelii* extract had relatively good persistence (larval mortality >70% at 7 DAA) and *P. cubeba* + *T. vogelii* extract mixture had moderate persistence (larval mortality >50% at 7 DAA). In general, the residual activity of the test materials started decreasing at 3 DAA. The residual activity of profenofos decreased sharply from 3 DAA to 5 DAA and 7 DAA, i.e. larval mortality decreased from about 70% to 18% and 0%, respectively. Thus, *T. vogelii* extract and its mixture with *P. cubeba* extract hold the potential as alternatives to conventional insecticides for the control of crucifer pests.

**EFFECT OF *DENDRANTHEMA* ON *COTESIA PLUTELLAE* PARASITISM IN BRASSICACEOUS CROPS: CONTROL OF DIAMONDBACK MOTH, *PLUTELLA XYLOSTELLA***

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In Myanmar, the infestation of the diamond backmoth (DBM) was considered as one of the major constraints to cruciferous vegetable production. DBM becomes resistance to many pesticides and uses of pesticides cause damages not only to the environment but also to the farmers. It is safer and cheaper than pesticides to plant selected flowers into brassicaceous crops in the control of diamond backmoth. Two commercial fields of each of cabbage, cauliflower, and kale, with active spraying programmes, were used and all were under same treatment. The larval population was examined before the treatment and repetition was carried out after 14 days. Parasitism rate of diamond backmoth larvae by *Cotesia plutellae* was significantly higher in the fields adjacent to *Dendranthema* than away. *C. plutellae* parasitism rate occurred highest in cabbage plants (61.11%) and lowest in kale

plants (25%) when planted adjacent to *Dendranthema* flowering plot but DBM larval population was not significant. Serious elimination of adult parasitoids was occurred by the pesticides at their recommended doses. DBM population was 0.71, 0.6, and 0.2 larva /plant in kale, cauliflower, and cabbage respectively, but small white butterfly population was significantly higher in adjacent plots as the result of *Dendranthema* plant.

## **EFFECTS OF THE CONSORTIUM OF ENDOPHYTIC BACTERIA, CHITINOLYTIC BACTERIA, AND PLANT GROWTH-PROMOTING RHIZOBACTERIA ON THE GROWTH OF BANANA AND THE ACCUMULATION OF BANANA BUNCHY TOP VIRUS**

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Banana Bunchy Top is one of the most important diseases of banana in Indonesia. Nurhayati (2003), in West Java (Bogor, Cianjur, Pandeglang, Subang dan Sumedang) the virus has been spread widely with the disease incidence was about 7.2-38.6% As an alternative control of the disease, each isolate of endophytic bacteria (*Pseudomonas* PK5), chitinolytic bacteria (*Aeromonas caveae*), and Plant Growth-Promoting Rhizobacteria (*Bacillus cereus* L32) were investigated individually and/or in combination. The effects of treatments were also investigated to the abundance of fluorescent *Pseudomonads* and heat tolerance bacteria using plate-count method. Based on the green house experiment data, at 60 days after inoculation of Banana Bunchy Top Virus (BBTV) the height of the plant treated with bacteria were significantly higher than control plants. The height of the plants treated with bacteria was at range of 82.7 to 88.2 cm while control was up to 71.6 cm. The accumulation of BBTV on the plants treated with endophytic or chitinolytic bacteria individually were not significantly different compared with control but for the other treatment the accumulation of BBTV was higher than control. In the field, 120 days after transplanting, the diameters of stem of plants treated with *Bacillus* and/or *A. caveae*, individually or in combination among them, were relatively lower compared with control. Application of *Pseudomonas* individually or in combination with *Bacillus* or *A. caveae* caused the diameter of stem were relatively higher than control. The highest diameter of stem on 120 days after treatment was up to 17.27 cm on the plants treated with *Pseudomonas* combined with *A. caveae*. The highest population of heat tolerant bacteria, i.e  $1.8 \times 10^4$  cfu/g soil, was found in the soil both treated with combination of *Bacillus*+*A. caveae* and *Bacillus*+*Pseudomonas*+*A. caveae*, while the lowest was found in the soil treated with *A. caveae*, i.e  $1 \times 10^3$  cfu/g soil. Population of fluorescent *Pseudomonads* in the soil treated with *Bacillus* and *Bacillus* + *Pseudomonas* was similar with Control, while in the other treatments the population of fluorescent *Pseudomonads* were relatively higher than those in control.

## **PRODUCTION OF ANTAGONISTIC ACTINOMYCETES AGAINST *FUSARIUM OXYSPORUM* BY SOLID STATE FERMENTATION**

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The *Streptomyces* sp. isolate 22.2 was isolated from Termite mound and proved to have antagonistic effect against *Fusarium oxysporum* that caused Fusarium Wilt in solanaceous crops (tomato, potato, pepper, and egg- plant). The antagonist isolate 22.2 had chitinolytic activity, therefore, chitin could be used as their carbon source in culture medium. The biomass production of



antagonistic actinomycetes for using as a plant pathogen fungal control agent could be possible by the utilization of shellfish processing wastes. Shrimp shell powder prepared from dried shrimp processing waste was used as a major carbon source in culture medium. For optimization of solid-state fermentation of the antagonist, response surface methodology based on central composite design (CCD) was used. The design was employed by selecting ratios of shrimp shell powder-to-rice bran for being carbon sources in solid medium that having soy bean meal as nitrogen source at the ratio of carbon and nitrogen source 10:1, moisture content, and incubation time as model factors. The maximum yield of the antagonistic actinomycetes biomass derived from the optimized solid state fermentation using shrimp shell powder-to-rice bran ratio, 1; moisture level, 60%; and incubation time, 5 day was  $7.5\text{--}8.0 \log \text{cfu.g}^{-1}$  dry matter.

#### **METABOLIC FINGERPRINTING OF *ERWINIA CAROTOVORA* ISOLATED FROM JACKFRUIT, CHUMPHADA AND VEGETABLE**

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Bacteria were isolated from jackfruit and chumphada which shown gummy from tree branch and die back symptom which identified the causal agent as *Erwinia carotovora* group by *pel* gene. Moreover, the bacteria can infect either tree or vegetable where as EC isolated from vegetable can not (Sudjasin, *et.al.* 2005). The objective of this study was use metabolic profile to study phenotypic variability of EC isolated from tree and vegetable. Bacteria were grown on nutrient agar at 30°C for 16 hr. Bacterial suspension were prepared by scrubbing bacteria and diluting in inoculation fluid at 63% transmittance. The bacterial suspension of each strain was inoculated 150 µl/well into Biolog GN2® microplate. Plates were incubated at 30°C for 16 hr and measured carbon source utilization by Microlog™ System. Bacterial carbon source utilization profiles were translated into binary numeral system. Phylogenetic dendrogram based on carbon used as substrate characteristic was generated by simple matching coefficient and clustered by unweighted pair-group method, arithmetic average (UPGMA). The *Erwinia carotovora* (EC) grouped in the same branch at 86% similarity coefficient while *Erwinia chrysanthemi* (ECH) separated at 77%. The EC which isolated from vegetable and tree were separated at similarity coefficient of 89.5%. The EC isolated from tree divided into two branches while the EC isolated from vegetable mostly in the same branch. From the result, the bacteria isolated from tree emphasis in EC member that metabolic profile similarity more than 80%. However, they may be a different sub-species group which 93% similarity of sub-species level had been shown in *Pantoea stewartii* subsp. *stewartii* (Willson, *et al.*, 1999).

#### **SOYBEAN INDUCE ITURIN A PRODUCTIVITY OF *BACILLUS SUBTILIS* NB22**

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Iturin A is a lipopolypeptide which shows antifungal activity for several kinds of plant pathogenic fungi. *Bacillus subtilis* Nb22 is one of the Iturin A producing bacteria. Previously, we showed that the suppressive effect of the solid state culture of *B. subtilis* Nb22 for *Fusarium* yellow of Taasai by combination with organic matters as media, and soybean cake was the most effective treatment for suppression and for Iturin A producing by *B. subtilis* Nb22. Hence, it is deduced that IturinA production is one of the critical matters for suppression of plant diseases by *B. subtilis* Nb22. In this study, we compared commercial polypeptons which were derived from different raw materials

and digested by different enzymes for Iturin A production in liquid medium. Number 3 medium (polypepton 1%, glucose 0.5%,  $\text{KH}_2\text{PO}_4$  0.1%,  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  0.05%) was used as basal medium for Iturin A production (Phae and Shoda, 1991). All of 7 kinds of polypeptons were purchased from Nihon Pharmaceutical (Tokyo, Japan). Raw materials of polypeptons were soybean cake, purified soybean protein, fish meat, and milk casein, respectively. After 5 days incubation at 25°C by shaking, there were no differences among 7 kinds of polypeptons for cell numbers in culture. By using 3 kinds of polypeptons which were derived from soybean cake with digested by different enzymes, *B. subtilis* Nb22 produced Iturin A, whereas by using of polypeptons which were derived from purified soybean protein, fish meat, and milk casein, Iturin A was not detectable in liquid culture. Our results showed that soybean contained inducer(s) for Iturin A productivity of *B. subtilis* Nb22 and the inducer(s) were not available by purification of protein from soybean.

#### **STUDY ON NATURAL ENEMIES OF INSECT PESTS ATTACKING VEGETABLES, BEANS, ORANGE FRUIT TREES IN HA NOI, VIETNAM.**

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Natural enemies of key insect pests play a big role in reducing their population. This study concentrated only on the key insect pests in vegetables, beans, orange fruit trees and their natural enemies found in Hanoi, where these crops are heavily cultivated. We found 7 species of predatory fly belong to Chamaemyidae and Syrphidae family of Diptera. They are natural enemies of aphids attacking on cucumber fields in Hanoi region. We found 14 species of indigenous natural enemies of *Thrips palmi*, belong to 4 orders (*Hemiptera*, *Thysanoptera*, *coleoptera* and *Hymenoptera*). Among 14 species, 13 species are predator and only one species is parasitoid. The relationship of population dynamic between *Thrips palmi* and *Orius sauteri* are closely, between *Thrips palmi* and *Orthotylus* sp. are more closely. We found 13 species of predatory bug which belong to 5 families on leguminous crop at Dang Xa-Gia Lam, Hanoi. There were 4 species of whitefly belong to Aleyrodidae: Homoptera attacking on citrus trees and 3 parasitoids species, 3 predator species in Gia Lam, Hanoi. The life cycle of the predatory bug *Orius sauteri* Poppius, predatory fly *Syrphus ribesii* Linne, *Eocanthecona furcellata*, and *Coranus fuscipennis*. The predatory bug *Orius sauteri* Poppius was successfully mass-reared on *Corcyra cephalonica* egg and *T. palmi* larvae for release to the field. Yield of cucumber in every three treatments (chemical control treatment, chemical control + biological treatment and biological control treatment) were significant different if compared to the control treatment. In the biocontrol treatment and in the chemical treatment, the cucumber yield was not significant different at 5 % level, this demonstrated that the effect of predacious bug is equal to insecticide control.

#### **SURVEY OF COCONUT CADANG-CADANG VIROID SEQUENCE IN OIL PALM WITH ORANGE SPOTTING DISORDER USING MOLECULAR DIAGNOSTIC TOOLS**

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The lethal cadang-cadang disease of coconut palms (*Cocos nucifera* L.) in the Philippines is caused by *Coconut cadang-cadang viroid* (*Pospiviroidae: Cocadviroid*). It has caused extensive losses to coconut production in the Philippines. Several species of palm and other monocotyledons in Oceania and South-East Asia have been shown by molecular hybridization assay to contain CCCVd-related sequences. In African oil palm (*Elaies guineensis*) plantations in South East Asia and the

South Pacific, CCCVd-related molecules were frequently associated with an orange leaf spotting disorder previously described as “genetic” orange spotting (GOS). In this study, variants of CCCVd have been identified in plantation oil palms with orange spotting disorder growing in Malaysia. These variants were detected by molecular hybridization of dot blots and Northern blots of two-dimensional polyacrylamide gels (2D-PAGE) with a  $^{32}\text{P}$ -labelled 246 nt form of CCCVd (CCCVd<sub>246</sub>) cRNA probe. In addition, a ribonuclease protection assay (RPA) has been developed for detecting the 246 nt sequence of CCCVd. It has been widely used as a powerful sensitive method to detect and quantify specific RNAs and its variations in nucleotide sequence of a RNA population. A small scale survey in three commercial plantations in Malaysia showed OS incidence ranging from 13-16 %. Thirty palms were screened for CCCVd sequences using methods described above and 17 out of 30 commercial oil palms sampled contained CCCVd sequences. Cloning and sequencing of RT-PCR products from the oil palm showed over 90 % sequence similarity to the 296 nt form of CCCVd (CCCVd<sub>296</sub>) from the Philippines. Three size classes are described comprising 297, 293 and 270 nt. Mutations and deletions accounted for the different sizes. At present, OS is not considered to be economically important, hence, no major research effort has been carried out to investigate this problem, especially the etiology and epidemiology of the disorder. However, with this evidence, serious consideration is needed to study the threat of CCCVd to the oil palm industry.

#### INTEGRATED PEST MANAGEMENT USING BIOPRODUCT FOR CHINESE KALE PRODUCTION

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Field experiment was set up in Suphanburi chinese kale production area using RCBD of 12 treatments or technologies during 29 Feb to 19 Apr, 2008. The size of the plots depending on the commercial field 5x7 m. The 9 treatments investigated were KU-Technology package of integrated management system of disease and insect pest. Evaluation of the results was based on pest control efficacy and yield obtained. The result revealed that all KU-Technology packages (T4 to T12) provided the better yield increased ( $P=0.05$ ) and reduction of disease severity (*Alternaria* leaf spot) and number of insect pest incidence (*Plutella xylostella*, *Spodoptera litura*, and *Phyllotreta flexuosa*) compared to those of sole chemical treatment (T2 copper hydroxide seed treatment+6-copper hydroxide+mancozeb fungicide+6-abamectin insecticide spray intervals) and untreated control (T3). The KU-Technology of T5 (seed treatment and 3-foliar spray intervals with *Pseudomonas fluorescens* SP007s), T10 [SP007s seed treatment and 3-foliar sprays+4-botanical spray of Non-taai-yaak (*Stemona collinsea*) +1-natural enemy release of stink bug (*Eocanthecona furcellata*) and earwigs (*Proreus similans stallen*)], and T11 (SP007s seed treatment+3-foliar plus algae extract sprays+4-botanical sprays+1-natural enemy release) exhibited the best result in terms of increasing yield (with 10.3 t/ha obtained from either T5 or T10) that were significantly different ( $P=0.05$ ) from T1 of conventional grower plots (alachlor+8-swine placenta extract plus EM+6-abamectin+8-copper hydroxide sprays). Furthermore, the lower epidemic of *Alternaria* leaf spot and insect incidence of *P. xylostella*, *S. litura*, and *P. flexuosa* correlating with the higher yield increase obtained from those KU-Technology packages was observed. The SP007s formula enhanced more plant growth and yield increased than SP007s cell culture suspension. The result also showed that insect monitoring and decision based on action threshold (T10, T11) were able to reduce the number of insecticide application and total cost of chemical control. These technologies should be an important integral part of Chinese kale pest management system. The KU-IPM Technology package of microbial antagonists (*P. fluorescens* SP007s, *T. harzianum* plus sodium silicate)+botanical pesticide+natural enemy in T10, T11, and T12 was the most promising to enhance plant growth and yield increase of Chinese kale

production. These studies demonstrated that a combination of KU-biological technology resulted in a reduction of all pest development and increased yield better than higher application rates of pesticides.

## **RISK IDENTIFICATION AND MITIGATION FOR INSECTICIDE USE IN VEGETABLES**

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Farmers resort to relying heavily on chemical control when insect pest pressure in vegetable production is very intense. Vegetable production offers a difficult situation for compliance to good agricultural practice, pre-harvest intervals in particular, when the financial situation is tight or when weather conditions require an early harvest. Some farmers spray every 2-3 days or even worse spray in the late afternoon and harvest early the next day. A nation-wide monitoring of vegetables in 2006 showed that about 30% of the samples contained detectable residues, which were generally below MRLs. There is therefore, a compelling need to identify risk and risk mitigation measures in this situation. Vegetables were sprayed at the recommended rate with insecticides late in the afternoon, harvested early in the morning of the next day and analyzed for residues. Home processing of vegetables, such as washing and boiling were done, while fresh fruits were also stored under ambient conditions to simulate wet market conditions to determine residues at this point in the supply chain. Dietary risk assessment for insecticides is made. Examples are discussed where insecticide residues, at one day after spraying, were within and above ASEAN MRLs; another discusses a situation without ASEAN MRL. Home processing reduces pesticide residues which may be present in vegetables. Substantial reduction under ambient temperature and indoor sunlight was also noted. Malathion registered the greatest reduction of residues. In countries where harvesting of vegetables do not conform to registered good agricultural practice, a re-assessment can be made and use patterns re-registered after satisfying a dietary risk assessment. Supervised pesticide residue trials (SPRTs) on insecticide use in minor crops like okra, kangkong and pechay need to be done. ASEAN countries should continue to work together in collaborative research to produce SPRT data that can protect consumers as well as for CODEX MRLs to protect our exports.

