Volume 15 Number 2, December 2009

Journal of ISSAAS

The International Society for Southeast Asian Agricultural Sciences

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CONTENTS

Page

Contributed papers

ACKNOWLEDGEMENT

The author sincerely thanks Professor Dr. Keiko T. Natsuaki, Tokyo University of Agriculture, for her encouragement and kind review of this manuscript. Also special thanks to Mr. Komatsubara and Mr. Ali of the Laboratory of Tropical Plant Protection, Tokyo University of Agriculture, Setagaya Campus, for the tremendous help in inputting the DNA data into the DDBJ. The author also thanks Mr. Hiroshi Yoshioka, for providing begonia seedlings for this experiment.

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J. ISSAAS Vol. 15, No. 2:12-20 (2009)

GEOGRAPHIC DISTRIBUTION OF BEMISIA TABACI BIOTYPES COLLECTED FROM AUTUMN-CULTURED POTATO FIELDS IN SYRIA

Azusa Fujiie[1], Abdul Mohsen Said Omar[2], Ahmed Bahij Sawas[2], Abbas Abbas[2], Mohammad Abdul Hadi[2], Emad Alden Sawas[2], Ayman Barakat[2], Shigenori Ueda[3] and Keiko T. Natsuaki [4]

[1] Former Japan International Cooperation Agency (JICA)
Syria Office and Attachment to General Organization for Seed Multiplication (GOSM) in Syria, E-mail: fwgh1797@mb.infoweb.ne.jp
[2] General Organization for Seed Multiplication in Syria
[3] National Agricultural Research Center for Kyushu, Okinawa Region in Japan
[4] Department of International Agricultural Development, Tokyo University of Agriculture, Japan

(Received: December 26, 2008; Accepted: July 10, 2009)

ABSTRACT

Potatoes are one of the most essential crops in irrigated fields of Syria. In 2007 we investigated whiteflies in autumn-cultured potato fields in six Syrian prefectures, Al-Hasakeh, Aleppo, Idleb, Hama, Homs and Damascus. Whiteflies were always observed in each investigation, and the density was 0.030-0.695 individuals per compound potato leaf. Moreover, in 2007, 14 samples of adult whiteflies were collected from 12 autumn-cultured potato fields, one tomato field and one yellow water pan in seven prefectures, Al-Hasakeh, Aleppo, Idleb, Latakia, Hama, Homs and Damascus. The samples were identified using whitefly mitochondrial cytochrome oxidase I (mtCOI) sequence analysis, and confirmed that they were the Q, B and non-B (B2) biotypes of *Bemisia tabaci*. The six samples from Aleppo and Hama were the Q biotype, the four samples from Latakia, Homs and Damascus the B biotype and the four samples from Al-Hasakeh, Aleppo and Idleb the non-B (B2) biotype. This paper is the first report of the geographic distribution of *B. tabaci* biotypes collected from autumn-cultured potato fields in Syria.

Key words: whitefly, B biotype, Q biotype, mtCOI

INTRODUCTION

Potatoes (*Solanum tuberosum*) are one of the most prosperous crops in well-established irrigation systems in Syria. Potatoes are cultivated in fields of about 29,500 ha and the yields are above 600,000 t per year (CBS, 2006). In Syria, there are two cropping types, spring-cultured and autumn-cultured potatoes. The General Organization for Seed Multiplication (GOSM), a national organization in Syria, exclusively imports, produces and distributes the main crop seeds including seed potatoes (GOSM, 2006). GOSM, in cooperation with the Japan International Cooperation Agency (JICA), is propagating healthy and virus-free seed potatoes to switch from the importation of seed potatoes to domestic production.

Seed potatoes produced under supervision by GOSM are, however, severely infested with insect pests such as aphids (*Myzus persicae*, *Aphis gossypii* and *A. fabae*),

wireworms (*Agriotes* spp.), and the potato tuber moth (*Phthorimaea operculella*) (Netherlands Potato Consultative Institute, 1996; GOSM, 2005; Fujiie *et al*., 2008). The damage caused by diseases such as late blight, early blight, skin spot, *Rhizoctonia* canker, black scurf, silver scurf, common scab, and bacterial tuber soft rot (Netherlands Potato Consultative Institute, 1996; GOSM, 2005), as well as virus disease (Chikh Ali *et al*., 2006, 2007ab; Sankari, *et al*., 2007) is devastating. Farmers have suffered serious yield losses from these insect pests and diseases in potato cultivations of commercial fields. Moreover, the attack by many whiteflies occurs in autumn-cultured potatoes in GOSM and commercial fields.

Using the samples collected on potatoes in Syria in 2006, we reported that autumn-cultured potatoes were usually infested with whiteflies, and this whitefly was shown to be the Q biotype populations of *Bemisia tabaci* (Fujiie *et al*., 2007). This biotype has recently occurred in many countries, and has become a serious threat for crops and ornamental plants, such as tomato, melon, pumpkin, cotton and poinsettia. Moreover, this biotype has a stronger resistance to chemical pesticides compared with other biotypes.

However, there is scanty scientific knowledge of this biotype in Syria, because it is not yet recognized as a dangerous insect pest on potatoes. Therefore, we investigated densities, biotypes and geographic distribution of biotypes of whiteflies from autumn-cultured potato fields.

MATERIALS AND METHODS

The survey was conducted in the main potato growing areas in nine prefectures of Syria, Al-Hasakeh (the eastern part), Aleppo (the northern part), Idleb (the midland part), Latakia (the Mediterranean side), Hama (the midland part), Tartus (the Mediterranean side), Homs (the midland part), Damascus (the midland part), and Dara'a (the southern part), in October and November, 2007. There were, however, no potato fields in Latakia, Tartus nor Dara'a in this season.

We investigated whiteflies in 14 autumn-cultured potato fields in six prefectures, four times in Al-Hasakeh, six times in Aleppo, once in Idleb, twice in Hama, twice in Homs and once in Damascus, between October 17 and November 13, 2007. The numbers of adult whiteflies were counted on 200 random compound leaves in each field, and the average number of whiteflies per leaf was estimated.

Moreover, 14 samples of adult whiteflies were collected from 12 autumn-cultured potato fields, one plastic house-cultured tomato field and one yellow water pan in seven prefectures, Aleppo (five from potato fields and one from one yellow water pan), Hama (one from a potato field), Damascus (one from a potato field), Homs (two from potato fields), Idleb (one from a potato field), Latakia (one from a tomato field) and Al-Hasakeh (two samples from potato fields), from October 17 to November 13, 2007 (Table 1).

Two individuals per sample were identified using the whitefly mitochondrial cytochrome oxidase I (mtCOI) sequence analysis (Frohlich *et al*., 1999; Brown, 2000; Ueda and Brown, 2006). Phylogenetic analysis was run by the maximum likelihood method of TREE-PUZZLE version 5.2 (Strimmer and von Haeseler, 1996; Strimmer *et al*., 1997). One thousand puzzling steps were calculated using the Hasegawa-Kishino-Yano (HKY) method of substitution (Hasegawa *et al*., 1985).

Table 1. Whiteflies collected in Syria in 2007.

Sample abbreviation	Date	Prefectures	Note
WF-17	October 17	Aleppo	Potatoes (Field)
WF-18	October 17	Aleppo	Potatoes (Field)
WF-19	October 17	Aleppo	Potatoes (Field)
WF-20	October 23	Hama	Potatoes (Field)
WF-21	October 24	Damascus	Potatoes (Field)
WF-22	October 24	Homs	Potatoes (Field)
WF-23	October 24	Homs	Potatoes (Field)
WF-24	October 25	Aleppo	Yellow water pan
WF-25	October 25	Aleppo	Potatoes (Field)
WF-26	October 31	Idleb	Potatoes (Field)
WF-28	October 31	Latakia	Tomatoes (Plastic house)
WF-29	November 11	Aleppo	Potatoes (Field)
WF-30	November 13	Al-Hasakeh	Potatoes (Field)
WF-32	November 13	Al-Hasakeh	Potatoes (Field)

RESULTS AND DISCUSSION

Investigations of whiteflies in autumn-cultured potato fields

The assessments of whitefly populations were carried out in autumn-cultured potato fields in Syria. Whitefly individuals were confirmed in every field, Aleppo 1-4, Hama 1-2, Damascus 1, Homs 1-2, Idleb 1, Al-Hasakeh 1-4, in six prefectures (Table 2). Whiteflies, which were counted in the fields, consisted mostly of *B. tabaci*, although not at all the individuals were identified to species.

The population density ranged from 0.030 individuals per compound leaf in a field in Aleppo, to 0.695 in a field in Al-Hasakeh, and the densities were higher in Al-Hasakeh. In Aleppo and Hama the densities in 2007 were four times higher than those in 2006 (Fujiie *et al*., 2007). Even though few whiteflies were observed on spring-cultured potatoes (data not shown), autumn-cultured potatoes were infested with whiteflies. This phenomenon might be explained by whiteflies emerging in spring and not only infecting potatoes, but also many other plants that have fresh new leaves during this season.

Maximum likelihood tree for *Bemisia tabaci*

Figure 1 shows the maximum likelihood phylogenetic tree for *B. tabaci* reconstructed using the whitefly mitochondrial cytochrome oxidase I (mtCOI) sequence as a molecular marker. The Q, B and non-B (B2) biotypes were identified from 14 collected samples.

Table 2. Average whitefly numbers per leaf from autumn-cultured potato fields in six prefectures of Syria in 2007.

Field in each prefecture [1]	Date	Whitefly counts (No. / leaf) [2]
Aleppo 1	Oct. 17	0.075
Aleppo 2	Oct. 17	0.040
Aleppo 3	Oct. 17	0.030
Hama 1	Oct. 23	0.130
Hama 2	Oct. 23	0.255
Damascus 1	Oct. 24	0.220
Homs 1	Oct. 24	0.085
Homs 2	Oct. 24	0.060
Aleppo 4-1	Oct. 29	0.150
Idleb 1	Oct. 31	0.050
Aleppo 4-2	Nov. 6	0.100
Aleppo 4-3	Nov. 7	0.170
Al-Hasakeh 1	Nov. 13	0.180
Al-Hasakeh 2	Nov. 13	0.695
Al-Hasakeh 3	Nov. 13	0.635
Al-Hasakeh 4	Nov. 13	0.595
Average		**0.217**

[1] "Aleppo 4-1", "Aleppo 4-2" and "Aleppo 4-3" are from the same field at the GOSM laboratory site, and the others at fields of farmers.
[2] Adult whiteflies on 200 compound leaves of potatoes were investigated each time.

The populations from Syria are shown as "WF17-WF26, WF28-WF30 and WF32" in the tree; all other populations are sources of reference sequences used in the analysis. Information from Fujiie *et al*. (2007) was added as "SyWF2, SyWF3 and SyWF7". The numbers placed at each node indicate the percentage of supporting puzzling steps (only values >50 are shown). The two sequences have been submitted to the DDBJ/EMBL/GeneBank databases under the following accession numbers: Damascus WF21 (AB473558) , Al-Hasakeh WF30 (AB473559).