## **GERMPLASM EVALUATION OF PATHOGEN-TESTED POTATO ACCESSIONS GROWN FROM APICAL CUTTINGS IN THE PHILIPPINE HIGHLANDS**

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Sets of germplasm with wide range of genotypic characteristics were evaluated in the low mountain zone in the Philippine highlands. The trial was conducted to determine the growth and yield of 32 accessions grown from apical cuttings and to select promising accessions for further evaluation in different agro-ecological zones in the Philippine highlands. Tuber yield of selected accessions and check varieties Ganza, Igorota and Granola ranged from 1.25 to 23.29 t/ha and were significantly different among accessions. A total of 14 accessions were selected both by the researchers and farmers for their good yield, desirable tuber shape, skin color, and shallow eyes. Most of these selected accessions were resistant to late blight. It is recommended that these selected accessions be screened further for their adaptability in different agro-ecological zones in the Philippine highlands. Selected accessions will be included in the National Testing Center for final evaluation. Outstanding accessions will be recommended to the Philippine Seed Board for variety release.

## **FOOD SAFETY AND AGRO-PRODUCTION OF PLANT AND ANIMAL ORIGIN**

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Food safety has become more and more important and sometimes reaching to the crisis of risk in term of contaminants and consumer awareness. These situations have threatened and made food production system instability where stakeholder has to minimize as fast as possible. One of the visible pictures is the emerging of food safety risk that always appears one by one. However, the unavoidable factor such as global warming is also played an important role for these incidences without any reliable prediction. During 2000-2007, the development of food safety systems in Thailand is increasing and also regulatory support. Several quality standards have been issued and implemented such as National GAP within the Ministry of Agriculture and Cooperatives, ThaiGAP, GlobalGAP, GMP, HACCP, ISO 22000 and also Agricultural Standard Act B.E. 2551. These regulatory, both in voluntary and mandatory basis aim to reduce risks of any causes of food safety by management of the prerequisite factors, certified processes and also try to early identify any emerging hazards as preventive approaches. These indicators reviewed from many incident countries comprise of three different environment issues; the environment surrounding the food production, the food production chain from farm to table/fork and consumers. However, this can not be excluded the contamination by intention as had happened recently in case of melamine in feed and baby powder. In this paper, the various indicators for emerging hazards have been identified and will be presented in detail as predictive devices for the country in the future.

## **‘CLEAN AND SAFE’ AGRICULTURE IN NORTHERN THAILAND: ACHIEVEMENTS, CHALLENGES AND PRIORITIES**

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Concern about health and environmental hazards has led 'clean and safe' agricultural products to be an important issue among consumers, farmers and governments worldwide. This has been reflected in the increasing supply of and demand for organic and eco-labelled products. While developed countries' interests are focused on certified organic production, developing countries such as China and Thailand develop their produce along various levels of 'clean'. The clean continuum ranges from production practices including high chemical, safe-use chemical, chemical-free and no chemical to environmentally friendly practices (organic). The ideal clean produce system is perceived to be one that utilizes organic practices that allow the use of alternative fertilizers and bio-pesticides rather than chemicals. Safe-use and chemical-free practices are between organic and conventional practices and are a possible step before converting conventional farms directly to organic farms. Organic farming in Thailand was initially developed by farmers and non government organisations (NGOs) in the 1980s, and was subsequently implemented by the Thai government through a series of policies on clean produce to meet international standards. The progress began in 2004, where, in order to meet the requirement to export and improved domestic food quality, the policy on agricultural chemical-use reduction had established and extended the Good Agriculture Practice (GAP) program for major economic crops including vegetables. The government also declared 2004 as the year of 'Health for All' and highlighted clean and healthy food in a public campaign to raise

consumer awareness. In 2005, the government promoted organic agriculture as a national agenda. In 2007, the government restated the advanced policy for 2007-2008 on 'food safety' which takes into account the food chain or 'from farm to table'. There are various 'clean and safe' agricultural systems being developed in Thailand, although there is some confusion about what they actually mean and how they operate. This paper aims to review the initiatives on 'clean and safe' agriculture with emphasis on vegetables in 'clean and safe' farming systems in northern Thailand. The background of 'clean and safe' agriculture such as definitions, aims and principles will be briefly described. Then the discussion will focus on some important components of 'clean and safe' vegetable production systems in northern Thailand including research and development, certification systems, and market.

### **GOOD AGRICULTURAL PRACTICE IN TRANSITION OF DURIAN GROWERS TOWARDS PARTICIPATORY APPROACH IN CHANTHABURI PROVINCE, EASTERN THAILAND**

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The specific objectives of this study were to 1) determine GAP of durian growers towards farmers-participation approach, 2) examine existing condition and constraints in durian cultivation, and 3) initiate durian GAP innovation. Information on durian GAP was gathered from relevant agencies and in-depth interview with stakeholders and durian growers in Chanthaburi province. They also have been certified on durian GAP by Department of Agriculture, Ministry of Agriculture and Cooperatives, Thailand. There were several advantages on GAP durian production such as suitable physical factors for cultivation, local wisdom and skillfulness on cultivation technique that came from their long experiences, capability input used and also abundant recommendation technology to attain both quantity and quality towards market standardization. In addition, there were more market channels that access surrounding the areas. Weak points included exaggeration input used, higher cost, and market risk. However, because of GAP promotion, there were significantly lower chemical input used particularly fertilizer and pesticides used among certified growers. There were also increasing diversified crops that reduced risk instead of durian mono crops. Furthermore, cultivators have more opportunity to access R&D program from Office of Agricultural Research and Development (OARD), and Horticulture Research Centre (HRC), respectively. Currently, over existing oil crisis, the respondents faced a lot of constraints in particular high cost of transportation while compare with the other resource product, Rayong province. Recommendations for GAP promotion from concerned agencies were: 1) local wisdom harmonized with recommendation technology should be promoted, 2) durian central wholesale market center for GAP durian products only should be urgently provided, 3) image and brand name promotion should be continuously promoted both domestic and abroad through various media channels, and 4) appropriate and efficient vertical durian promotion data should be easily accessible.

**CAPACITATION OF LOCAL COMMUNITIES OF GEN. NAKAR AND INFANTA QUEZON ON GOOD MANAGEMENT PRACTICES IN BANANA PRODUCTION THROUGH FARMER-MANAGED TRIALS**

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The municipalities of Infanta and General Nakar in Quezon, Philippines are predominantly agriculture-based. These municipalities were badly affected by the November 2004 flashfloods due to overflowing of the Agos river that runs between these 2 municipalities, following successive typhoons and days of torrential rains. Illegal logging in the Sierra Madre mountain ranges was blamed for exacerbating the disaster. Close to 1,000 died and millions of pesos worth of properties were destroyed. The towns were inundated with mud and water. Resource-poor farmers were among the most badly affected, with their farmlands destroyed, covered by layers of mud and debris. Farmers were able to use the land again only after a year. Heeding the call to assist in the rehabilitation of the affected areas, the Project established farmer-managed trials on local banana cultivars in 22 trial sites involving 14 farmer-cooperators and a total of 2-ha. area (144m<sup>2</sup>-2400m<sup>2</sup> per site). A package of technologies (POT) for local banana cultivars was introduced by the Project which provided free tissue-cultured planting materials, fertilizers and technical support in exchange for farmers' participation in trials that included fertilizer treatments as per POT and biofertilizers. Farmer provided land, labor and security for the trials and gave free access to the Project team for monitoring and sampling. Further, the Project actively sought the involvement of the Local Government Units of Infanta and General Nakar who, are mandated to pursue and fund agricultural development of their constituent areas. This paper discusses the preliminary outcome of the farmer-managed trials and the other activities on assisting in the local capacitation of the local community in pursuing an expanded and sustainable banana production program before Project phase-out in June 2009.

**NUTRIENT DIGESTIBILITY COEFFICIENT OF WEANER PIGS FED DIETS SUPPLEMENTED WITH ESSENTIAL OIL MIXTURES AS FEED ADDITIVE**

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This experiment was conducted at Naresuan University, Phitsanuloke, Thailand to evaluate the potential of using 5 mixtures of essential oil extracted from clove, peppermint and orange peel in weaner pig diets for nutrient digestibility evaluation using 35 days old crossbred Duroc X (Landrace X Large White). Twenty four pigs consisting of 12 males and females were housed in individual cages and randomly distributed into 6 groups of 4 pigs each in a Completely Randomized Design. The pigs in each group were randomly fed with one of 6 diets as follows: diet 1 was a basal diet (control diet) containing corn-soybean meal. Diet 2, 3, 4, 5 and 6 was a basal diet supplemented with a mixture of clove oil : peppermint oil : orange peel oil at the ratios 1:1:1, 1:2:1, 1:2:2, 2:1:1, 1:2:2, and 2:2:1, respectively at 5 ml/kg diet. Experimental period consisted of 3 days for diet adjustment followed by 3 days of total feces collection for nutrient analysis. The results showed that digestibility coefficient of dry matter, crude protein, gross energy, crude fiber, ether extract and ash of the pigs fed diets 1, 3,

4, 5 and 6 were not significant different among treatments. However, the pigs fed diet supplemented with 5 ml/kg diet of mixture of clove oil : peppermint oil : orange peel oil at the ratio 1:2:1 had the highest nutrient digestibility coefficient. A mixture of essential oil extracted from clove, peppermint and orange peel at the ratio 1:2:1 has a potential for use as feed additive in weaner pig diets.

#### **SOIL CONSERVATION AND WEED MANAGEMENT THROUGH REDUCED TILLAGE AND HERBICIDE APPLICATION IN VARIOUS PRODUCTION SYSTEMS**

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This study being conducted in five Philippine provinces is a proponent of the Gramoxone technology (GSL) which stresses that through effective weed management and reduced tillage, the risk of soil erosion in farms will be minimized, if not reduced to zero, coupled with providing cost-saving benefits and increased yields to farmers. This technology involves pre-plant application and inter-row spraying of Gramoxone 20SL to control weeds. This is being compared to the farmer's practice (FP) of cultivation and clean culture. It aims to prove that Gramoxone technology is safe to users, cost-effective and practical to use in light of sustainable agriculture. It is also expected to explore different means of weed management as a way to combat soil erosion in farms and crop plantations in the Philippines. Three-year results of the study in four of the sites show that soil erosion was reduced in GSL over FP by 76.17, 61.33, 32.6 and 69.4% in Sites 1, 2, 3 and 4, respectively. Soil erosion in GSL treatments in these sites are below the allowable limit set by FAO which is 10 tons/hectare/year. Applying GSL reduced cost over FP by 38.6% in Site 1(corn), 20.0% (upland rice) and 28.0% (corn) in Site 2, 65.3% (cabbage) and 67.3% (potato) in Site 3, 33.6% (corn) in Site 4 and 44.5% (lowland rice) in Site 5. Yields in GSL treatments also showed significant increases over FP in most of the cropping seasons in the various sites. For weed management, applying Gramoxone as pre-plant and as inter-row is effective in suppressing the growth of all kinds of weeds and when applied at least one week before planting, the herbicide has no side effects on the crop. In Site 1, however, there was a shift to *Imperata cylindrical* in the corn field, hence, other methods of weed control should be included once the condition continues.

#### **THE UTILIZATION OF KAKAWATE (*GLIRICIDIA SEPIUM*) JACQ. KUNTH EX WALPH. WOOD ASH FOR CONCRETE ADMIXTURE**

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The search for raw materials in the innovation of technologies is now undertaken in many countries. Kakawate (*Gliricidia sepium*) is a multipurpose tree and its distribution in the Philippines is endemic. This study sought to determine the other uses of its waste, as the disposal of ash and sludge is a growing problem. A related problem is the recycling of other waste materials. Because of the high volume of kakawate trees in the area and that ash of kakawate wood is considered waste taken from dirty kitchens of every household, recycling the ash is made possible in the formulation of construction material for low-cost housing. It is a good admixture in the formulation. A methodology for the determination of the compressive strength of concrete cylinder mixed with kakawate (*G. sepium*) Jacq. Kunth ex Walph. using the proportion 20% ash and 80% cement for the



mixture 1:2:3. Information about the wood material's physical properties and related environmental and waste management issues are discussed as bases for the acceptability and practicability of wastes and recycled material (WRMs) and developed design to be recommended for construction of low-cost housing projects without sacrificing the strength of the structure.

### **ADOPTION OF VERMICOMPOST TECHNOLOGY: A KEY TOWARD SUSTAINABLE FOOD PRODUCTION**

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Kalinga is a consistent top hybrid rice producing province in the Philippines but the profit margin of the farmers is minimal due to the exorbitant prices of chemical fertilizer. Vermicomposting is an appropriate undertaking due to the presence of abundant rice straw which is a good substrate to produce quality organic fertilizer but farmers are not doing it. Thus, a study was conducted to identify the different factors affecting the adoption of vermicompost and test the difference of the net income of adopters before and after using vermicompost as fertilizer. There were 50 respondents, each were given with 200 pcs earthworm breeders and 10 kg vermicompost. Descriptive statistics were used to analyzed the data. Findings showed that the average annual income is far below the poverty line. There were only five respondents who used commercial organic fertilizer before using vermicompost. Statistics revealed that net income is greatly increased with the incorporation of vermicompost in their farming activities. The dominant reasons impeding the use of vermicompost in the farm are expensive cost of earthworm breeder, lack of information, and insufficient extension support in the community. To address these problems, subsidy from external sources must be established. Appropriate reading materials and support of extension offices coupled with frequent personal monitoring is needed to match the growing demand of the farmers.

### **DIGESTIBILITY AND FEEDING VALUE OF CATTLE RUMEN CONTENTS IN SWINE DIETS**

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The shortage and high cost of feed ingredients for livestock and poultry has forced raisers to identify raw materials, that are not used as food for man, for animal feeding and this includes cattle rumen content (CRC). This study was conducted to determine the digestibility, nutritive and feeding value, and economics of CRC as a component of plant protein-based swine diets. Five treatments were evaluated: Diet I (No CRC), Control), Diet II (10%), Diet III (12%) and Diet IV (14%) using Completely Randomized Design with three replications. Percentage dry matter recovery of cattle rumen contents was 25.02%. Proximate analysis revealed that CRC contains: crude fiber (24.8%), nitrogen free extract (53.99%) and crude protein (15.41%). Gross energy was 0.72 kcal/kg with an ether extract digestion coefficient of 82.48%. Crude protein and nitrogen free extract were moderately digestible, 65.17% and 46.57%, respectively. Crude fiber digestibility was 38.68%. Average initial and final weights, cumulative feed consumption and average daily gain of pigs were statistically similar in all treatments. Feed conversion ratio did not significantly vary during the starting and finishing stages, but varied significantly during the growing stage. Significant variations on protein efficiency ratio were noted only during the growing stage. Pigs fed with Diet V had the highest dressing percentage of 65.12 while Diet IV fed pigs had the lowest backfat reading of 1.66

cm. Pigs fed with Diet IV had the lowest cost of feed per unit gain in weight during the growing and finishing stages. Cattle rumen contents could be nutritionally and economically incorporated in swine diets at 10 to 14 percent levels.

## COCCINELLID FAUNA IN RICE AND VEGETABLE AGROECOSYSTEMS IN NORTHERN PART OF THAILAND

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Field survey of coccinellid fauna was carried out in the rice and vegetable agroecosystems in the northern part of Thailand in Chiang Mai area from October 2007 until September 2008 to determine their role and efficiency as natural enemies for biological control. Specimens were collected and identified using Natural Enemies Reference Depository (NERD) of the National Biological Control Research Center (NBCRC) at Kasetsart University in Bangkok. This investigation revealed more than 20 species of coccinellids which are generalist predators of insect pests of rice and vegetable. Few coccinellid species were found to be phytophagous and were not of biological control importance. Among these predatory coccinellids, *Curinus coeruleus* (Coleoptera: Coccinellidae) was an exotic species, introduced to Thailand by the National Biological Control Research Center since 1989 for successful biological control of leucaena psyllid, *Heteropsylla cubana* (Homoptera: Psyllidae). These coccinellids are considered naturally-occurring and could be attributed as partial but effective biological control agents for regulating the populations of certain insect pests in the rice and vegetable agroecosystems. Their conservation and augmentation programs are highly advocated.