The Q biotype was confirmed from five samples (WF-18, WF-19, WF-20, WF-25, WF-29) collected on potatoes, and one sample (WF-24) trapped in one yellow water pan. On the other hand, the B biotype was confirmed from three samples (WF-21, WF-22, WF-23) on potatoes and one sample (WF-28) on tomatoes, and the non-B (B2) biotype from four samples (WF-17, WF-26, WF-30, WF-32) on potatoes. A part of the B and non-B (B2) biotypes from Syria probably belongs to the Mediterranean/Asia Minor/Africa invasive genetic group (Boykin *et al*., 2007). The samples of WF17, WF26, WF30 and WF32, which were classified as the non-B (B2), and the biotype of *B. tabaci* from Yemen in the Arabian Peninsula belonged to the same group (Fig. 1). The

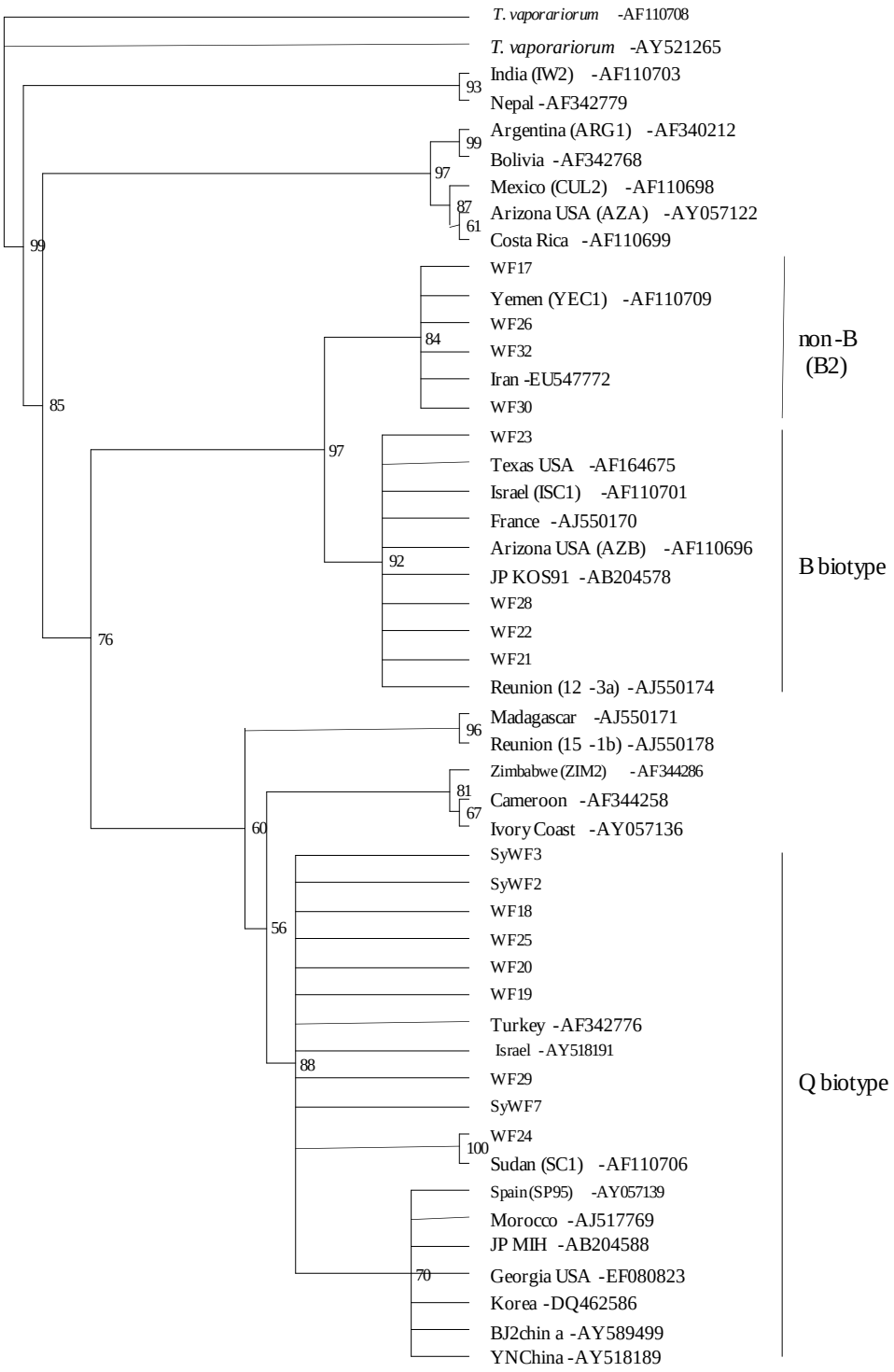

Fig. 1. Maximum likelihood phylogenetic tree for *Bemisia tabaci* reconstructed using the whitefly mitochondrial cytochrome oxidase I (mtCOI) sequence.

data from Yemen, Yemen (YEC1)-AF110709, was most closely related to B-like variants (Frohlich *et al*., 1999). Delatte (2005) also reported that the biotype of *B. tabaci* in Yemen was the B and B2. These facts are essential for further classification of WF17, WF26, WF30 and WF32.

Geographic distribution of *Bemisia tabaci*

This insect is distributed in potato fields of six prefectures in which potatoes are grown, Al-Hasakh, Aleppo, Idleb, Hama, Homs and Damascus, and in one tomato field in Latakia. The distributions of the Q, B and non-B (B) biotypes were in Aleppo and Hama Prefectures, in Latakia, Homs and Damascus Prefectures and in Al-Hasakeh, Aleppo and Idleb Prefectures, respectively. The Q biotype was also identified from the samples collected on potatoes in Aleppo and Hama in 2006. (Fujiie *et al*., 2007).