## DEVELOPMENT OF A REDUCED USE PESTICIDE PROGRAM FOR THE SUSTAINABLE MANAGEMENT OF DISEASE, INSECT AND WEED ON CHINESE KALE PRODUCTION

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Epidemiology of pest complexes is one of the most serious problem affecting Chinese kale production in Thailand. Pest management in this vegetable crop traditionally has been accomplished through pesticide application that pose the risk of developing resistance and environmental concerns. Field trial was conducted during March-May, 2008 at Suphanburi production area to determine the effects of biocontrol agents and products in combination with cultural practices on the incidence of Alternaria leaf spot (caused by *A. brassicae*) and insect pest and weed population. Reduced pesticide programs comprising combinations of *Pseudomonas fluorescens* SP007s powder formulation (for disease control); *Bacillus thuringiensis*, Non-taai-yaak extract; *Stemona collinsea*, and natural enemy including stink bug: *Eocanthecona furcellata* and earwigs: *Proreus similans stallen* (for control of insect pest); and hoe weeding and straw mulching (for weed control) were investigated. Additional programs with alachlor herbicide, all alone pesticides (alachlor, copper hydroxide, abamectin, mancozeb), conventional practices (mentioned pesticides and swine placenta extract plus EM), and nontreated control were included in the experiment. Reduced pesticide programs provided adequate levels of disease, insect and weed management compared with nontreated control. Although the

programs did not clearly affect the abundance of weed populations, there were program differences in the incidence of disease and insect pests. When one of reduced pesticide program (5-Non-taai-yaak and 3- *P. fluorescens* SP007s foliar spray intervals) combined with alachlor herbicide, it significantly reduced *Alternaria* leaf spot, insect pests (*Phyllotreta flexuosa* and *Spodoptera litura* except *Plutella xylostella*), and weed population (broad leaf and early season grass) and increased yield compared to all alone pesticide and conventional programs. In this study, reduced pesticide programs comprised of stink bug and earwigs; and hoe weeding clearly reduced *P. xylostella*; and grass weed respectively. These reduced pesticide programs appear to be a promising strategy for pest management of Chinese kale production and could minimize grower reliance a conventional pesticide application.

### **GROWING MALAPAPAYA, *POLYSCIAS NODOSA* (BLUME) SEEMAN, AN ENVIRONMENTALLY, ECONOMICALLY AND FRIENDLY SOURCE OF LIVELIHOOD**

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Malapapaya is a soft wood tree *Polyscias nodosa* from the family ARALIACEAE. It is one of the most economically useful and promising lesser-used specie. It is a tall tree reaching a height of about 25 m and 50 cm diameter. It is harvestable 6 to 7 years after planting. It is one of the best sources of wood in the manufacture, among others, of plywood and veneer, wooden shoes, handicrafts/woodworks. Its most significant contribution to environment is its usefulness for the reforestation of denuded forest areas and best replacement for non biodegradable food containers. To be able to give not only the farmers, the community, but the Indigenous People a source of livelihood, help the country recover from disastrous killer flash floods due to denudation of forest and do away with the non biodegradable food containers. A seedling nursery for growing malapapaya was established in Rizal, Philippines. Plants are ready for sale and field planting or transplanting when they reach the height of 10-20 cm or 8-10 months old from sowing. The cost to produce a seedling ready for field planting is PhP10 and can be sold for PhP25 each with a return of investment of 40%. It is worth growing and producing malapapaya seedlings to supply the demand for planting materials here and abroad.

### **THE ECONOMIC EFFECTS OF RAINMAKING IN LAMTAKHONG RIVER BASIN, NAKHON RATCHASIMA PROVINCE**

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This research sought to analyze cost and return of rainmaking (weather modification activities) at Lamtakong River Basin, Amphoe Seekue and to reduce rainmaking expenditure. The research collected cost and return of rice, maize, cassava and sugarcane farms data of 2006/2007 crop year and interviewed 60 farmers of each crop. Regression analysis, ratio and descriptive method were used. To reduce rainmaking expenditure, rainmaking could operate only during May until October. Numbers of raining date were statistically affected on maize and rice yield. Rice farms at irrigation area obtained higher yield than rain fed area. There were 737.04 kilogram per rai and 433.00 kilogram per rai. Some scenarios showed statistically indifferent yield between rain fed area and non-rain fed area however statistically

different numbers of raining date. We might conclude that the rain might not directly increase yield but some indirect benefit were excluded or uncounted.

**SUSTAINABILITY ANALYSIS ON RESOURCES MANAGEMENT PLAN OF  
AGRICULTURAL COMMUNITIES AT KLONG MUANG WATERSHED, RAROENG SUB  
DISTRICT, WANG NAM KHIEO DISTRICT, NAKHON RATCHASIMA PROVINCE,  
THAILAND**

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The sustainability analysis on resources management plan of agricultural communities aimed to analyze the existing natural resources potential and environmental status as well as the socioeconomic conditions at Klong Muang Watershed, Raroeng Sub District, Wang Nam Khieo District, Nakhon Ratchasima Province then assessed the sustainability of community after applied the suitable resources management plan. The results revealed that the rainfall potential was in the moderate level where as the climatic conditions were in the warning stage. The potential of water resources was in the moderate level, but water quantity and quality were in the warning status. The potential of soil fertility was in the moderate level, but risky level for soil erosion conditions. Socioeconomic conditions were in the risky level. Land use and natural resource management plans were introduced to the community of Klong Muang Watershed. The study area was classified into Conservation Zone and Utilization Zone. Check dams construction and reforest remediation will be conducted to the Conservation Zone as well as water storage area, soil and water conservation practices for erosion control and organic fertilizer strategy will be applied in the Utilization Zone. The community co-operative shop will be opened in order to combine agricultural product and increase negotiative power. The minor job should be trained for higher income and decrease migration of the communities. The result on sustainable analysis showed that the status was changed from risky conditions to natural conditions.

**MAKING AID WORK FOR SUSTAINABLE COASTAL GOVERNANCE THROUGH  
CONSERVATION PARTNERSHIP AGREEMENTS (CPAS):  
THE EXPERIENCE OF THE SAGIP LINGAYEN GULF PROJECT (SLGP) IN  
MAINSTREAMING ACADEMIC KNOWLEDGE AND TECHNOLOGIES FOR COASTAL  
COMMUNITY DEVELOPMENT**

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The Philippines is one of the largest island-groups in the world. However, despite its vast and rich coastal resources, about 80% of the municipal fishing families still live below the poverty line. Overexploitation of resources, environmental damage both from marine and terrestrial origins, and increasing population contribute to a declining economic status of coastal fisherfolks. Sustainable and balanced development of coastal communities remain a challenge to most foreign-aid projects such as the Sagip Lingayen Gulf Project (SLGP) which is an Integrated Conservation and Development/Coastal Resources' Management (ICD/CRM) project funded by the Netherlands. SLGP developed models for co-management of the coastal environment leading to sustainable coastal resources, water quality and livelihoods. Its interventions include marine protected areas (MPAs) and

mangroves management, high value invertebrates' restocking, mariculture and water quality management, coastal law enforcement and direct legal assistance, resource-linked livelihood development and institution-building for local coastal governance. These are operationalised through a pioneering management and budgetary framework called the Conservation Partnership Agreement (CPA). The CPA internalises a set of working principles and strategies in making aid utilization for resource conservation and rural development more relevant, effective and efficient. Further, the CPA represents an important paradigm shift towards output-orientation, contractual accountability and rationalised cooperation. With CPAs, the SLGP partners who are permanently mandated institutions to undertake coastal resources management (CRM) buy into the implementation of CRM strategies developed jointly with and advocated by the SLGP, to further their own CRM programmes. The SLGP and its partners, Alaminos, Bani, Bolinao and Anda, San Fernando City and the Province of Pangasinan, Philippines and a number of people's organizations shared 15 months of experience in joint CPA implementation. This experience is shared in this paper for its instructive value to future ICD/CRM programming; it emerges a very specific set of insights from the field about "what CRM intervention strategies work, how, why and under what specific set of conditions".

**UNDERUTILIZED CROPS: THEIR IMPORTANCE IN THE SUSTAINABLE  
MANAGEMENT OF THE AGRICULTURAL LANDSCAPE OF THE LAGUNA PROVINCE,  
PHILIPPINES**

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The Philippines is among the countries in the tropics endowed with rich natural biodiversity. Despite this, only a few plant species are being fully utilized today for food, income and even for environmental conservation and enhancement. Laguna is one of the provinces in the country that is characterized by diverse agricultural landscape which often consists of mixed cropping systems where underutilized crops are a major component. Underutilized crops are plant and tree species that many communities traditionally use for food, fiber and animal fodder, oil or medicine but have further underdeveloped potential uses including diversifying cropping systems, developing value-added products, protecting the environment and restoring degraded lands. This study was conducted to show the importance of underutilized crops in enhancing agrobiodiversity of Laguna through a measure of its contribution to vegetation cover and implications on environmental protection; illustrate the economic importance of underutilized crops in Laguna through an estimation of their potential contribution in household occasional income hence their contribution to community/ local income; and provide recommendations on how these underutilized crops might be integrated into the farmers' decision-making on land use management and how the neglect of these biological resource may be overcome. At least 83 underutilized plant species were identified, mostly tropical fruit trees shrubs that serve as vegetables; medicinal herbs and rootcrops that are locally consumed. Underutilized tree species alone, contribute up to 40% of the total tree population in mixed cropping system. Occasional income from these crops benefits various sectors in the rural communities.. A review of the nutritive value of these plant species revealed valuable sources of minerals and vitamins, often lacking in the daily diet of the rural poor. To maximize potential contribution to environmental enhancement, food security and economic productivity, proper integration of these underutilized crops in different agroecosystems is necessary. Integration may include domestication or inclusion in the production system or conservation of species outside the production system.

**PRESENT STATUS AND SOME PROBLEMS OF SOYBEAN PRODUCTION  
UNDER RICE POLICY REFORM IN JAPAN: CASE STUDY IN SAGA PREFECTURE**

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In Japan, in order to uplift the extremely lower ratio of food self-sufficiency (40%; 2007), an increase of crops converted from paddy rice has been conducted with the emphasized intention along the context of rice policy reform based on the higher multi-utilization of paddy field in the recent years. However, the production of converted crops such as wheat & barley, feed grain (maize) and soybean has not necessarily been going upward due to the combination of some complicated factors like technological problem on growing, lower profitability in comparison with rice and vulnerability of labor force and farmers' group. On the other hand, there are also some production areas with good performance, overcoming the difficulty on crop growing, farm management and farmers' organization. Therefore it is considered that the research topics concerned with pulling out the successfully experienced lessons from the good examples will be beneficial from the viewpoint of practice. A case of Shiroishi-town in Saga prefecture provides the excellent examples in increasing the production of soybean. One of the greatest reasons in the increased soybean is attributed to the effective use of crop converted policy accompanied with adjustment of rice production. In this case, farmers' group plays an important role on materializing this use effectively. This presentation aims to clarify effective roles played by farmers' group in accordance with the crop converted policy, taking an example to rural area focused on soybean production in Saga-prefecture of Japan while explaining the national policy for the increase of soybean comprehensively.

**ASSASSIN BUGS (INSECTA, HETEROPTERA, REDUVIIDAE)  
COLLECTED BY THE AFRP EXPEDITION TO SOUTHEAST ASIA FOR 10 YEARS**

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Assassin bugs, or the Reduviidae, form the second largest family in number in the insect order Heteroptera, comprising approximately 7,000 species worldwide. All of them show predatory habits, feeding on small arthropods such as insect and millipedes, with a certain group having vertebrate-blood sucking habits. As the family includes many members attacking such pest insects as beetles and larvae of moths, some species have been investigated for use in biological control against agricultural pests (e.g. *Pristhesancus plagipennis* against pests of cotton and soybean crops in Australia). By the middle of 20th century, a number of reduviids had been described or recorded from various areas of Southeast Asia such as Sumatra, Java, Borneo (Kalimantan), Sulawesi and New Guinea (Irian Jaya) by old heteropterists such as Distant, Miller and Wygodzinsky. Since that time, little has been published on the Reduviidae in Southeast Asia for about forty years. Within the past ten years, several species of the Reduviidae have been newly described and recorded from Southeast Asia such as Vietnam, Thailand and Indonesia (East Java, Bali and Flores) by the members of AFRP. These facts indicate that these regions are still poorly investigated even though there are several historical studies on the Reduviidae. In the course of extensive faunal studies of the Southeast Asian Reduviidae conducted with AFRP for about ten years in undersampled countries such as Vietnam, Thailand and Indonesia (East Java, Bali and Flores), we collected a number of specimens of the Reduviidae. The collection indicates that high species diversity of the Reduviidae may be also kept in Southeast Asia. Moreover, many of the species collected were recognized not only to be unrecorded in respective countries or areas but also to be undescribed (new to science). This presentation highlights the

assassin bugs from the faunistic viewpoint listing the species collected by our surveys from Southeast Asia for ten years and providing information available for considering the predators as biocontrol agents as well.

## **LOCAL KNOWLEDGE ON THE SUSTAINABLE USE AND MANAGEMENT OF INDIGENOUS PLANT RESOURCES IN THE CORDILLERAS, PHILIPPINES**

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The Cordilleras is home to a rich diversity of indigenous plants that is widely used in various purposes. The sustainable use and management of these resources is commonly entwined with the rich cultural practices and beliefs of the local people. This study aims to elucidate the application of local knowledge on sustainable management of indigenous plant resources in the Cordilleras, Philippines. Documentation activities such as Key Informant (KI) interview, field visit, desk literature search and literature survey was conducted in two case study sites: Benguet and Kalinga. The information gathered serve as the baseline in the conceptualization of the information system. Open source tools were used in the development of the Database Information System (DIS). The DIS consists of project homepage and database of lesser-known indigenous plants used in various purposes in the Cordilleras. Out of the 449 total plant species recorded in the DIS, about 67.04% or 301 were identified as indigenous. The 301 documented indigenous plants species were used for: organic farming system (1.34%); sustainable indigenous farming system (3.34%); community health care (28.09%); food and food supplements (30.77%); cultural practices (10.03%); construction and livelihood (20.74%) and ornamental, landscaping and gardening (5.69%). In terms of growth habit of the indigenous plants, herbs accounted for 29.03%, shrubs (26.88%) and trees (26.88%). Most of the indigenous plants species belongs to Moraceae (9.68%), Rosaceae (8.60%) and Palmae (7.53%). In the study area, local people perceive indigenous plants as valuable resources and God's creatures. They employ conservation practices for its sustainable use and management such as *gen-gen* system (soil and organic matter conservation), *sul-ulan* (control pest attacking grains and cereals), sound farming system (e.g. fallowing) and *muyong* or *pinugo* commonly practiced by Ifugaos (indigenous forest management). The local knowledge on sustainable use and management of indigenous plants plays a vital role in the lives of the local people in the Cordilleras. It is also an important knowledge base in the sustainable use and management of bio-resources in the upland communities in the country.

## **THE MULTIFUNCTIONALITY OF AGROFORESTRY: ARE THEY REAL OR JUST IMAGINATIONS?**

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Agroforestry is an age-old land use practice of integrating trees on farms. It is claimed to have various functions like the conservation of biodiversity, rehabilitation of degraded lands, creation of sustainable rural communities and most recently, mitigation of climate change. Despite its claimed multifunctionality, it is still being questioned as to how this land use approach fare with other land

uses like mining, monoculture agriculture and even forestry. The main reason for this questioning was that despite the many programs of government and non-governmental organizations about its promotion, its practitioners seem not to have gained substantially from its conceived potentials. It is along these contexts that this paper is hereby developed. This paper examines the socioeconomic and environmental feasibility of the different agroforestry systems/models in the Philippines. Specifically, this study seeks to 1) document/characterize the different agroforestry systems that are being practiced in the selected areas in the Philippines with emphasis on the economic, environmental and social functions; 2) analyze the economic and financial viability of the different agroforestry systems/models; 3) assess the impact of agroforestry on the biophysical, socioeconomic and environmental conditions within the farmers' farm (in particular) and farming community (in general).

### **SUSTAINABLE AGRICULTURE IN PADDY FARMING SYSTEM**

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The agricultural sector has multiple roles in developing country. It provides resources for the live hood and adequate incomes of a majority of people without destroying the environmental base. In Malaysia, Agriculture and Agro-Industries Ministry targets to push the national rice production from the current 72 per cent to 90 per cent by the year 2010 (Azhari, 2008). However, this is not an easy task because there are several problems that the farmers will face. As a solution, introducing sustainable management is a best alternative to increase paddy production and increase socio-economy of the farmer. Furthermore, it can promote a sustainable living environment. Therefore, the main objective of this paper is to discuss and identify the sustainable agriculture system of paddy farming in Malaysia. This research employed a qualitative research design using observation and case study approach. The respondents are farmer, researcher and agriculture officer. The location of case study is paddy farming area at Sabak Bernam, Selangor and Muda Agricultural Development Authority (MADA) at Northern Malaysia. Sabak Bernam location was chosen because it has the most productive paddy fields and MADA has the largest size of paddy planted area (hectare) in Malaysia. This paper also provides examples of successful adaption of sustainable agriculture at others countries. As a conclusion, the result shows that paddy farming in two locations in Malaysia have used sustainable agriculture system in certain phase of management paddy farming.

### **STRATEGIES FOR THE INSTITUTIONALIZATION OF THE SOLID WASTE MANAGEMENT PROGRAM IN AN ACADEMIC COMMUNITY: TOWARDS SUSTAINABLE MANAGEMENT OF RESOURCES**

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The program of the Philippine government on solid wastes provides for the systematic, comprehensive and ecological management of waste materials from various sources. The participation of various sectors includes the academe, it is not just a seat of learning, it also opens avenue for research and development undertakings. In this research, the strategies that can strengthen the institutionalization of the solid waste identified and how such strategies can support proper management of resources were determined. The relation of the program to sustainable resource



management was looked into. Simple random sampling method was employed in the selection of respondents composed of the stakeholders such as the faculty, staff, parents, households and students. The respondents are willing to support the program and there are various strategies that could be adopted which include production of information education campaign materials, crafting of policies related to the program coupled with strict enforcement of such whenever necessary, involvement of stakeholders in the composting, recycling, segregation and proper disposal activities, periodic monitoring of the activities, construction and operationalization of the Material Recovery Facility, improvement of the existing dumpsite, inclusion of the solid waste management program in the research priorities of the University and generation of appropriate technologies in handling solid wastes. The stakeholders find the implementation of the program essential and worthy of support, the strategies are significant to properly manage the resources.

### **SUSTAINABLE AGRICULTURAL TECHNOLOGIES AND PRACTICES DEVELOPMENT PROGRAM: POVERTY REDUCTION TOOL**

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The “Sustainable Agricultural Technologies and Practices Development Program (SATPDP)” primarily aims to generate and verify agricultural technologies and practices for the benefit of the farmers of Occidental Mindoro, responding to the province’s poverty reduction programs while addressing agricultural sustainability. The program consist several projects that include both basic and applied researches such as: 1) Inoculated Organic Fertilizer Production Project; 2) Vermicomposting Project; 3) OMNC Improved Banana Production Project; 4) Farm of the Past and Future Project; and 5) Technology Generation and Verification Project. The program disseminated the generated and verified agricultural technologies, specifically to the farmers to improve their farming practices and income. The program accomplished 1) researches and verification studies; 2) establishment of organic fertilizer plant – increasing demand for organic fertilizer; 3) showcased agro-forestry technologies – serve as blue print in upland management; 4) increasing adoption rate of organic fertilizer production and utilization by the community an indicator of the massive advocacy promotion – resulted to reduced production cost and enhance the fertility of the soil; and 5) financial assistance to student labor in the implementation of the projects. The program changed the institution’s latest Annual Performance Rating (APR) of “very satisfactory” as overall rating”; served as income generating projects and related learning experiences in the teaching-learning process.

### **EFFECTS OF HUMAN-INDUCED ENVIRONMENTAL CHANGE IN MANGROVE FORESTS ON ARMORED SCALE (COCCOIDEA: DIASPIDIDAE) COMMUNITIES IN SOUTHERN THAILAND**

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Mangroves provide for the livelihood of millions of people in the coastal area of the tropics and subtropics. They also minimize damage to property and losses of life from tsunamis and storms. Rehabilitation and conservation of mangroves have been implemented, however, influence of those human activities on mangrove ecosystem is difficult to assess and not clearly understood. Therefore, it would be useful if an ecological indicator that reflects the influence of human activities on mangroves is available. Several species of scale insects (Insecta: Coccoidea) are known to occur frequently in

urban environment or artificially disturbed conditions. In earlier studies, they have been used as indicators for urbanization. Armored scales (Diaspididae), in particular, would be environmental indicators for mangroves due to their specific morphology and sedentary lifestyle. In the present study, the distribution and population constitution of three genera of armored scales, *Aulacaspis*, *Fiorinia*, *Lepidosaphes* on mangroves were assessed in three experimental sites, which differ in human-induced environmental factors, in southern Thailand. A highly infested zone (HIZ) was defined as a series of same mangrove species with less than 10m intervals, including any trees infested by any one of three armored scale genera with an average population more than 5 individuals in a 50 cm piece from a sampled branch. No HIZ of *Aulacaspis* were found in Site I, which was a natural forest with few human's visits, while they were found in Site II, which was a natural forest with frequent human's visit and in Site III, which was an artificial forest. On the other hand, HIZs of *Fiorinia* and *Lepidosaphes* were found only in Site I and II, but not in Site III. Such difference in the distribution pattern between three armored scale genera seems to be useful as an indicator for human-induced environmental change in mangrove forests.

## EVALUATION OF Cu COATED UREA ON SELECTED SOIL SERIES OF MALAYSIA

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Urea is useful fertilizer because it is immediately available to plants and have an immediate response. Urea as a fast release fertilizer however is subjected to rapid depletion from the soil due to ammonia loss and leaching. If fast release fertilizers are applied too heavily, the plant can be damaged usually by burning. As well as it caused ground water pollution by leaching. The application of urea normally resulted in high losses more than 30- 50% due to different environmental and biological factors. There is need to produce an efficient slow release fertilizer which is more efficient, environmental friendly and economically beneficial. For this purpose a study was conducted in order to find out an environmental friendly controlled release fertilizer. In this laboratory experiment, the effects of cu coated urea on release of Total nitrogen in selected soil series were observed. An incubation experiment was carried out for 6 weeks from 2<sup>nd</sup> June to 15 July2008 in laboratory. Three soil series: Rengom, Holy rood and Serdang were sampled and used as fresh soil. The release of urea N, ammonium and nitrate was analyzed every week for each sample and it's 3replications, by spectrophotometer and distillation method respectively. The results of experiment showed that the cooper coatings significantly reduce the fast release of urea by inhibiting the urease activity.

ABSTRACTS OF POSTERS

ISSAAS INTERNATIONAL CONGRESS 2008

IN-HOUSE ELISA TEST FOR CYMBIDIUM MOSAIC VIRUS IN DENDROBIUM SPP.

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In-house Enzyme-linked immunosorbent assay for the detection of *Cymbidium mosaic virus* (CymMV) was developed. First, monoclonal antibodies (MAbs) against CymMV were raised by the fusions of P3-X63-Ag8.653 myeloma cell line and the spleen cells from CymMV-immunized BALB/c mice. After characterization of the obtained hybridomas for their ability to produce specific MAbs, clone Cy1 and Cy2 were chosen for further development of ELISA protocol. Comparison of direct, indirect and sandwich enzyme-linked immunosorbent assay (ELISA) for the detection of CymMV demonstrated that indirect ELISA gave highest sensitivity which as low as 5 ng/ml CymMV concentration could be detected. The efficiency of the developed ELISA test was then compared with the commercially available GLIFT kit using *Dendrobium spp.* plant and tissue culture samples. The results showed the same positive and negative samples obtained from two methods. In addition, by comparing between leaf and root tissues, we found that approximately half of the numbers of positive root samples gave stronger signals than the leaf samples. These results provide the in-house ELISA protocol for routine investigation of CymMV contamination which is needed for the production virus-free propagating materials especially beneficial for orchid tissue culture.

DEVELOPMENT OF A SCREENING METHOD FOR ISOLATION OF  
ENDOPHYTIC BACTERIA FROM SUGARCANE

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Endophytic bacteria are a group of bacteria living in plant tissues without harm for the host plant. Bacteria were found from surface-disinfected plant tissue or internal plant tissue extraction. In several crops, endophytic bacteria have been found on their beneficial effects such as; plant growth and health production, nitrogen fixation, phytohormones production, antifungal compounds production which tended to induce systemic resistance of plant. In sugarcane, endophytic bacteria was become a major concern on enhanced plant on growth and yield. Our study was focused on isolation and screening method of endophytic bacteria from sugarcane tissue. Two extraction methods were studied as 1) sugarcane tissue grinding and 2) sugarcane tissue centrifuge. Different media were used to isolate bacteria; nutrient agar and modified Czapek solution agar (Czapek solution agar with 20% sucrose plus 250 ppm bromthymol blue). Extraction of bacteria through centrifuge and isolation with modified czapek agar was showed a potential for screening of endophytic bacteria from sugarcane tissue. There was minimized extraction time used in each sample with similar result of colony type

and acid production. After the selection, bacteria were determined on their ethylene production from acetylene using gas chromatography. Bacteria were divided to group by acid production data, growth ability on high sucrose content and acetylene transformation to ethylene activity. One of selected endophytic bacteria was identified as *Bacillus megatherium* using Biolog Microlog® Bacterial Identification System.

#### INTRODUCTION OF HOT WATER TREATMENT AS ORGANIC SEED DISINFECTION METHOD IN JAPAN

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The simplest method for organic seed disinfection of rice is Hot Water Treatment (HWT) which only involves the soaking of seeds in hot water prior to sowing. In Japan, HWT at 60°C for 10 min is used to control pathogens of rice<sup>1)</sup>, but it may adversely affect germination. If cultivars differ in sensitivity to HWT used, thermosensitivity of different cultivars need to be understood in relation to the adoption of HWT. The authors investigated the effect of HWT at 60°C for 10 min on germination of 19 cultivars contained 10 Japonica type and 9 non-Japonica type of rice. One of the variable used in the germination test is temperature conditions in the range of 15 to 30. The thermosensitivity was different among cultivars and seed performance was divided into three types i.e.-accelerate type, no effect type and decelerate type. Our results showed that under Japonica cultivars, 40% of the cultivars were accelerate type, 30% were no effect type, and 30% were decelerate type. Under non-Japonica type, 44% of the cultivars were no effect type, 56% were decelerate type, and there was no accelerate type. Especially under the low temperature, germination rates of some cultivars were increased by HWT. Therefore, such stimulatory effects of HWT offer great hope for enhancing seed performance under the broader range of cultivation temperatures. On the other hand, seed had also been damaged for germination ability of another group of cultivars including Indica rice by HWT. And so it is necessary to note the selection cultivar because germination decelerated on some cultivars. The authors suggested that it is necessary to set appropriate processing conditions in not only Japonica cultivars but also the Indica cultivars.

#### EFFICACY OF PLANT EXTRACT AND SILICON AMENDMENT ON THE CONTROL OF BACTERIAL WILT OF TOMATO UNDER GREENHOUSE CONDITION.

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Bacterial wilt of tomato caused by *Ralstonia solanacearum* is one of the most destructive disease in tropical and subtropical areas. The goal for production of tomato in greenhouse with integrated management by plant extract and silicon amendment is an alternative effective management the wilt disease to obtain product with high quality and safety for either consumer and environment. Inhibition of *R. solanacearum* strains To-Ud3<sup>amp</sup> by crude extract of Chung Chia (*Zanthoxylum* sp.) and guava (*Psidium guajava*) was carried out in laboratory by paper disc diffusion method. Diameter of inhibition zone of *R. solanacearum* by Chung Chia and guava were 0.52 and 0.43 cm, respectively. Efficacy evaluation of Chung Chia and silicon in the form of salicylic acid (Si1) and sodium silicate (Si2) to control bacterial wilt in tomato cv. Seeda in greenhouse found that treatment Si1 and

Si2 gave the highest of survival rate by 78 % whereas control was the lowest of survival rate by 11 %. Treatment Si1 provided the highest tomato yield at 150 gm/plant whereas control was only 10 gm/plant. Initial rhizosphere population of *R. solanacearum* was  $1.48 \times 10^8$  cfu/g of soil and gradually decreased every week after treatment. At the eight weeks post inoculation, treatment Si2 had the lowest population of *R. solanacearum* at  $4.72 \times 10^2$  cfu/g of soil whereas control was the highest *R. solanacearum* population at  $5.72 \times 10^2$  cfu/g of soil which was significantly different.

## 2-DIMENSIONAL POLYACRYLAMIDE GEL ELECTROPHORESIS (2D-PAGE) OF KHAK NUAL PAPAYA (CARICA PAPAYA)

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Two-dimensional polyacrylamide gel electrophoresis (2D-PAGE) differentially expressed from leaf, flower, mature fruit and root of Khak Nual Papaya (*Carica papaya*) were determined by a 18 centimeters of non linear gradient of pH ranged 3 – 10 strip for isoelectric focusing and 12.5% sodium dodecyl sulfate polyacrylamide gel electrophoresis. The 2D-PAGE patterns were visualized using silver stain. Approximately 1,042 – 1,329 protein spots were resolved from different parts of papaya. Comparison the amount of total proteome in some parts, we found the most number of protein spots in flower. There were 1,118, 1,329, 1,190 and 1,042 protein spots in flower, mature fruit, leaf and root, respectively. Protein patterns are in the area pI 4 – 8/MW 10 - 100 and pI 9.5 – 10/MW 15 – 50. This preliminary study of 2D-PAGE papaya may be able to be used for analysis in order to the understanding on proteomic and protein database of papaya.

## EFFICIENCY OF GENE TRANSFORMATION BY AGROBACTERIUM TUMEFACIENS IN NODE TISSUE OF NILEGRASS (ACROCERAS MACRUM)

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Forage grasses are critical to livestock industries throughout the world. Ninegrass (*Acroceras macrum*) is one of the most important tropical forage grass species. It is commonly used for pastures, hay production and silage. Soon after its release Nilegrass has become one of the major forage crops grown in Taiwan. Dry yield and crude protein content in Nilegrass are found greater than Pangolagrass (Jeng et.al., 2004). Improvement of forage by conventional breeding is slow due to the genetic complexity of these species (Ha et.al., 1992). Genetic transformation is an alternative that permits direct introduction of useful genes into a plant's genome. Agrobacterium-mediated transformation allows stable integration of transgene into the plant genome (Hiei et.al., 2000). Agrobacterium-mediated transformation has been successfully used to transfer genes into a wide range of forage grasses plant species. The object of this study, The efficient genetic transformation system for Nilegrass, using Agrobacterium-mediated TDNA delivery, is described herein. Sterilized nodes were infected and co-cultivated with 2 strains of Agrobacterium tumefaciens, EHA 105 and LBA 4404, which harbor the plasmids, pCambia(1301) and pTOK(233), respectively and contain genes for hygromycin phosphotransferase (HPT) and  $\beta$ -D-glucuronidase (GUS). Agrobacterium solution concentration of 0.8 O.D at 600 nm were co-cultivation on solid LS medium,

supplemented with 1 mg/l BA, 30 g/l sucrose and 2.6 g/l phytagel, 50 and 100  $\mu$ M acetosyringone, 3 5 and 7 days of co-cultivation period. The efficiency of gene transformation was evaluated by determination of GUS expression. In this study, the highest percentage of transformation was 82.22 % after transformation with EHA 105 at 50  $\mu$ M acetosyringone for 7 days. Putative transgenic plants and control plants were chosen analyzed by PCR analysis Bands corresponding to the HPT gene and GUS gene were clearly shown in transgenic plants. Preliminary study of Agrobacterium-mediated gene transformation in Nilegrass is a useful technique for generate of transgenic Nilegrass containing genes of agronomic importance and can be applied as a promising system to enhance transformation efficiency in Poaceae family.

#### **RISK ASSESSMENT OF RHIZOSPHERE BACTERIA COMMUNITIES ON TRANSGENIC AND NON-TRANSGENIC PAPAYA UNDER CONTAINMENT CONDITION**

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Khak Nual line 116/5 is transgenic papaya resistant to Papaya ringspot virus (PRSV), which was investigated for the effect on the rhizosphere bacterial community under containment conditions. Investigation on the attraction or repellence of rhizosphere bacteria to transgenic papaya was tested by growing papaya in the native soil containing pot with a diameter of 12 inches. The pot was connected to six surrounded-pots filled with sterilized soils equally distributed, with PVC tubes diameter of 2 inches, to transgenic and non-transgenic papaya plants were grown in each pot. Rhizosphere soil samples were taken every 30 day begins 60 days (papaya seeding state) of interval until 210 days (papaya premature fruit stage). The analysis of soil bacterial population structure was determined by using the community-level physiological profiles (CLPP) which based on the utilization of 95 carbon sources. Characterization of bacterial species, diversity and population were also investigated of attract or repel between rhizosphere bacterial of transgenic papaya and non- transgenic papaya. The results revealed that the population profiles of rhizosphere bacteria and bacterial species and population obtained from both treatments were not difference from each other and then not found of rhizosphere bacteria were attract and repel from non transgenic to transgenic papaya. These results indicated that transgenic papaya did not affect on rhizosphere bacteria ecology under the containment conditions.

#### **MATURATION OF MICRO-PROPAGATED PLANTLET INFLUENCES VEGETATIVE AND YIELD PERFORMANCES IN BANANA 'KLUAI KHAI' (AA)**

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Banana 'Kluai Khai' (AA) is commercially grown in Thailand with suckers as conventional plant materials. A new clone 'KB2' was recently released by Kasetsart University in Thailand. Subsequently, micro-propagated plantlets were required for mass propagation. The appropriate maturation of plantlets and plant performance of micro-propagated plants compared with conventional suckers were questioned. This research aimed to investigate how maturation of micro-propagated plantlets affected the field and fruit performances. A randomized complete block experiment was set up at Pakchong Research Station in Thailand (15°N, 101°E at 340 m MSL). The 'KB2' micro-

propagated plantlets, acclimatized in a nursery for 4-6 months, and suckers were planted and compared for vegetative morphology and yield components during the first crop. All the micro-propagated plants exhibited apparently more vigorous vegetative developments than the plants from the suckers. The micro-propagated plants produced 5-6 more leaves, as well as significantly larger leaf and pseudostem sizes, than sucker plants. Moreover, the micro-propagated plants gave higher fruit yield and quality than the sucker plants. The four-month-acclimatized micro-propagated plantlets tended to provide proper vegetative and yield performances over the others. The results revealed that four-month acclimatization was an appropriate maturation for micro-propagated 'KB2' plantlets. All of the micro-propagated plants exhibited more vigorous vegetative developments with slightly higher fruit yield compared to the sucker plants.