The Q biotype was first reported to be locally distributed in the Iberian Peninsula (Guirao *et al*., 1997). In recent years, this biotype has been reported from China (Zhang *et al*., 2005; Chu *et al*., 2006), Japan (Ueda and Brown, 2006), New Zealand (Scott *et al*., 2007) and Syria (Fujiie *et al*., 2007). The biotypes of *B. tabaci* could be only identified using molecular sequence methods (Brown, 2000), because morphological identification is impossible. In this study we also applied this method and showed the geographical distribution of *B. tabaci* in Syria with the information of its biotype for the first time.

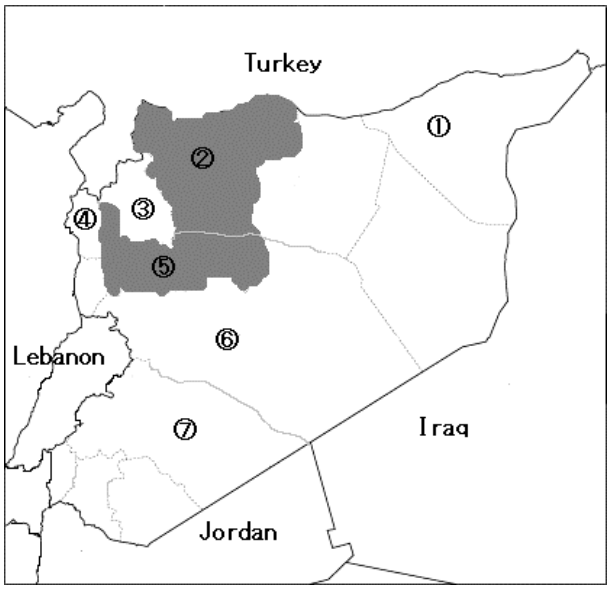

Fig. 2. Map showing the geographic distribution of *Bemisia tabaci* in Syria in 2007. The Q biotype was found in 2 (Aleppo) and 5 (Hama) Prefectures. On the other hand, the B biotype was in 4 (Latakia), 6 (Homs) and 7 (Damascus) Prefectures and the non-B (B2) biotype in 1 (Al-Hasakeh), 2 (Aleppo) and 3 (Idleb) Prefectures.

B. tabaci is the vector of viruses in genus *Begomovirus*, such as *Tomato yellow leaf curl virus*, Tobacco leaf curl Japan virus, *Honeysuckle yellow vein mosaic virus* and *Eupatorium yellow vein virus*, therefore either of the biotypes is harmful in potato protection. However, the Q biotype is a bigger pest, because the resistance to chemical pesticides is

pesticides is stronger than the B (Nauen *et al*., 2002; Horowitz *et al*., 2005). Thus the Q is one of the most dangerous pests.

In this report, we showed the geographic distribution of *B. tabaci*, particularly the distribution of the Q biotype in Aleppo and Hama (Fig. 2). Latakia and the adjacent southern prefecture, Tartus, are near Hama, and these prefectures are a major source of tomatoes which are severely damaged with this biotype. Strong management measures are required to protect the expansion of the Q biotype to tomato fields in Latakia and Tartus.

CONCLUSION

Whiteflies were investigated and collected in autumn-cultured potato fields in Syria. The density was 0.030-0.695 individuals per compound potato leaf. The samples were identified using whitefly mitochondrial cytochrome oxidase I (mtCOI) sequence analysis. They were the Q, B and non-B (B2) biotypes of *Bemisia tabaci*. This paper is the first report of the geographic distribution of *B. tabaci* biotypes in Syria.

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J. ISSAAS Vol. 15, No. 2:21-33 (2009)

AGROMYZID LEAFMINERS AND THEIR PARASITOIDS ON VEGETABLES IN CENTRAL VIETNAM

Dang Hoa Tran

Department of Plant Protection, Faculty of Agronomy, Hue
University of Agriculture and Forestry, 102 Phung Hung, Hue, Vietnam.
Email: trandanghoa@huaf.edu.vn

(Received: November 14, 2008; Accepted: May 1, 2009)

ABSTRACT

Vegetable crops were surveyed in three regions of Central Vietnam to record abundance and diversity of agromyzid leafminers and their associated parasitoid species. The five leafminer species were found. *Liriomyza sativae* was the most abundant species. *Liriomyza bryoniae* was new incursions, and became the second most abundant species. *Liriomyza chinensis* occurred only on onion. *L. huidobrensis* was much less abundant. *Chromatomyia horticola* was abundant on Indian mustard. In all, 13 species of hymenopterous parasitoids were reared from the leafminer-infested leaves. Eleven species were reared from *L. sativae*, and 5 from *L. chinensis*. The species composition and abundance of parasitoids varied with plants and regions. *Neochrysocharis okazakii* and *N. formosa* were most abundant in the north central coast region while *N. okazakii* and *Hemiptarsenus varicornis* were most abundant in the south central coast region. *Chrysocharis pentheus*, *Acecodes delucchii* and *N. formosa* predominated in the central highland regions. The parasitoid species most frequently reared from the leafminers on welsh onion and Indian mustard was *N. okazakii* while *N. formosa* was the most abundant species of leafminers on cantaloupe and yardlong bean. *Chrysocharis pentheus* was the most abundant parasitoid species reared from leafminers on garden tomato. *Hemiptarsenus varicornis* was reared from every type of host plant, and was the second most abundant species on cantaloupe. The number and diversity of parasitoid species in Central Vietnam indicates the potential for parasitoids to control leafminers.