#### **FLOWER BIOLOGY AND YIELD OF PITAYA (HYLOCEREUS POLYRHIZUS) AS AFFECTED BY BIO M AND ADDITIONAL POTASSIUM FERTILIZER APPLICATION**

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The study aimed to determine the flower development pattern of Pitaya using scanning electron microscopy (SEM) and through plant observation using digital camera. Effect of Bio M fertilizer and additional potassium application at different levels on the yield of Pitaya was also studied. Flower shoot meristem and floral buds at various stages of development were tagged, examined and prepared for scanning electron microscopy (SEM) and digital photograph. For SEM the samples were fixed in 70% FAA, dehydrated, mounted and coated prior to the observations. Micrographs and photographs of the different stages of development from the vegetative to the flowering stage were obtained. It shows the different floral organ of the pitaya. The information obtained from the micrographs and photograph can be used to develop a timeline for flowering and to explain how flowering and pollination affect fruit set in pitaya. Apart from that this study is beneficial towards the future breeding and hybridization of pitaya in order to create higher number of fruits and seedless fruit. The recommended rate of K in field 10, UPM was 286 kg/ha/yr (71.4 g/plant/yr). Bio M (NPK 8:8:8) was applied on the experimental plot at the rate of 360 grams/plant (1.44 tons/ha/yr) applied 6 times per year (once every two months). There were four treatments, 0, 25%, 50%, and 100 % (0, 17.85g, 35.7g, and 71.4g, respectively) of potassium. The results showed that at 50 % level of K fertilizer application rate, the yield of pitaya was significantly higher compared to yield obtained at 100 % level of K fertilizer application rate.

#### **GROWTH AND NUTRITIONAL VALUES OF CHINESE KALE GROWN IN THE NUTRIENT SOLUTION WITH DIFFERENT NITROGEN AND POTASSIUM CONCENTRATIONS**

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Vegetables is the major source of minerals and vitamins which are essential human nutrients. Growing vegetables in the nutrient solution of the hydroponic technique allows the easy way to control nutrient uptake by plant roots. As a result of this technique, the better yield and quality in term of increasing of nutritional values and antioxidant compounds can be achieved. At the present, hydroponically grown leafy-vegetables are popular among Thai consumers. However, the

understanding of the effect of essential plant minerals on the nutritional values of Thai leafy-vegetables still limited. Therefore, two experiments in completely randomized design were conducted at the Kasetsart University, Nakhon Pathom to investigate the effects of N and K concentrations on growth and nutritional values of Chinese kale grown hydroponically using the Dynamic Root Floating Technique (DRFT) during June and July 2008. In the experiment 1, Chinese kale was grown in the modified Enshi's nutrient solution with 150 225 and 300 mg N/l and in the experiment II, was grown in the solutions with 150, 250 and 350 mg K/l. The results showed that the plant fresh-weight (g/plant), leaf number, leaf area (cm<sup>2</sup>), chlorophyll a and b contents (mg/ 100 g FW), and nitrate (NO<sub>3</sub><sup>-</sup>) content (mg/ 100 g FW) were increased but the vitamin C content (mg/100 g FW) was decreased as N concentrations in the solution increased. This is because of vegetative growth was stimulated when plant received higher nitrogen concentration and less glucose molecules remained for vitamin c synthesis. (3). It was found that the K concentration of 250 mg/l gave the highest plant fresh and dry weight. However, K concentrations had no effect on leaf number, leaf area, vitamin C, carotenoid, chlorophyll a and b contents and nitrate content. Therefore, if concerning the safety and quality for consumption, Chinese kale should be hydroponically grown in the nutrient solution with 150 mg N/l and 250 mg K/l.

**SEASONAL CHANGES IN NONSTRUCTURAL CARBOHYDRATES IN JASMINE (*JASMINUMS SAMBAC* AIT) FLOWERS AND ROLES OF PHOTOPERIODS AND TEMPERATURES ON ITS QUALITY.**

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The problem of commercial jasmine flowers production is there are low yield and small size in cool season. This experiment studied the relationship between total nonstructural carbohydrate (TNC) content in flowers and flowers quality such as weight, size and number of flowers. Since daylength and temperature were reduced under cool season, the role of photoperiod and temperature on flowers size and TNC content were also examined. After treatments, flower numbers were recorded and flower's weight, diameter, length and petal length were measured after sepal had been discarded. Then TNC of flowers were analyzed. The results showed that TNC content decreased during cool season from October to January. Flowers size and weight were decreased with decreasing flower's TNC. Jasmine plants that exposed to artificial lights extend to 12, 13, 14, 15, and 16 hour photoperiods during cool season of December for 15 days had more flower numbers than under natural condition with approximate 11 hour photoperiod. However, 12-16 hour photoperiods had no effects on increasing flower's weight, size and TNC. Jasmine plants that cultivated under 25°C and 35 °C in growth chambers at the same time with photoperiods treatment gave better results in flower quality and TNC content than average 19.2 °C natural condition. The higher temperature, the better flower quality and higher TNC were found. The results indicated that during cool season with limiting in daylength and low temperature, temperature had more effects on improvement jasmine flower quality than photoperiod. Low temperature also caused low carbohydrate content in flower which impacted poor jasmine flower quality.

**INDUCED OFF-SEASON FLOWERING BY SUPPLEMENTED FLUORESCENT LIGHT IN DRAGON FRUIT (*HYLOCEREUS UNDATUS*)**

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Dragon fruit or pitaya naturally flower only between March and October in the Northern tropical region due to long day period. Extension of production over off-season fruiting associates with premium price. Simulated shortening night by extended light after sunset or night-break possibly accounts for off-season flowering. This research aimed to investigate how supplemented fluorescent light could induce flowering during short day season. The experiment was established at a dragon fruit orchard in Chanthaburi, Thailand (13°N 102°E). Each selected post of mature plants was installed with a daylight fluorescent tube above the canopies. The lighting programs (nightly operated in January – February, 2008) were composed of two- and four-hours after sunset, (18-20 and 18-22 h), and two-hour night-break (22-24 h). The developmental stages (from flower bud emergence to fruit harvest) and fruit qualities were investigated. The plants in natural conditions (control) did not flower during the experiment, whereas all supplemented light treatments exhibited induced flower buds within 43-48 days. The duration from the bud emergence to fruit harvest was about 112 days in all light treatments. The night-break treatment yielded 67% fruit set, maximum fruit number and fruit weight. The fruit development and quality at harvest (titratable acidity, pH and total soluble solid) were not significantly different among the lighting treatments. The results indicated that lighting supplementation from fluorescent tube in short day season potentially replaces long day condition, resulting in the flower induction. The night-break lighting was apparently most effective for flower bud induction and development.

#### **GENETIC AND PHENOTYPIC CORRELATION ANALYSES ON NINE SWEET CORN ADVANCED INBRED LINES USING SAS PROC MIXED MODEL**

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The mixed-model analysis of variance has been used in many recent studies in evolutionary quantitative genetics. In this two-way statistical model in SAS, the variance component corresponding to the random statement is the covariance associated with a level of the random factor across levels of the fix factor. Therefore, the SAS model has a natural application for estimating the genetic correlation among traits measured. Correlation studies were undertaken for ten yield related traits on a series of nine near-homozygous sweet corn inbred lines obtained from various tropical source populations. The SAS program used estimated the genetic correlation coefficients among traits observed where blocks were considered as fix effects and inbred lines as random. The "ASYCOV" was added to the "PROC MIXED" statement in order to produce the variance-covariance matrix of variance components. The "TYPE = UN" option requested in "RANDOM" statement resulted in an unstructured covariance matrix for each inbred line being estimated, while the "G" and "GCORR" options produced genetic covariance-variance matrix and genetic correlation matrix between traits, respectively. In general, genetic correlation coefficients were greater than the corresponding phenotypic correlations. Husked fresh yield showed a positive significant genetic correlation with number of ears per hectare (0.99), plant height (0.97), dehusked ear yield (0.96), number of kernel rows per ear (0.91), ear diameter (0.74) and number of kernels per row (0.58). Total soluble solid concentration (-0.52) and days to silking (-0.51) were found to be negatively correlated with husked fresh yield. The interrelationship between these traits showed that they are under the influence of certain common genes, which can be exploited as selection criteria in breeding programs. Selection for one trait would also improve the other positively correlated traits. Husked fresh yield also revealed positive and significant phenotypic correlations with all traits mentioned for genetic correlation. The interrelationship among these traits, therefore, revealed that husked fresh yield could be efficiently increased by obtaining maximum expression of number of ears per hectare, plant height, number of kernel rows per ear and ear diameter, and obtaining minimum expression of days to silking.

### **EFFECT OF CONTAINER VOLUMES ON GROWTH OF NURSERY GROWN EUCALYPTUS LINERS AND THEIR INITIAL GROWTH POTENTIAL AFTER TRANSPLANTING**

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Growth of eucalyptus propagules from tissue culture (clone CT186) and from shoot cutting (clone CT300) grown in 3 different sizes of opaque plastic tube containers; 40 cm<sup>3</sup> (12 cm high), 90 cm<sup>3</sup> (15 cm high) and 120 cm<sup>3</sup>, were compared during a 120 – day nursery production period. Consequently, initial growth potential after transplanting was evaluated after transferring these liners into a 2.7-litre plastic pot for 43 days. The results showed that plant height and dry mass during nursery production increased with an increase in container volumes in both clones and the largest plants were obtained from a 120 cm<sup>3</sup> container. On day 120, clone CT186 from tissue culture in all container sizes reached the standard size for out planting while clone CT300 from shoot cutting did not meet the standard height and standard root quality and required two more weeks to reach the standard size. Bulk density of saturated growing medium in different container sizes was slightly different. Water-filled porosity and total porosity of growing medium were greatest in 40 cm<sup>3</sup> followed by 120 cm<sup>3</sup> and 90 cm<sup>3</sup> containers, respectively while air-filled porosity tended to increase with increased container height. However, the changed physical properties of growing medium due to container sizes had no clear relationship with growth of eucalyptus liners during nursery production. After transplanting for 43 days, plants from 120 cm<sup>3</sup> containers had greater height and dry mass than those from 90 cm<sup>3</sup> and 40 cm<sup>3</sup> in both clones but dry weight of new roots regenerated from the original root balls after transplanting was not different. In each clone, relative growth rate of plants from different container sizes was comparable after transplanting despite of the different plant sizes at transplanting.

### **APPLICATION OF GAMMA IRRADIATION FOR STORAGE POTATO**

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Since deficiency of controlled store in Iran and environmental problems of chemical material the use of gamma irradiation to control sprouting and increase the length of storage time of potatoes has been proposed as an alternative to cold storage or the use of chemical sprout suppressants. In this study potatoes of Agria Variety were irradiated at a dose of 0.10 KGY and stored along with the unirradiated controls at 12±3°C for a period of more than 6 month from October to April .After 4 month of storage the sprouting ranged from 5 to 12% in irradiated potatoes and 45 to 74% in unirradiated samples and after 6 month the unirradiated potatoes were discarded because of heavy sprouting and rotting. The rot attack was approximately double in unirradiated samples. It was found that losses through dehydration were 10.3 to 15.1 % in the irradiated potatoes. Also a comparative study of reducing and non-reducing sugars, vitamin-C content, total sugar, starch and protein was carried out between unirradiated and irradiated samples. The results suggested the efficacy of Gamma irradiation for ensuring availability of the storing quality of potato during lean periods from October to April.

## ON-FARM TRIAL ON BAGGING OF MANGO FRUITS USING RECYCLED MATERIALS

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This study was conducted to verify the potential effect of fruit bagging technology by using different recycled materials on the production and quality of mango fruits. This was conducted in a farm from a top mango-grower municipality in Abra. Recycled bagging materials such as *cement paper, newspaper, foil paper, transparent plastic, glossy magazine paper, and mimeo paper* were effective in controlling wind bruises and insect pests of mango fruits. However, *plastics and foil papers* were not effective to control diseases. Fruit bagging did not affect the weight and sugar content of the fruits. In terms of profitability, newspaper, glossy paper, cement bag, and mimeo paper showed the highest net profit and ROI. In bringing the technology directly in the farm, farmers had more chances to witness directly the effects and practicality of such, like the use of recycled materials to produce better fruits with higher price. Conducting a harvest festival wherein farmers and stakeholders were invited and they were convinced that mango fruit bagging is effective to improve mango fruits, hence, had increased production. The study likewise emphasized the advocacy for food security by using a practical technology that is environment-friendly, not hazardous to man's health, and inexpensive but effective to protect mango fruits from pests, diseases, and wind bruises, thus better fruits was produced. The utilization of 'waste' resources that could minimize input cost is also a part of resource management for future generation. Such sustainable agricultural production was shown to farmers and stakeholders, particularly in the commercially-produced fruits, like mango. This also brought the attention of the LGUs in the province in nominating the farmer-cooperator in the search for the Outstanding Farmer of the Year, for which he got the award.

## A COMPARISON OF GROWTH, PERFORMANCE AND FEED COST OF PIGS RAISED ON DEEP LITTER IN A SEMI-BIO SYSTEM AND IN A CONVENTIONAL CONFINEMENT SYSTEM

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When pigs are raised on deep litter in Thailand problems with infections and dirty pigs are often observed due to the hot and humid climate. Feeding of fermented feed can improve gut health and balance the microorganism in the litter. For the experiment fermented vegetable waste was chosen as feed due to its low cost. The objective of the study was to compare growth performance and feed cost of pigs fed fermented vegetable and rose on deep litter in a semi-bio system with the results obtained for pigs raised in a conventional confinement system. Eighty castrated Duroc X (Large White X Landrace) males and females of 20 kg BW were randomly divided into groups of 10 pigs and kept in 1) conventional pens with concrete floor or 2) on a 90 cm deep liter consisting of a mixture of rice husk and wood saw dust. In both systems there were 1.8 m<sup>2</sup> per pig. In the conventional confinement system, concentrate feed was provided *ad libitum* until the pigs reached 100 kg BW. The pigs housed on deep litter were fed *ad libitum* with a mixed diet comprising concentrate feed and fermented vegetables at the ratios 2:1, 1:1 and 1:2 during the growth periods from 20 to 50, 50 to 80 and 80 to 100 kg BW. There were four replications per treatment. T-test was used to compare the two treatments. The performance of the pigs in the semi-bio system compared with the results obtained in the conventional confinement system showed no significant differences

for average daily weight gain, feed intake, feed conversion ratio and running days. However, feed cost per kilogram of weight gain was significantly lower ( $P<0.05$ ) in the pigs housed on the deep litter in the semi-bio system than in the pigs housed in the conventional confinement system (21.21 vs 34.79 Baht /kg of weight gain). It was concluded that a semi-bio system with deep litter had no negative effect the growth performances of the pigs and economic return of the pigs raised in that system was better than in a conventional confinement system.

#### **COMPARATIVE STUDY OF DRYING ROSEMARY LEAVE, LAVENDER FLOWER AND ROSE PETAL WITH SOLAR, TRAY AND VACUUM MICROWAVE DRYERS**

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Field level experiments on solar drying of rosemary leave, lavender flower and rose petal using indirect solar dryer developed by the Department of Food Engineering, Agro-Industry Faculty, Chiang-Mai University were studied. Air velocity of 0.5 m/s was forced passing over the samples. Color assessment, moisture content, water activity ( $a_w$ ) total ash, tannin and total phenolic compounds were analyzed as the quality parameters. Subsequently, quality parameters from solar dryer, tray dryer, and microwave vacuum rotary drum dryer were compared. Dried product qualities of rosemary leave, lavender flower and rose petal using solar dryer with moisture content of less than 7% were comparable to those dried in tray dryer and microwave vacuum rotary drum dryer. Electrical energy used by solar dryer, tray dryer and microwave vacuum rotary drum dryer for drying process of rosemary leave were 6.92, 292.83 and 14.88 Baht/ 1 kg (fresh), respectively. For lavender, the electrical energy costed 7.53, 262.80 and 16.61 Baht/ 1 kg (fresh), respectively. Finally, electrical energy used for rose petal drying process were 6.93, 292.83 and, 9.09 Baht/ 1 kg (fresh), respectively.

#### **DRY MATTER PARTITIONING IN POTATO GENOTYPES UNDER ORGANIC PRODUCTION IN THE PHILIPPINE HIGHLANDS**

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Genotypes CIP 380251.17, CIP 13.1.1 and PHIL 5.19.2.2 were the best performers in terms of leaf area index, net assimilation rate and crop growth rate. Assimilates partitioned into leaves, stems, roots, stolons and tubers at 45, 60, 75 and 90 DAP differed among genotypes and at different stages of development. Among the plant organs, the roots and stolons had the highest dry matter contents in genotype PHIL 5.19.2.2 at 45, 60 and 75 DAP. Assimilates partitioned in tubers increased in most of the genotypes at 75 DAP and decreased at 90 DAP except in genotypes 380251.17 and PHIL 5.19.2.2. Genotypes PHIL 5.19.2.2, CIP 13.1.1 and CIP 96-06 had the highest total yield of 4.57, 4.21 kg and 4.13 kg, respectively and computed marketable yields of 6.33, 5.46 and 5.92 tons/ha. Correlation analysis revealed positive significant correlations in: dry matter content of leaves with sunshine duration in Granola; dry matter content of stems with rainfall in genotype CIP 380251.17 and with maximum temperature in genotype CIP 573275. Significant negative correlations were observed in: crop growth rate with rainfall in genotypes CIP 13.1.1 and PHIL 5.19.2.2; and leaf area index with minimum temperature. Among the characters, positive correlations in net assimilation rate with extra large tubers were observed. Highly significant positive correlations were observed between net assimilation rate and crop growth rate.

## **YIELD LOSS STUDY OF BROWN SPOT DISEASE IN ORGANIC CLAY MUCK (OCM)**

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Brown spot (formerly called *Helminthosporium oryzae*) is the most serious disease affecting rice growing area in organic clay muck (OCM) soil especially in Block F, Sawah Sempadan, Projek Barat Laut Selangor (PBLs), Malaysia. It was found that brown spot disease can cause reduction in the quality and yield of rice and its seed where it can reach up to 50 % damage to the plant. It also can damage the quality and the weight of rice seed up from 50 % to 90 %. This disease is caused by *Bipolaris oryzae*. The disease is now known to be associated with unbalanced or poor soil. This study was therefore conducted to investigate the yield loss of brown leaf spot disease infestation on rice. Five scales of brown leaf spot infestation score (0 %, 25 %, 50 %, 75 % and 100 %) were used with five replications for each scale of score. Five panicles of rice variety MR 220 were selected and averaged for each replication and samples were separated into empty and full grain and weight separately. The analysis of variance showed that effect of brown leaf spot on yield loss was significant among five scales of score. 100 % brown leaf spot infestation score showed the lowest yield about 2662.4 kg/ha or 66.4 % losses compared to 0 % brown leaf spot infestation score which can get 7924 kg/ha. The findings showed that the brown leaf spot disease can cause the reduction in yield as high as 66.4 % in severe infection.

## **EFFECT OF TREE ONION EXTRACTS AS PREBIOTICS ON NEWCASTLE DISEASE VACCINE TITER IN BROILER**

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Newcastle disease (ND) is an acute paramyxoviral infection to the poultry birds. Immune responses play a pivotal role in protection against diseases. Prebiotics are a non-digestible food ingredient that beneficially affects the host is naturally occurring found in some plants and Tree onion was one of the sources of prebiotics. The purpose of this study was to determine the humoral immune response against ND virus in broiler chicks fed with tree onion extracts using hemagglutination inhibition (HI) test. Ninety Arbor Acres male broilers were assigned to 3 dietary treatment groups with 3 replications 1) basal diet 2) 2% Colistin and 3) 2% Tree onion extracts. Vaccinated with Newcastle diseases vaccine was given to each chicken on day 21 and day 31 then collected serums from 3 chickens each group in day 38. The results found no significantly difference but broiler fed 2% Tree onion extract v/v mixed into water had highest HI Titer. That was show Tree Onion – fed – group can stimulated immune system especially humoral immune system.

## **PROBIOTICS PROPERTIES OF BACTERIA ISOLATED FROM POULTRY IN THAILAND**

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Probiotics can be defined as single or mixed cultures of living microorganisms, which beneficially affect the host (human or animal) by improving the properties of indigenous microflora. For animal production, they are the biological products which have a capacity to improve growth

performance and increase the immune system in the animals. The aims of this study were to isolate probiotics lactic acid bacteria from chicken faeces and to examine their probiotics properties for use in chickens. The samples were collected by fecal swap from 120 healthy antibiotic-free poultry on between November, 2006 and November, 2007 in Thailand. The bacterial strains were selected based upon bio-safety, viability during storage, *in vitro* tolerance to different pH/ gastric juice and bile, and antimicrobial activity. Subsequently, the effective strains in the laboratory were evaluated *in vivo* to determine their effect in promoting growth. The results revealed that CMU-FP02 and CMU-FP003 were the best in growth promotion ( $p < 0.05$ ). We hypothesized that this growth promotion occurred as a result of the bacteria to thrive under bile and acidic conditions. They also were capable of antagonizing the notorious microbes and excluded them from causing disease to the chickens.

#### **EFFECT OF LOCAL PLANT EXTRACTS AS PREBIOTICS ON BROILER PERFORMANCE**

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The prolonged use of antibiotic has the potential to increase bacterial resistance and the level of drug residues in edible animal products. Alternatives to them, such as prebiotics, probiotics and other feed additives, have been studied. Thailand has many plants that analyzed the possibility as prebiotics and may be substitute antibiotic use to improve broiler performance. This study was performing to determine the effects of local plants extract on broiler growth performance for use substitute antibiotic in the future. 2% of each Shallot and Tree onion extract was used in this experiment. The results found Average daily gain (ADG), Feed intake (FI) and Feed Conversion Ration (FCR) of all trial were not significantly difference ( $p > 0.05$ ) but Shallot and Tree onion had higher ADG, FI and greater FCR with no significantly difference when compared to antibiotic - fed group. It might conclude that both Shallot and Tree onion extract might substitute for the antibiotic use in broiler production as we hypothesized.

#### **GERMINATION OF JATROPHA CURCAS IN RESPONSE TO DESICCATION AND STORAGE TEMPERATURE**

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*Jatropha* is an emerging crop which is being promoted as an alternative feedstock for biofuels. It belongs to the family Euphorbiaceae and the genus *Jatropha* has approximately 175 succulents, shrubs and trees. The crop has been described as a wonder crop as the seeds contain around 37% oil which can be combusted as fuel without refining. It is claimed that *Jatropha* can be grown on marginal land and therefore it will not compete with crop-land unlike other edible oil such as oil palm. The above-mentioned positive characteristics have resulted in new areas for growing *Jatropha* and thus the need for planting materials. *Jatropha* can be grown both *via* cutting as well as seeds, however, seeds are preferred as it is easy to handle and transport. A number of reports have shown that *Jatropha* seeds deteriorate rapidly in storage and therefore cannot be stored for prolonged period of time. This study was initiated in order to determine the effect of desiccation on germination and storage of *Jatropha* seeds under three conditions namely in the deep freezer, in the fridge and under room temperature. The local Malaysian variety was used in this study. Mature seeds were

desiccated to 35, 25, 15, 10 or 7% and subjected to germination test. Seeds from each of this treatment was also extracted and placed in storage under the three conditions mentioned earlier for one, two or three months. The results of this study indicated that *Jatropha* seeds tolerated desiccation to low moisture content of below 10% and are not sensitive to temperature below freezing. This indicates that *Jatropha* seeds can be classified as orthodox. However, if seed moisture content is more than 10%, they undergo freezing injury if kept under freezing conditions. No significant decline in germination was observed for seeds with moisture content below 10% irrespective of condition or time of storage. Further studies have to be carried out in order to understand the long-term storage of *Jatropha curcas*.

### **TRANSLOCATION OF HEAVY METALS IN JATROPHA CURCAS (PHYSIC NUT) GROWN IN ABANDONED MINE AREAS**

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*Jatropha curcas* (physique nut) is a small tree that adapts well in a wide range of conditions like dry and poor soil, thus, the study assessed its adaptability in an abandoned mine area of Mogpog, Marinduque, Philippines by looking into the growth performance, and profile of heavy metal (HM) uptake and translocation of the plant. Because abandoned mine areas are generally devoid of top soil, some mitigating measures (e.g. use of mycorrhiza, compost, lime) to improve the soil condition and regulate the transport were also examined. Initial results showed that *Jatropha* seedlings with no compost and with or without lime exhibited the poorest growth. The tallest and biggest stem diameter were observed in seedlings treated with mycorrhiza plus compost and lime. Without compost or lime, mycorrhizal inoculation was ineffective. Addition of lime, however, significantly increased stem diameter, root, leaf, stem and total dry weights by 40%, 97%, 42%, 262% and 50%, respectively, as compared with the unlimed treatment. Heavy metal (HM) analysis of tissues showed that lead was readily translocated in the leaves, irrespective of treatments. Mycorrhizal treatment, in general, decreased lead and zinc translocation to the shoot, except copper. The study also showed that soil amendment is required for plants like *jatropha* to survive in an abandoned mine area.

### **ENRICHMENT OF ACETOGENIC BACTERIA AND ACETOCLASTIC METHANOGENS FOR ENHANCING METHANE PRODUCTION IN ANAEROBIC TREATMENT**

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Because of natural crude oil crisis and global warming issues, biomass-derived fuels (biofuels/bioenergy) are likely to have a future as a replacement for fossil fuel-based energy. Biogas, which is one of the most bioenergy produced by anaerobic digestion of organic polluted wastes, is accomplished by four major microbial groups: hydrolytic bacteria, acidogenic bacteria, acetogenic bacteria and methanogens. The efficiency is depended on the kinds of substrate and the balance of species and quantities of the microbes. Therefore, this study aims to enrich acetogenic bacteria and acetoclastic methanogens, which govern limiting step of biogas production, for used as a starter in further study. To enrich the acetogenic bacteria such as enrich butyric utilizing bacteria (BAUB) and propionic utilizing bacteria (PAUB), and acetoclastic methanogens (ACM), mixed culture obtained

from anaerobic pond were fed by butyric acid, propionic acid, and acetic acid, respectively. After that for 2 months, each enriched microbial group was investigated the activity of substrate utilization and was enumerated the number of microbial cell. For microbial activity, 10% v/v of each enriched bacteria was incubated in a closed vial containing 75 ml of 20 mM of acetic acid, butyric acid, propionic acid, lactic acid and ethanol, which are intermediates in anaerobic digestion. Gas and liquid samples were taken and analyzed once a day. Results indicated that lactate was less utilized by all enriched microbial group. Enriched BAUB and enriched PAUB, which are acetogenic bacteria, preferred to utilize ethanol (0.1 and 0.334 g COD/g VSS/d, respectively) and produced methane as 1.96 ml/d and 0.35 ml/d, respectively, whereas enriched ACM preferred to utilize acetic acid (0.48 g COD/g VSS/d) and produced methane as 1.95 ml/d. Enumerating by most probable number (MPN), microbial cells of enriched BAUB, enriched PAUB and enriched ACM are  $9.3 \times 10^6$ ,  $7.4 \times 10^7$  and  $7.5 \times 10^5$ , respectively. These results showed the microbial activities and the microbial cells of the enriched microorganisms higher than that of mixed culture. Consequently, these enriched microorganisms will be studied further as a triculture to increase methane production and to reduce start-up period of anaerobic reactor.

#### **ACADEME AND COMMUNITY INITIATIVES: AN APPROACH IN THE PRESERVATION AND MANAGEMENT OF UPLAND AND LOWLAND AREAS IN OCCIDENTAL MINDORO**

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This research was undertaken by the College in response to the global challenges for Sustainable Management of Bio-Resources and Community Empowerment, aligned with the agreement of the College with the National Economic development Authority (NEDA) through the Provincial Development Council to address the prevailing environmental, economic, social and technical problems in the province. Further, the initiatives were anchored on the Research Agenda of the College, the Regional and National priorities in research focusing on natural resources management such as: protection of the environment and sustainability promotion with the following objectives: To consolidate efforts in the establishment of multi-dimensional approaches in rehabilitating, protecting and sustaining the ecosystem; Showcase upland technologies; and Provide alternative mechanisms in the livelihood activities of the stakeholders. The different programs and projects were documented to determine its long term impact to the preservation of the upland, lowland and coastal resources of the province. The involvements of the GOs, NGOs and the affected communities were tapped. Findings revealed that the Initiatives focus on Experimental Forestry Center, On Site Entrepreneurial Projects as Performance Thesis (OSEPPT), Initiating Sustainable Upland Development Projects and Mangrove Gene Bank Development. The Mangrove Gene Bank Development serves as the ready source of propagules for the coastal communities and NGO's conducting mangrove areas rehabilitation activities. The establishment of Experimental Forestry Center showcased the preservation of different endemic species of flora and upland technologies particularly SALT. The On Site Entrepreneurial Projects as Performance Thesis (OSEPPT) harnesses the skills of the students and provide a source of livelihood after graduation. And showcase the one hundred five (105) successful Projects in the whole province. The Upland Development Projects harnesses the capabilities of the indigenous people in the production, management and sustenance of upland resources through demonstrations of agroforestry projects. Rate of participation and access to the program, economic return/benefit, availability of the technology, and consideration to the cultural values of the respondents during advocacy and adoption of the program were found significant success indicators.



## **STRATEGY OF LEADERSHIP IN LOW-COST RICE PRODUCTION<sup>1</sup>**

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At present, the cost of energy use of agricultural machinery, which replaces a mankind labor of rice production in Phichit province, is as high as 46% of the total expenses. An assessment from this study had estimated that the cost of machinery used could be reduced to as low as 28.50 % of the present cost. The purpose of this study was to present strategies of leadership in low-cost rice production. In-depth interview was a tool for data collection from administrators in 5 farmer institutions. The interview covered 4 aspects of the management; a group management, a capital management, an agricultural machinery management, and an encourage management. Result of the study revealed that the encouraged management was the most important aspect of the management. A synthesis of managerial agricultural machinery managements, and related environmental factors from this study had recommended 3 strategies that could help the groups in planning their managerial administration. There were; 1) a strategy for an adjusting basic structure of managerial administration, and forming a positive attitude toward a group formation. This strategy would be launched with a transparence administration as an obligation, 2) a strategy for the development of potentiality and quality of the management. This strategy would be launched with a knowledge enrichment, and group supporters as an obligation, 3) a strategy for creating a good atmosphere and moral in a group administration. This strategy would be launched with a sufficient welfare pattern as an obligation. These allocated three strategies would enhance a confidence of members in a group' activities, organized a systematic work pattern, create a group's unity and cooperation, and empower related partners to join the group.

## **MUSHROOM FOR PROFIT: A LIVELIHOOD ASSISTANCE PROJECT FOR THE YOUTH IN PANGASINAN**

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The R&D project generally aimed to create/open innovative alternative livelihood assistance for the agriculture graduates of Pangasinan. Specifically, the project aims to: develop and strengthen manpower capabilities of 300 unemployed graduates on mushroom low cost technology, efficient and economically productive industry utilizing indigenous or agro-industrial/forest wastes; develop strong partnership among 10 local government units (LGU), 5 people's organizations, non-governmental organizations and 2 state colleges and universities and private higher education institutions in promoting mushroom production technology and assist 300 beneficiaries. The choice of the LGUs and other offices was based on the premise that majority of PSU graduates originated from these municipalities, identified as impoverished municipalities (KALAH I sites) and the manifestation of political support from the local executives. Consultation and planning with the potential partners and stakeholders as well as formulation of implementing rules and regulations was undertaken to identify perceived problems and solutions on the issues related to mushroom production. Training of screened beneficiaries on mushroom package of technologies and management were conducted in the Mushroom Research and Development Center, Sta. Maria, Pangasinan and the rest were in the stakeholders' places. IECM were distributed to the beneficiaries. Equipments, supplies and materials were purchased to enhance the capability of the proponents and beneficiaries to sustain the production of mushroom and delivery of services. Design of ideal mushroom fruiting house was given to the

potential mushroom growers. The need for a directory of the identified beneficiaries were documented which was necessary for planning and decision-making purposes of the management. M&E thru on-site/field monitoring and evaluation of the beneficiaries' project were conducted to validate the accomplishments written on the report.

**DEVELOPMENT OF BACILLUS AMYLOLIQUEFACIENS KPS46 FORMULATION FOR CONTROL OF SOYBEAN DISEASE**

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*Bacillus amyloliquefaciens* strain KPS46 had been reported to secrete antimicrobial metabolites and induce systemic resistance to the host plant. The additional based formulation advantages to withstand environmental stress and increase the survival rate and control efficacy stability of biological control bacteria was developed. The ratio of soybean meal: molasses and fish meal: molasses tested for enhancing multiplication for mass production was investigated. The optimal ratio was 10:5 g/l which costs calculated from all ingredient material was 0.10 and 0.12 US \$ per 10-liter. It was lower cost than nutrient glucose broth of 13.58 US \$ per 10-liter. The dry formulation should be maintained or increased its efficacy that was developed by using several local materials as carrier to reduce cost and enhance value of production. Viability investigated after 360-day shelf life of KPS46 maintained in wettable formula used rice husk ash dust, dry cow dung, decomposed cow dung, and talcum as carrier storage at room temperature were 8.8, 8.7, 8.5, and 8.4 log CFU respectively. Greenhouse and Field experiment of KPS46 developed as wettable formula could reduce Sclerotium damping-off, bacterial pustule caused by *Xanthomonas axonopodis* pv. *glycines* and anthracnose caused by *Colletotrichum truncatum*. It promoted plant growth of green soybean under field experiment to increasing quality and quantity of marketable yield with 24.1 and 29.5 % compared with non-treated control for the first crop and the second crop respectively. The return of investment (ROI) was 43.30% higher than conventional of 33.59%.