Key words: Conservation, diversity, integrated pest management, *Liriomyza*, *Neochrysocharis*

INTRODUCTION

In Southeast Asia, several invasive, polyphagous *Liriomyza* species are becoming major pests in vegetable growing areas (Shepard *et al.*, 1998; Sivapragasam and Syed, 1999; Rauf *et al.*, 2000). The predominant species are *Liriomyza sativae* Blanchard, *Liriomyza huidobrensis* (Blanchard) and *Liriomyza trifolii* (Burgess) (Diptera: Agomyzidae) (Murphy and LaSalle, 1999). The Asian species *Liriomyza chinensis* (Kato) (Diptera: Agromyzidae) is not polyphagous, but is a serious pest on *Allium* spp. It has been reported in China, Japan, Malaysia and Thailand (Spencer 1973; Chen *et al.*, 2003), Indonesia (Rauf *et al.*, 2000), Korea (Hwang and Moon, 1995) and Taipei (Shiao, 2004). Besides the polyphagous *Liriomyza* species, *Chromatomyia horticola* (Goureau) (Diptera: Agromyzidae) is an important pest infesting vegetable (particularly pea and lettuce) and ornamental crops in Japan (Saito, 2004). Recently, outbreaks of *C. horticola* have been found in several countries including China (Chen *et al.*, 2003), Indonesia (Rauf *et al.,* 2000) and Malaysia (Sivapragasam and Syed, 1999).

Agromyzid leafminers are known to have rich natural enemies. Over 40 species of parasitoids have been recovered worldwide from the leafminers (Waterhouse and Norris, 1987) including 27 species in Japan (Konishi, 1998), 14 species in China (Murphy and LaSalle, 1999; Chen

et al., 2003), 11 species in Indonesia (Rauf *et al.*, 2000) and 8 species in Malaysia (Murphy and LaSalle, 1999). These species of parasitoids have been recognized for their potential contribution to the integrated pest management (IPM) of leafminers in both glasshouses and open fields (Waterhouse and Norris, 1987; Minkenberg, 1990). A strategy for a biological control based integrated pest management (IPM) system that is appropriate for agromyzid leafminers in vegetable production areas would include the conservation or enhancement of locally occurring natural enemies. Only if local parasitoids were shown to be ineffective would it be appropriate to consider importing appropriate natural enemy species from the area of origin of the pests or from related leafminer populations from other areas.

Because of the rapid increase in leafminer-infested crops in Vietnam, vegetable growers frequently apply large quantities of primarily broad-spectrum insecticides (Tran and Takagi, 2005). Frequent applications of these insecticides, however, will adversely affect parasitoid abundance in the vegetable agro-ecosystem (Johnson *et al.*, 1980; Saito *et al.*, 1996), can promote the development of pesticide resistance within fly populations (Keil *et al.*, 1985; Johansen *et al.*, 2003) and frequently lead to an increase in leafminer density (Murphy and LaSalle, 1999). Before an effective IPM system can be developed for these pests, it is necessary to identify the key native species and determine their distribution and abundance across different geographical areas and land use systems.

Vietnam can be divided into the following ecological regions: north east, north west and Red river delta in the north, north central coast, south central coast and central highland in the central, northeast south and Mekong river delta in the south (Nguyen, 2002; Michael and Andreas, 2004). In the north, the temperatures are subtropical. Shifting seasonal wind patterns result in dry and cold winters and wet summers. The central areas typify the tropical monsoon climate, with high temperatures and abundant precipitation. In the south, distinct wet and dry periods are evident, but temperatures are higher than in the north (Le, 1997). Central Vietnam is divided into three regions (Fig. 1). The climate of Central Vietnam is diverse. While the weather of the south central coast region is warm all the year round, it is cold in winter in the north central coast areas. The Central highland region is including some plateaus with 500–1000m above sea-level. The climate of the central highland region is large different from two other regions. There are two different seasons, the hot (from April to October) with the total rainfall and the cold (from November to March) (Le, 1997). Because of different climate, crop growing season are diverse within these regions.

While surveys for leafminers and their parasitoids have been conducted in northern and southern Vietnam (Thang, 1999; Tran, 2000; Ha, 2001; Andersen *et al*., 2002; Tran *et al.*, 2005), there is very little published information available from Central Vietnam. Because of the geographical distance, climatic and crop habitat differences, it is suspected that large variations in leafminer and its parasitoid fauna exist within Vietnam. The objectives of this study were to determine the abundance and diversity of leafminers and their parasitoids in commercial vegetable crops in the three regions of Central Vietnam.

MATERIALS AND METHODS

Field surveys of leafminers and their parasitoids were conducted in 15 major vegetable growing municipalities in six provinces of Central Vietnam in 2004 and 2006, i.e. Thanh Hoa, Nghe An and Thua Thien Hue in the north central coast region, Quang Nam in the south central coast region, and Kon Tum and Gia Lai in the central highland region (Fig. 1). Because most vegetable production was only available in the open fields from January to July, field collections were made monthly in the growing season.