**POTENTIAL FOR APPLICATION TIME OF PSEUDOMONAS FLUORESCENS SP007S AND BIOFERTILIZER FOR ALTERNARIA LEAF SPOT MANAGEMENT OF CHINESE KALE**

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Application timing of *Pseudomonas fluorescens* SP007s based on plant growth stage of planting date, seedling development, and leaf stage with seed treatment, and two (at 17 and 31-day-old plants), and three-foliar spray intervals (at 14, 28 and 42-day-old plants) were evaluated in natural endemicity of commercial Chinese kale field at Suphanburi with a history of *Alternaria* leaf spot caused by *A. brassicae*. The effect of  $1 \times 10^6$  cfu/ml *P. fluorescens* SP007s in either formulations of 6-month shelf life powder or its pure culture suspension; and with or without algae biofertilizer (Goemar BM86<sup>(R)</sup>) combined foliar spray intervals compared with conventional grower and all alone synthetic chemical plots, were also determined. *Alternaria* leaf spot incidence and severity were assessed everyweek, and plant growth promotion and total yield were recorded at seedling development and harvesting time respectively. The experiment was laid out during March-May, 2008 as RCBD design of total 13 treatments in 3x7 m plot size with 3 replications. All treatments applied

with SP007s provided significant disease reduction and yield increase better than conventional grower and alone synthetic chemical plots under 19-21% trace level of natural disease endemic ( $P=0.05$ ). Over all, the application timing of SP007s with two-or three-foliar spray intervals, a combination of SP007s and algae biofertilizer foliar spray or SP007s alone, and SP007s powder formulation or its pure culture suspension had no significant effect on total yield obtained, although there were treatment differences in the promoting of plant growth at seedling development and incidence of *Alternaria* leaf spot of Chinese kale. These findings suggest the importance of disease trace level and timing for application that naturally occurring product like SP007s could be used successfully to reduce synthetic chemical use on Chinese kale.

**DETECTION AND IDENTIFICATION OF *ACIDOVORAX AVEANAE* SUBSP. CITRULLI, CAUSAL AGENT OF BACTERIAL FRUIT BLOTCH IN THAILAND**

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Bacteria were isolated from a range of naturally infected cucurbitaceous hosts in Ratchaburi Nakhonpathom Kanchanaburi Lopburi and Suphanburi province. Physiological, biochemical, pathogenicity, ELISA, PCR and Biolog<sup>™</sup> tests were carried out. Two type strains of *Acidovorax aveane* subsp. citrulli isolated from cantaloupe and watermelon were used as positive control throughout these test. The bacterial isolate RB-WS, BL-CA, and SK 2-4 showed positive result on PCR, ELISA, Biolog<sup>™</sup> and other tests. The pathogenicity of 3 bacterial isolates was confirmed on young seedling of cucurbitaceous hosts. Based on the presence of symptoms recorded for 7 days after inoculation, we observed some slight variations in aggressiveness. This may due to the method of inoculation. In conclusion, the bacterium that cause fruit blotch of cantaloupe and watermelon was *Acidovorax aveane* subsp. citrulli and detected in Nakhonpathom Ratchaburi and Suphanburi province.

**SEED COATING WITH MIXED BACTERIAL ANTAGONIST AND STICKER AGENT FOR CONTROL OF *ASPERGILLUS FLAVUS* INFECTION OF SWEET CORN**

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The experiment was conducted in laboratory and greenhouse conditions to determine the effect of sweet corn seed coating technique using various sticker agents combined with 3-antagonistic bacterial strains, *Bacillus amyloliquefaciens* KPS46, *Pseudomonas fluorescens* SP007s and *Serratia marcescens* Spt360 under different storage conditions. The percentage of seed germination and seedling vigor of sweet corn cv. insee2 was evaluated at 15-day interval for 3 months using blotting and pot bioassay. Coated seed treatment with different sticker agents including carboxy methylcellulose, Tween80 and TensionT7 exhibited lower percentage of seed germination and seedling vigor (shoot and root length) than antagonistic bacteria coated seeds, except polyacrylate

(PLA) and chitosan extract that showed highest percentage seed germination but not seedling vigor. To improve the efficacy of seed coating against *Aspergillus flavus* infection, seeds coated with each antagonistic bacteria, PLA and chitosan combinations were assessed. PLA and chitosan combined with antagonist were better effective than antagonist alone. Seed coated with combined PLA+SP007s or chitosan + SP007s were significantly highest ( $P<0.05$ ) in enhanced seed germination and seedling vigor, where seed coated with PLA + KPS46 significantly reduced *Aspergillus flavus* incidence. None of these sticker agents showed negative effect on seed health and survival of benefit bacteria on seeds that indicated the advantage of improved efficacy of antagonism and PGPR. However, the storage temperature was important factor affecting survival and efficacy of antagonistic bacteria coated onto the seeds. Coated seed stored at room temperature showed a 2-4 fold decrease in bacterial density compared to coated seed stored at 10°C.

### THE EFFECT OF NITRATE KIND OF FERTILIZER TO POTATO COMMON SCAB IN VIETNAM

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Potato common scab, which caused by *Streptomyces scabies*, was considered as one important disease that attack potato tuber on the world. There were some published papers concerned to potato common scab control showing ammonium sulphate has special effect on potato common scab. In Vietnam, the investigation for potato common scab controlling by ammonium sulphate is rather less. This field examination shown that both kind of nitrate (urea and ammonium sulphate), has no effect to water-soluble aluminum, but has some effect on soil's pH as well as on potassium available and potato yields. Nitrate fertilizer decreased soil's pH from stage of forming tuber to harvesting, increased the quantity of potassium availability from germination to mature tuber. For pH(H<sub>2</sub>O), it decreased from before planting to at harvest. It is similar results for pH(KCl). For potassium available quantity, it is lower before planting and higher at the stages of tuber forming, tuber development. Urea fertilizer has less effect to potato common scab than ammonium sulphate. The scab rate and scab index were 36.7 and 12.6% (by urea) compared with 29.7 and 10.6% (by ammonium sulphate). But ammonium sulphate has good effect to potato yield, 20.8tons/ha in compare with 17.1tons/ha by Vietnamese style cultivation, and 17.6tons/ha compared with 15.2tons/ha by Japanese style cultivation.

### SCREENING AND FIELD TRIALS OF CHILLI VEINAL MOTTLE VIRUS RESISTANT SOURCES IN CAPSICUM SPP.

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Chili is an economical importance crop; however it is susceptible to a large number of diseases, including *Chili veinal mottle virus* (CVMV) for which the best control strategy is genetic resistance. Therefore, the objective of this work was to screen *Capsicum* spp. accessions collected by Tropical Vegetable Research Center (TVRC) and GRIN/SINGER, USA to find possible sources of resistance to CVMV. Out of 400 accessions of *Capsicum* spp. inoculated with CVMV-KPS9, 30 did not express symptoms. In addition, viruses were not found in the leaf tissues as measured by indirect ELISA. Field tests of four CVMV resistant accessions, demonstrated that most of the CA446,

CA1151, CA1195 and CA1258 plants were not infected with CVMV among the virus-infested fields. These accessions seem to be suitable for breeding programs aiming at incorporating resistance for this disease into commercial chili cultivars.

### **TOMATO YELLOW LEAF CURL DISEASE AND MANAGEMENT IN NORTHERN VIETNAM**

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Tomato yellow leaf curl disease (TYLCD) is the main limiting factor to production of tomato in the North Vietnam. The causing agents of this disease are a complex of virus species that in nature are transmitted by the whitefly *Bemissia tabaci*. In the field the disease is caused by at least two viruses of the genus Begomovirus (family Geminiviridae) with ss DNA, Tomato leaf curl Vietnam virus (ToLCVV, AF264063) and Tomato yellow leaf curl *Vietnam virus* (TYLCVNV) and they are found in tomato leaf samples with yellow leaf curl symptom by PCR using specific primers for ToLCVV (ToLCVV-sp-F2 & ToLCVV-sp-R2) and TYLCVNV (TYLCVNV-sp-F1 & TYLCVNV-sp-R1). Management of the disease using tomato resistant varieties Magic and Savior and by vector control using yellow traps, a bio product "Somec 2 SL", Bion and a pesticide Actara 25WG, showed effective to decrease the population of the virus vector *Bemissia tabaci* and the occurrence of the disease in the fields.

### **ASPARAGUS FARM PRACTICAL AGAINST A HIGH GAP STANDARD: PRACTICE AND TRANSFORMATION COST**

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Agricultural product quality was considered to food safety in deep of sanitary and phyto-sanitary. The quality system of agricultural production was interpreted through the good agricultural practice (GAP) which was diverse. It was depended on level of concern or the requirements from customers / countries. GLOBALGAP is a GAP standard which was required by major EU retailers for agricultural product via suppliers around the world. The Q-GAP system approach was a basic practice for farmer production system which was guaranteed by Thai government. The motivation of farmer to develop their practice to higher GAP standard was concerned by various partners. Farmer group of GLOBALGAP and Q-GAP certified were investigated, particularly in scope of farmer practice and transformation cost by using asparagus produce model in a major asparagus production area of Nakhon Pathom, Kanchana Buri and Ratcha Buri. The study was focused to the supply chain from farmer to supplier whose can be access to oversea market. GLOBALGAP option 2 certified farm (n = 8) and Q-GAP certified farm (n = 6) were interviewed and were determined with farm audit report. Difference of asparagus sale price in both farmer groups was obtained, which was 13.2% of price incentive to GLOBALGAP practice. Price incentive was a significant factor to enhance the additional invests of quality management system (QMS) within the farmer group. Major activities of quality

management system were as 1) Adoption of traceability system, 2) Manage all training cost, 3) Sample analysis, 4) Administration and 5) Organized of third party audit. The pesticides usage was significant difference, particularly for abamecthrin and chlorpyrifos, which were not allowed to use for exporting products to Europe. All transformation cost to GLOBALGAP was analyzed for pay back period. By calculation from additional investment cost per beneficial gain, the pay back period was 1.07 year. However, the GLOBALGAP certified farmer was able to access broader market level and worldwide than Q-GAP certified farmer.

**LIFE HISTORY OF *AMBLYSEIUS CINCTUS* CORPUZ AND RIMANDO (ACARI: PHYTOSEIIDAE) ON BROAD MITES LARVAE, *POLYPHAGOTARSONEMUS LATUS* (BANKS) (ACARI: TARSONEMIDAE) AND ITS PREDATION RESPONSE ON BROAD MITES AT DIFFERENT PREDATOR: PREY RATIOS IN LABORATORY AND GREENHOUSE CONDITIONS**

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*Polyphagotarsonemus latus* (Banks) is one of important pests of several crop plants worldwide. This study aimed to get more information about possible biological control agent of this pest. Life history of *Amblyseius cinctus* Corpuz and Rimando, a predacious mite that currently was evaluated the potential use as biological control agent on *P. latus*, was studied under laboratory conditions of  $27.3 \pm 1.8$  °C,  $72.6 \pm 10.5$  %RH with 12/12 L/D. Eggs and larvae of *P. latus* were provided as prey on excised pieces of mulberry leaf arenas. *A. cinctus* has 4 stages before developed in to adult, which are egg, larvae, protonymph and deutonymph, respectively. They could be able to completed their life cycle on this prey within  $4.7 \pm 0.6$  days with developing times of these four stages were  $1.4 \pm 0.4$ ,  $0.9 \pm 0.2$ ,  $1.2 \pm 0.4$  and  $1.2 \pm 0.4$ , respectively. Interestingly, males of *A. cinctus* were developed slower than female, but their stayed alive shorter time than females. Female could give birth for new young within approximately two days with the average of  $2.41 \pm 2.73$  egg per day, which grew to be female more than male. Unfertilized female were not reproduced. The varieties of predator: prey ratio of *A. cinctus*: *P. latus* were used to determine the predation potential of predators on mulberry leaf arenas and on young basil plants in laboratory and greenhouse condition, respectively. In laboratory condition, *A. cinctus* could feed at about 100 broad mite nymph per day with could produce eggs about 2-3 eggs per day. In greenhouse condition, the 1:120 predator: prey ratio were the suggested ratio for future studies in evaluate the effectiveness of this predator in *P. latus* control. The future study plans to evaluate this predator as a biological control agent of *P. latus* will be discussed.

**LOCALISING AND INTEGRATING COASTAL RESOURCES EDUCATION IN THE DEPARTMENT OF EDUCATION-BASIC EDUCATION CURRICULUM: THE SAGIP LINGAYEN GULF PROJECT EXPERIENCE**

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Since the 1990s when the Coastal Resource Management (CRM) went on full implementation across the Philippines, strategies meant to ensure sustainability of efforts have continuously evolved. Information, Education and Communication (IEC) strategies is a pillar of CRM intended to raise awareness on, imbibe knowledge about, and change behaviours towards the sustainable use of coastal and marine resources. Generally, IEC campaigns target the most immediate resource users, through a variety but often informal means, placing a premium on reaching out to the younger set of audience expected to carry out the advocated CRM principles well into the next generation. However, because of the fragmented nature of these campaigns, much of the inputs are often lost beyond the campaigns. By working through the more formal system of primary and secondary schools, it is expected that an unbroken chain of future stewards of coastal resources will be more systematically targeted. The Sagip Lingayen Gulf Project (SLGP), an Integrated Conservation and Development/Coastal Resources' Management (ICD/CRM) Project developed models for co-management of the coastal environment leading to sustainable coastal resources, water quality and livelihoods. One of these models was the integration of CRM education into the formal school curriculum. Based on the lessons from past related initiatives and through Conservation Partnership Agreements, the SLGP developed and implemented localised and integrated curricula in 29 public elementary and high schools involving 40 Science teachers and more than 2,000 students, an over achievement from the initial target of pilot testing in 10 schools. Further, this effort was legitimated by the Department of Education, strongly supported by mother LGUs who both committed to expand to other schools and to continuously localise the curricula. Based on a review of past and current related initiatives, it appears that this experience is the farthest any CRE effort has gone to date.

## **POLICY ANALYSIS OF COASTAL ECOTOURISM DEVELOPMENT ON MANGROVE ECOSYSTEM**

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The mangrove ecosystem is one of the important ecosystems in topics and has great economic and ecotourism potential. The mangrove ecosystems in the area have a very limited diversity. A lot of development activities have negatively affected in this area. The balance between economic gain and environment social loss should be weighted in favor of the longer term objectives so that establishment of sustainable resources development will not be ignored. Attention should also be paid to the impact of coastal ecotourism development. The study sought to examine the environmental suitability of mangrove ecosystem and coastal area for ecotourism development, to obtain the optimum plans for the associated enterprise in relation to variables and parameter which relate the potential use of physical, economic and institutional restraints while considering the objectives of entrepreneur and policy planners. Geographic Information System (GIS) methods were used for evaluating the mangrove ecosystem suitability and Analytical Hierarchy Process approach was used for resolving the spatial land use conflict to evaluate policy. The result show that all along Northern coast was originally mangrove forest ecosystem, complete with all richness of bio-diversity attained in it. However Indonesia should utilize institutional facility, such as forestry agency, tourism agency, and other related institutions, to develop coastal ecotourism better, especially mangrove forest ecosystem, so coastal ecotourism project can be sustainable.

## **WATER TURBIDITY MEASUREMENTS IN ENDAU ROMPIN NATIONAL PARK AREA USING WATER QUALITY FIBER SENSOR**

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The objective of this study is to calibrate water quality fiber sensor in the unit of RCTIME for turbidity measurement using commercial turbidity meter in the unit of NTU with sets of data taken from streams and rivers in Endau Rompin National Park. The research utilized the method of transmittance light measurement through plastic optical fiber named as water quality fiber sensor to interpret the capacity of water turbidity in Endau Rompin National Park area. The water quality fiber sensor consists of two systems named as BLUE and RED System operated at two different wavelengths which are at 470nm and 635nm respectively. The signal analysis and displays is controlled by Basic Stamp 2 microcontroller. Regression graph were plotted and value of linear correlation coefficient ( $R^2$ ) were determined to see on the accuracies of the data collected in term of linear relationship between turbidity meter (NTU) and water quality fiber sensor (RCTIME), where the value of  $R^2=1$  represent the theoretically perfect fit. This study proved that turbidity measurements can be determined by using water quality fiber sensor in Endau Rompin National Park area.