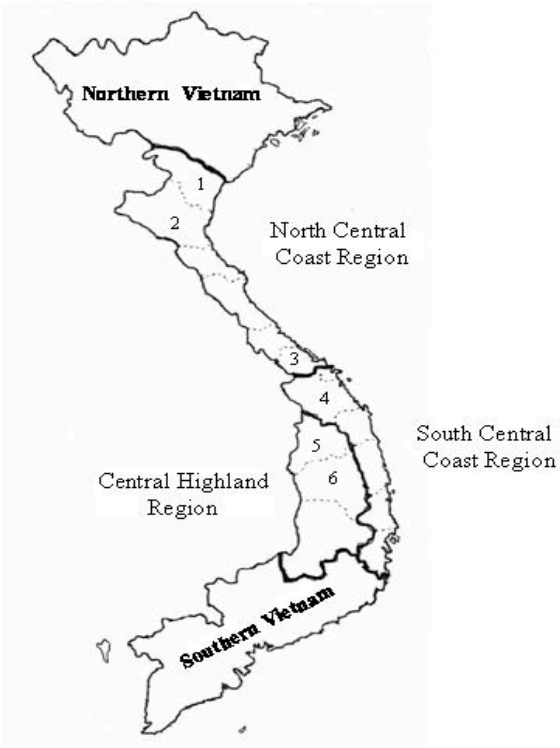

Fig. 1. A map of Central Vietnam showing study sites (based on Nguyen, 2002; Michael and Andreas, 2004). The sites are indicated in numbers: Thanh Hoa (1), Nghe An (2), Thua Thien Hue (3), Quang Nam (4), Gia Lai (5) and Kon Tum (6).

Leafminer-infested leaves were randomly collected from 20 species of vegetable crops of commercial vegetable fields (Table 1) and placed in plastic bags labeled with the name of the crop, location, date, and collector's name. Samples sizes were variable, depending on vegetable species, but generally 10–15 leaves per field were taken from crops with large leaves (e.g. cabbage, Indian mustard, eggplant, garden cucumber, etc.), whereas 20–30 leaves were removed from plants with small leaves (e.g. kidney bean, garden tomato, onion, etc.). Samples were placed in an icebox and brought to the laboratory. The leafminer flies and parasitic wasps were collected after emergence.

After clearing of other insects and residues, a piece of the leaves was placed in Petri dish (9 cm in diameter) lined with filter paper. Samples were maintained at room temperature (25 ± 5°C) and supplied daily with some drops of water for maintaining appropriate humidity in the Petri dishes. The numbers of emerged adult leafminers and parasitoids were recorded daily. All flies and wasps were kept separately in small vials containing 70% ethanol for identification. Relative abundance of parasitoid species was estimated from the ratio of the numbers of emerged adults of each parasitoid species to total number of emerged parasitoid adults.

RESULTS

Leafminer species

Five agromyzid leafminer species, i.e. *L. sativae*, *L. bryoniae*, *L. chinensis*, *L. huidobrensis* and *C. horticola* were reared from the collected leaves (Table 1). *Liriomyza sativae* was the most abundant species, infesting 15 vegetable species. *Liriomyza bryoniae* was found in Thanh Hoa and Nghe An provinces, the north central region. It became the second most abundant species attacking 10

Table 1. Number of agromyzid leafminers that emerged from different host plants in Central Vietnam.

Scientific name	Common name	*L. sativae*		*L. bryoniae*		*L. chinensis*		*L. huidobrensis*		*C. horticola*	
		2004	2006	2004	2006	2004	2006	2004	2006	2004	2006
Brassicaceae											
Brassica oleracea var. *Oleracea* L.	cabbage,			6 (1/1)[a]	41 (3/3)					0 (0/1)	1 (1/3)
Brassica oleracea var. *gongylodes* L.	kohlrabi			11 (1/1)	16 (2/3)						
Brassica chinensis L.	pak choi			9 (1/1)	14 (2/2)						
Brassica juncea L.	Indian mustard	84 (2/6)	181 (7/12)	31 (2/6)	85 (7/12)					69 (2/6)	141 (7/12)
Raphanus sativus L.	radish	8 (1/1)	17 (3/3)								
Asteraceae											
Chrysanthemum coronarium L. var. *coronarium*	garland chrysanthemum	1 (1/3)	2 (1/6)	37 (1/3)	76 (4/6)			0 (0/3)	2 (1/6)	0 (0/3)	1 (1/6)
Cucurbitaceae											
Cucumis sativus L.	cucumber	12 (1/3)	33 (3/4)	24 (1/3)	49 (2/4)						
Cucumis melo L.	cantaloupe	18 (1/1)	160 (6/6)								
Momordica charatia L.	Balsam pear		23 (2/2)								
Luffa accutangula (L.) Roxb	sinkwa towelsponge		8 (2/2)								1 (1/2)
Cucurbita moschata (Duchesne ex Lam) Duchesne ex Poir	crookneck squash	13 (1/1)	45 (2/2)								

Scientific name	Common name	*L. sativae*		*L. bryoniae*		*L. chinensis*		*L. huidobrensis*		*C. horticola*	
		2004	2006	2004	2006	2004	2006	2004	2006	2004	2006
Citrullus lanatus (Thunb.) Matsun & Nakai	watermelon	16 (1/1)	21 (2/2)								
Fabaceae											
Phaseolus vulgaris L.	kidney bean	145 (5/5)	311 (16/16)	9 (1/5)	21 (3/16)						
Vigna radiata (L.) R. Wilczek	mung bean	7 (1/1)	37 (3/3)								
Vigna unguiculata (L.) Walp. ssp. *sesquipedalis* (L.) Verdc.	yardlong bean	69 (3/3)	149 (5/5)								
Liliaceae											
Allium fistulosum L.	welsh onion					21 (2/2)[a]	150 (4/4)				
Allium cepa L.	garden onion					8 (1/1)	26 (3/3)				
Solanaceae											
Lycopersicon esculentum L. var. *lycopersicum*	garden tomato	206 (7/7)	428 (11/11)	0 (0/7)	2 (2/11)					0 (0/7)	1 (1/11)
Solanum melongena L.	eggplant	13 (2/2)	67 (6/6)	2 (1/2)	4 (1/6)						
Solanum torvum Sw.	turkey berry		7 (2/3)		29 (2/3)						
Total no. of emerged adults		592	1489	139	327	29	176	0	2	69	145

[a](Number of infested samples/ number of collected samples)

vegetable crops. It infested a widest range of Brassicaceae, was the most abundant species on garland chrysanthemum (*Chrysanthemum coronarium* L. var. *coronarium*). *Liriomyza chinensis* occurred only on *Allium* spp. *Liriomyza huidobrensis* emerged only from garland chrysanthemum leaves collected from Hue city, Thua Thien Hue province in 2006. *Chromatomyia horticola* commonly infested Indian mustard (*Brassica juncea* L.). This leafminer was also found infesting cabbage (*B. oleracea* var. *oleracea* (L.)), kohlrabi (*B. oleracea* var. *gongylodes* L.), garland chrysanthemum, sinkwa towelsponge (*Luffa accutangula* (L.) Roxb) and garden tomato (*Lycopersicon esculentum* L. var. *lycopersicum*) in 2006.

Parasitoid species

Thirteen parasitoid species of 3 families (Braconidae, Eucoilidae and Eulophidae) were reared from leafminer-infested vegetable leaves (Table 2). Parasitoid species composition and their abundance varied by region from which vegetable infested leaves were collected (Table 2). In the north central coast region, *Neochrysocharis okazakii* Kamijo and *Neochrysocharis formosa* (Westwood) were the most abundant species, accounting for 55.1% and 29.8%, respectively, of emerged parasitoids (11 species; 423 individuals). In the south central coast region, *N. okazakii* and *Hemiptarsenus varicornis* (Girault) were the most abundant species (51.2% and 24.9%, respectively) of the 9 species recorded. In the central highland region, *Chrysocharis pentheus* (Walker) and *Acecodes delucchii* (Bou□ek) were the most abundant of the six species recorded, (45.3% and 22.1%, respectively).

Table 2. Percentage and number (in parentheses) of parasitoid species by family reared from infested vegetable leaves collected from different regions of Central Vietnam.

Parasitoids	**North central**	**South central coast**	**Central highland**
Braconidae			
Opius chromatomyiae Belokobylskij & Wharton	0.0 (0)	0.5 (1)	0.0 (0)
Eucoilidae			
Gronotoma sp.	0.5 (2)	0.0 (0)	0.0 (0)
Eulophidae			
Neochrysocharis okazakii Kamijo	55.1 (233)	51.2 (103)	0.0 (0)
Neochrysocharis formosa (Westwood)	29.8 (126)	9.9 (20)	17.4 (15)
Neochrysocharis beasleyi Fisher & LaSalle	2.6 (11)	0.0 (0)	3.5 (3)
Neochrysocharis sp.	0.2 (1)	0.0 (0)	0.0 (0)
Hemiptarsenus varicornis (Girault)	1.9 (8)	24.9 (50)	2.3 (2)
Diglyphus isaea (Walker)	0.5 (2)	0.5 (1)	0.0 (0)
Cirrospilus ambiguus Hansson & LaSalle	2.1 (9)	0.0	9.3 (8)
Chrysocharis pentheus (Walker)	6.1 (26)	7.5 (15)	45.3 (39)
Asecodes delucchii (Bou□ek)	0.5 (2)	4.5 (9)	22.1 (19)
Quadrastichus sp.	0.7 (3)	0.5 (1)	0.0 (0)
Pnigalio sp.	0.0 (0)	0.5 (1)	0.0 (0)
Total	100 (423)	100 (201)	100 (86)

Parasitoid - host plant relationship

Parasitoid species and the proportion of each species reared from the leafminer-infested leaves varied with host plants (Table 3). A total of 9 species of parasitoids were recorded as natural enemies of leafminers on Indian mustard. The range of 5-7 parasitoid species were reared from the leafminers on welsh onion (*A. fistulosum* L.), garden tomato, cantaloupe (*Cucumis melo* L.) and yardlong bean (*Vigna unguiculata* (L.) Walp. ssp. *sesquipedalis* (L.) Verdc).

Table 3 Relative abundance of parasitoid species by crop type reared from leafminer- infested leaves of various types of vegetables in Central Vietnam.

Vegetable type	Leafminer infested	Parasitoids		
		Species	Relative abundance (%)	Total no. of emerged adults
Welsh onion	*L. chinensis*	*Neochrysocharis okazakii*	92.4	105
		Neochrysocharis formosa	2.9	
		Diglyphus isaea	2.9	
		Hemiptarsenus varicornis	0.9	
		Cirrospilus ambiguus	0.9	
Indian mustard	*L. sativae*	*Neochrysocharis okazakii*	76.8	142
	L. bryoniae	*Neochrysocharis formosa*	12.7	
	C. horticola	*Hemiptarsenus varicornis*	3.5	
		Quadrastichus sp.	2.1	
		Chrysocharis pentheus	1.4	
		Asecodes delucchii	1.4	
		Gronotoma sp.	0.7	
		Neochrysocharis beasleyi	0.7	
		Opius chromatomyiae	0.7	
Garden tomato	*L. sativae*	*Chrysocharis pentheus*	47.6	42
		Neochrysocharis formosa	30.9	
		Asecodes delucchii	11.9	
		Hemiptarsenus varicornis	7.1	
		Neochrysocharis okazakii	2.4	
Cantaloupe	*L. sativae*	*Neochrysocharis okazakii*	49.5	204
		Hemiptarsenus varicornis	24.5	
		Neochrysocharis formosa	19.1	
		Chrysocharis pentheus	3.4	
		Asecodes delucchii	2.5	
		Quadrastichus sp.	0.5	
		Gronotoma sp.	0.5	
Yardlong bean	*L. sativae*	*Neochrysocharis formosa*	68.1	91
		Neochrysocharis okazakii	12.1	
		Neochrysocharis beasleyi	10.9	
		Cirrospilus ambiguus	6.6	
		Neochrysocharis sp.	1.1	
		Chrysocharis pentheus	1.1	