## **QUALITY OF NATURAL RAINFALL AND RAIN-WATER FROM THE ROYAL RAINMAKING TO AGRICULTURAL ACTIVITIES IN CENTRAL RIVER BASIN**

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The central river basin is the cradle for economic agro-agriculture which depends on natural rainfall and the rain-water from the Royal Rainmaking especially in repeated drought areas as Nakorn Sawan and Lopburi. Increasing chemical applications in agriculture and other human activities may contaminate the rainfall naturally and artificially. Therefore, it is very important to examine the quality of rain-water. Study of rain-water quality from the Royal Rainmaking and natural rainfall was performed during 8 August, 2005 to 24 June, 2006. The rain-water samples from natural rainfall and the Royal Rainmaking were collected from 3 stations in the Central River Basin namely; Meteorological station, Amphor Muang, Lopburi; Agricultural Meteorological station, Amphor Takpha, Nakhonsawan and Hydrometeorological station at Pasakchollasit Dam. One hundred and fourteen samples of natural rain-water and 204 samples of the Royal rain-water were analyzed for 19 standard parameters (pH, acidity, alkalinity, sulfate, chloride, hardness, ammonia, nitrite, nitrate, calcium, chromium, copper, iron, lead, cadmium, zinc, manganese, magnesium and mercury) for drinking water (WHO standard). The following parameters were significantly different between natural and Royal rain-water: sulfate, chloride, calcium, iron and magnesium. These chemicals were mainly the composition in rainmaking materials. Besides, it appeared that cadmium was present in both types of rain-water in high quality which should be further monitoring. All parameters except cadmium are in acceptable limit of WHO standard for drinking water. Therefore, both types of rain-water can be generally used. However, the presence of some chemicals in both types of rain-water shows the alternative cycles of chemicals used in agricultural activities and the content in rain-water. It appeared that the more chemicals used in agriculture, the more chemicals presented in the rain-water and may finally accumulated in soil and vegetation.



**EFFECT OF INCREASING SOIL PORES BY VETIVER GRASS (*VETIVERIA ZIZANIOIDES* NASH.) IN HIGHLAND FRUITS PLANTATION**

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The effects of increasing soil pores due to deep tillage by roots of vetiver grass (*Vetiveria zizanioides* Nash.) in fruits plantation at Saun-Buak-ha, Doi-pui Highland Research Station, Chiangmai Province were studied in order to develop a plantation system on highland watershed. Vetiver grasses were planted on the bench terrace surrounding the scion and root stock of 3 species of persimmon (2 years tree). Two half circular rows of vetiver grass were grew around each persimmon tree with radius 0.5 meter and 1.5 meters respectively. The interval of each vetiver bundles was about 0.2 meters. The stem diameters of scion and root stock of persimmon were measured every two month. The inner rows of vetiver grass surrounding each persimmon were cut after 16 and 25 months of planting period to increase the soil micropores. Soil moisture content and soil tension were measured to calculate pore size distribution. The results revealed significantly increased of soil micropores (0.19-9 micrometer). Most of the dense root zones were located at 0.5 meter depths. However, the amount of soil micropores at 0.9 meter tend to increase after 25 months. After 38 months of vetiver plantation, the Juhong on persimmon root stock showed maximum diameter and growth rate about 6.11 cm and 0.22 cm per month respectively, whereas the scion Hongmei persimmon was 5.21 cm in diameter with a growth rate of 0.2 cm per month.

**FACTOR ANALYSIS OF THE IMPLICATION OF ADOPTING SUSTAINABLE APPROACH IN IRAN**

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Based on empirical evidences and research founding, the conventional agricultural extension and research approaches in Iran, have failed in significantly contributing to the formulation and addressing the strategies of sustainable approaches are dynamic interactive process designed to enhance and positively increase the impact of systematic and coordinated agricultural research and extension activities. One of the main characteristics of these approaches is that it is directed toward the problems of poor areas and small farmers. Therefore this approach can be best suited to the condition of Iranian small farmer's. The main purpose of this research was to investigate the implications of introducing sustainable approaches in Iranian context. This study was conducted within the general framework of descriptive survey research. The statistical sample of the research, contained two groups of extension socialists (n = 55) and agricultural researchers (n = 85), employed in the Ministry of Jihad agriculture which were selected and studied using proportionate stratified sampling method. Data were collected using a questionnaire which its validity was confirmed by a jury of extension experts and reliability was determined by calculating Coronbach's Alpha. Data analysis was accomplished using SPSS. Findings of this research indicated application of sustainable approaches in Iranian contexts implies that a set of infrastructure and educational should be taken in to consideration before launching programs in the country.

## **PRIVATIZATION OF AGRICULTURAL EXTENSION: TOWARD AGRICULTURAL SUSTAINABILITY**

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Nowadays privatization of agricultural extension as complementary alternative for public extension has important role to gain access to agricultural sustainability whereby some of countries have good experiences about it. The purpose of this study was investigation of extension agents and farmer's perception regarding to privatization and agricultural sustainability. The data collecting instrument was structured questionnaire. The Statistical sample was 32 extension agents and 120 farmers. Results show that %51.5 of extension agents have negative or semi negative perception to privatization and this percentage was %72.5 for farmers. Correlation coefficients in extension agents respondents indicated that the level of education has positive and significant relation with their perception to agricultural sustainability and so was the relation between population, land area, mechanization level and participation variables with farmers perception. Based on multiple regression analysis education level, management system and participation of extension agents variables explained %33 of variation in their perception and participation and land area variables for farmers sample explained %27 of variation in their perception. As a result of this research the following suggestions have been made: performing educational courses. Increasing educational coverage by using further agents specially women, enhancement of linkage between agents and researchers, execution of professional conferences, constitution of privatization committee and further studies about effects of privatization of agricultural extension on sustainability of agriculture.

## **AN EVALUATION OF AGROFORESTRY PRACTICES FOR SUFFICIENCY ECONOMY AND SUSTAINABILITY OF LAND USE**

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This study was conducted at Khlongphu-Khlongpook Watershed in Trat province, eastern of Thailand. Seven types of land use practices including natural forest, pararubber plantation, fruit orchard, pineapple, mixed fruit orchard, mixed tree plantation and homegarden were evaluated. Indicators were used evaluation are: 1) environmental indicators (soil loss, organic matter and plant diversity), 2) economic indicators (profitability, time dispersion of income and input self sufficiency), and 3) Social indicators (risk and uncertainties and food security). Agroforestry index (AFI) for evaluate of sufficiency level of agroforestry land was estimated by using the weighting and scoring techniques. The suitability indicators in each aspect will be obtained by using the primary data and secondary data, and ranking all factors are 1 to 5. The results showed that AFI were classified as follows; AFI 1 is homegarden, AFI 2 is natural forest, AFI 3 are rubber plantation, mixed fruit orchard and mixed plantation, AFI 4 is fruit orchard and AFI 5 is pineapple land, respectively. From AFI value, homegarden was highest sufficiency level more than any other land use systems. Generally, homegarden has a multi-layered configuration, and all species within it are considered useful for several purposes. Moreover, the ecological functions of nutrient and energy balance within this system are similar to natural forest. Even though homegarden gives lower economic benefits compared to other cultivation patterns, its environmental and social aspects are better in the long term in terms of providing sustainable income, food security, and low risk due to its crop diversity. Thus,

homegarden agroforestry is a one of high potential land use to promote sufficiency economy and sustainability.

### **SUSTAINABILITY OF TROUT AQUACULTURE: CASE OF TITICACA LAKE IN PERU AND ITS IMPLICATIONS TO SOUTHEAST ASIA**

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When it began in the 1940s, trout aquaculture was conducted by farmers as a supplementary activity, but it has become a specialized business among some farmers and private corporations in recent years. Aquaculture of Trout has grown to a popular industry in Titicaca Lake, in the southern part of Peru. This paper focuses on the economics and technology of the specialized aquaculture farmers to assess its sustainability. In fact, interviews with these farmers revealed their confidence in continuing this activity. Farming problems such as environment conditions and investment are factors that made farmers change from agriculture to aquaculture. There are three objectives in this paper: (1) To show this activity done by farmers, its impacts on the environment, food safety and farm household economy; (2) To demonstrate interactions between agriculture and aquaculture activities; and (3) To analyze Asian cases of aquaculture in order to show differences between agriculture and aquaculture activities.

A series of intensive interviews were conducted with farmers, companies and regional organizations to study economic and environmental issues. Questionnaire survey was also conducted on local people in order to know about their fish consumption. It became clear, strict environment rules are needed to maintain aquaculture of trout as worthy activity. There are also problems of investment and educating farmers with respect to aquaculture and environment conservation

### **STRATEGIES FOR THE INSTITUTIONALIZATION OF THE SOLID WASTE MANAGEMENT PROGRAM IN AN ACADEMIC COMMUNITY: TOWARDS SUSTAINABLE MANAGEMENT OF RESOURCES**

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The program of the Philippine government on solid wastes provides for the systematic, comprehensive and ecological management of waste materials from various sources. Its features call for the participation of various sectors including academe. After all, it is not just a seat of learning, it also opens avenue for research and development undertakings. In this research, the strategies that can strengthen the institutionalization of the solid waste identified. Likewise, how such strategies can support proper management of resources were determined. The relation of the program to sustainable resource management was looked into. Simple random sampling method was employed in the selection of respondents composed of the stakeholders such as the faculty, staff, parents, households and students. Based from the data gathered, the respondents are willing to support the program and there are various strategies that could be adopted which include production of information education campaign materials, crafting of policies related to the program coupled with strict enforcement of such whenever necessary, involvement of stakeholders in the composting, recycling, segregation and proper disposal activities, periodic monitoring of the activities, construction and operationalization of the Material Recovery Facility, improvement of the existing dumpsite, inclusion of the solid waste management program in the research priorities of the University and generation of appropriate

technologies in handling solid wastes. The stakeholders find the implementation of the program essential and worthy of support, the strategies are significant to properly manage the resources.

### **AGRO-TOURISM TOWARDS SUSTAINABLE MANAGEMENT**

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A study on agro-tourism towards sustainable management in 2006-2008 was performed by gathering and upgrading information from Saraburi and Nakhon Rachasima, Thailand as the model. The 11 ideal concerned stakeholders were interviewed. The findings revealed that standardization of agro-tourism was essential to ensure tourist satisfaction and create sustainable tourism, in which 32 indexes, comprising 7 compulsory standards will help to elevate agro-tourism standard towards sustainable management. According to stakeholders the indexes in order of importance were 13 indexes in management administration systematization, 5 indexes in consumer concerns, 2 indexes in opportunity for community participation, 4 indexes in facility and services accommodation, 3 indexes in tourism resources image, 1 index in farm activities to let tourists participate and recognize folk norms and farm culture, and 4 indexes in opportunity to enhance farm knowledge for tourists.

### **THE STUDY OF DIVERSITY OF AQUATIC ANIMALS IN KAPUR DISTRICT, RANONG PROVINCE TO DEVELOP INTO EDUCATIONAL ECOTOURISM**

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The biological diversity plays an important role in tourism industry in Kapur District, Ranong Province. This area holds a wide variety of fertile natural resources, especially mangrove forest as well as coral reef and sea grass. Hence, it can be foreseen that this place should be able to develop into an ecotourism destination and educational coastal ecotourism site. In this study, we aimed to survey the diversity of aquatic animals in the coast of Kapur district. The results of the study will be useful in creating an appropriate tourism activities' pattern, raising local people and tourist awareness on environmental conservation. The specimens were tri monthly collected during the period of March to November 2008 and studied from 7 locations; Laem-son beach, Koh Maprow, Koh Nok-hook, Koh Thoa, Koh Piak-num-yai, Koh Piak-num-noi and Ao Khoei. The results indicated that there was 86 species of aquatic fauna which were mollusc (39 species), echinoderm (18 species), crab (15 species), fish (5 species), shrimp (2 species), polychaete (6 species) and brachiopods (1 species). The numbers of species and species composition change depending on season. Koh Thoa is the site with most abundance of 23 aquatic fauna species, following by Laem-son beach (19 species) and Koh Piak-num-yai (13 species), respectively. In addition, one of rare species, tongue shell (*Lithophaga nasuta*) has been widely found in the area of Koh Thoa and Koh Nok-hook. In brief, this study reveals that the Kapur District is an important living habitat especially acting as nursery areas for conserving marine creatures. It should also be preserved as a significant biological and ecological learning environment with high potentialities for ecotourism.

**THE CAPACITY AND NETWORK DEVELOPMENT OF THE SUB-DISTRICT  
ADMINISTRATION ORGANIZATION TOWARDS THE PARTICIPATION OF  
ENVIRONMENT AND NATURAL RESOURCES CONSERVATION**

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The capacity and network development of the Sub-district Administration Organization towards the participation of natural resources conservation had been using mixed method of quantitative and participation action research in implementation the research with the 134 samples of the members and community leaders in Tambon Kok-kram, Supanburi Province. The research result revealed the development of capacity and the network of members of sub-district administration, community and children leaders on the environmental and natural resources conservation, also the development of the local wisdom in organic agriculture, and enhanced team working and the good relationship between them. They had better understanding on the environment and natural resources conservation and increased positive attitude to the organic agriculture base on the King Bhumipol's Philosophy of economic sufficiency including induced the public mind for the natural resources conservation for all of them.

**SURVEY ON FUNGAL DISEASES OF MEDICINAL PLANTS IN JAPAN**

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A great potential of medicinal plants as natural and genetic resources has been recognized. In Japan, however, the study on diseases and their causal fungi on medicinal plants has not been conducted sufficiently. Thus we organized a series of surveys on diseases of wild and cultivated medicinal plants including some traditional and/or Chinese medicinal plants for several years. In the surveys since 2004, over 90 diseased plant samples in 69 genera from 43 families were collected from total 12 locations in 8 prefectures in Japan. After observation of symptom development, fungi in over 32 genera were detected and identified mainly by morphological characteristics. Among them, 3 new fungal diseases, diseases by *Alternaria alternate* on *Petasites fragrans* (Sweet coltsfoot), *Septoria tussilaginis* on *Farfugium japonicum*, and *Pseudocercospora evodiicola* on *Evodia rutaecarpa*, were reported for the first time in Japan. Six fungi from *Aralia cordata*, *Arbutus unedo* (cane apple), *Glycyrrhiza glabra* (licorice), *Helleborus niger* (Christmas rose), *Paederia scandens*, and *Zingiber mioga*, respectively, were also partially identified as possible new pathogens and/or new species which have not been previously described. The study on fungal diseases of medicinal plants is significant for conservation and stable production of such useful plants. The evaluation of impact of fungal infection on quantity and quality of pharmaceutical substances should be also focused in the future. The present study showed the diversified fungal flora on medicinal plants in Japan.

## **BIODIVERSITY ASSESSMENT OF ICHNEUMONOID PARASITIDS (HYMENOPTERA: ICHNEUMONOIDEA) IN RICE ECOSYSTEM**

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The diversity of Ichneumonoid parasitoids (Hymenoptera:Ichneumonoidea) was studied to identify the Ichneumonoid parasitoids associated with the rice ecosystem. Five malaise traps were set up in the rice field situated at Bandar Baharu (northern part of Peninsular Malaysia) Kedah, Malaysia. The specimens were collected weekly for 3 consecutive weeks. A total number of 16 subfamilies were obtained from the sampling comprising of 159 individuals. The number of individuals obtained from each subfamilies was significantly different ( $p < 0.001$ ). The highest individuals abundance sampled were from the subfamily Microgastinae (38) , followed by subfamily Cryptinae (36) and Cardiochilinae (18) and Pimplinae(15). Only a single individual was obtained from the subfamilies of Cremastinae, Ichneumoninae, Mesochorinae and Rogadinae. The Shannon-Weiner Species Diversity Index ( $H'$ ) of ichneumonoids in the second (63 to 73-days of age) and the third sampling period (63 to 72-days of age), with the value of 2.7 and 2.51 respectively, were significantly higher than the first sampling period (56 to 63-days of age) which was only 2.07. This results were supported with the total number of subfamilies and individuals obtained from second and third sampling which were 12 subfamilies, 68 individuals and 14 subfamilies, 75 individuals respectively, as to compare with only 7 subfamilies and 16 individualas in the first sampling. The most abundance species captured were *Amauromorpha accepta metathoracica* Ashmead (Ichneumonidae: Cryptinae) *Cardiochiles* sp (Braconidae:Cardiochilinae) and *Macrocentrus* sp. (Braconidae:Macrocentrinae).

## **THE CONDITIONS AND SUBJECTS OF SIQUASA PRODUCT DEVELOPMENT**

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Regarding acid citrus Siquasa (Siquasa, *Citrus depressa* HAYATA) is produced mainly in the north area of Okinawa. From the health functionality the development of marketable new product of siquasa is desired, that is including not only juice but also use of unused by-product. This paper examined the present conditions and the subjects of product development of Siquasa. The following 4 points analyzed: (a) present conditions of Siquasa production (b) trend of Siquasa production markets (c) unused by-product generation at Siquasa processing factories (d) consumer recognition for Siquasa. As the result, the following points were cleared. (a) Production volume was decreased, but functionality of siquasa was introduced by mass media at 2000, then it turned into increase along with the price increase. Currently, new planting is actively conducted. (b) Since juice is main product, it is considered that there are many items. On the other hand, it is the issue of future product development that seasoning that is supposed to be used on a daily basis is not sold in daily supermarkets so much. (c) In certain processing factory, by-product of juice (juice squeezed for the second time, seed and final by-product, etc) makes up more than half of the material is hardly used. (d) By the first nationwide survey, the high recognition was clarified. Beverage such as juice or alcoholic drinks, or seasoning makes up the majority of the future expected products. In the future, to continually develop Siquasa related industry, the following 3 points become issues. (a) clarification of appropriate material price range, and creation of management model /product development based on it (b) development of integrated utilization technology which enables zero-emission (c) development of business model which supports integrated utilization technology from production/process/distribution aspect.



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