The most common parasitoid species reared from the leafminers on onion, cantaloupe and Indian mustard was *N. okazakii*. While *N. formosa* was the most abundant species of leafminers yardlong bean, this species was also the second most abundant on Indian mustard, garden tomato and onion. *Chrysocharis pentheus* was the most common parasitoid species reared from leafminers on garden

tomato. *Hemiptarsenus varicornis* was found on every host plant type, and was the second most abundant species on cantaloupe. *Diglyphus isaea* (Walker) was only found on onion, but it was not abundant. *Neochrysocharis* sp. was a new species of the genus from Vietnam, existing on yardlong bean in Thanh Hoa province, but it was not very common.

Host - parasitoid relationship

The parasitoid complex of *L. sativae* and *L. chinensis* was diverse (Table 4). Eleven parasitoid species were reared from leaves infested by *L. sativae*. *Neochrysocharis formosa* and *N. okazakii* were the most abundant species (31.7 and 30.1%, respectively, of all adult parasitoids that emerged). Five parasitoid species were reared from *L. chinensis* with *N. okazakii* being the dominant species, (82.5% of parasitoids reared).

Table 4. Percentage and number (in parentheses) of parasitoid species reared from leafminers *L. sativae* and *L. chinensis* in Central Vietnam.

Parasitoids	***L. sativae* being parasitized**	***L. chinensis* being parasitized**
Braconidae		
Opius chromatomyiae Belokobylskij & Wharton	0.5 (2)	0.0 (0)
Eucoilidae		
Gronotoma sp.	0.3 (1)	0.0 (0)
Eulophidae		
Neochrysocharis okazakii Kamijo	30.1 (112)	82.5 (127)
Neochrysocharis formosa (Westwood)	31.7 (118)	7.8 (12)
Neochrysocharis beasleyi Fisher & LaSalle	2.2 (8)	0.0
Neochrysocharis sp	0.3 (1)	0.0
Hemiptarsenus varicornis (Girault)	13.4 (50)	2.6 (4)
Diglyphus isaea (Walker)	0.0 (0)	5.8 (9)
Cirrospilus ambiguus Hansson & LaSalle	3.0 (11)	1.3 (2)
Chrysocharis pentheus (Walker)	13.4 (50)	0.0
Asecodes delucchii (Bou□ek)	4.8 (18)	0.0
Quadrastichus sp.	0.3 (1)	0.0
Total	100 (372)	100 (154)

DISCUSSION

Liriomyza sativae, native to the southern United States (Spencer, 1973), was found in 10 provinces in northern Vietnam (Ha, 2001) and in 27 conducted provinces of northern and southern Vietnam (Andersen *et al.*, 2002). The present study shows that *L. sativae* has also become one of the most important vegetable pests in Central Vietnam. *Liriomyza bryoniae* was relatively new incursions

into Vietnam. The first documented infestation of *L. bryoniae* in Vietnam was on mung bean in Hanoi (Red River Delta region) in 2003 (Grimstad, 2004). The present study indicated the occurrence of *L. bryoniae* on various vegetable species in the north central region. Further spread of this species within the country seems likely. Previous studies indicated the coexistence of leafminer species in vegetables in Europe (Minkenberg, 1990), America (Zehnder and Trumble 1984) and Japan (Abe and Kawahara 2001). The present study also revealed the coexistence of *L. sativae* and *L. bryoniae* in various vegetable crops in Central Vietnam. Therefore, it is necessary to compare the development, reproductive rate, migration ability, host plant exploitation and susceptibility to insecticide among the populations of these species for their control procedure finding (Abe and Kawahara 2001). Previously, *L. huidobrensis* was found only in Lam Dong province (northeast south region) at altitudes of 1000–1800 m. The species was accidentally introduced to the vegetable growing areas around Da Lat, Lam Dong most probably from imported infested plants (Andersen *et al.*, 2002). Due to its cold hardiness (Chen and Kang, 2002, 2004), *L. huidobrensis* within Vietnam may be expected of a further spread through introduction to other highland areas via infested plants (Andersen *et al.*, 2002), this species was also found on garland chrysanthemum in Hue city at low altitude. Andersen *et al.* (2002) reported that *L. chinensis* was found infesting *Allium* spp. in one province in the northeast region (Bac Ninh) and two provinces (Dong Nai and Ba Ria) in the northeast southern region. This study found that *L. chinensis* is common all over Central Vietnam. *Chromatomyia horticola* is easily separated from the others by its generally darker body and larger size. This species was reported to infest vegetable and ornamental crops throughout Asia, for instance pea in Indonesia (Rauf *et al.*, 2000), and pea and lettuce in Japan (Saito, 2004). In Central Vietnam, *C. horticola* was also found on several vegetable crops, in particular Indian mustard. The present study indicates that field vegetable growing in Central Vietnam is under siege from five agomyzid leafminers, and each crop is infested by one or more of these species. However, it is difficult for the growers to identify leafminer species occurring in their fields. Therefore, it is appropriate to consider that a control procedure for all leafminers is required (Abe and Kawahara, 2001).

Our extensive surveys revealed a parasitoid complex (13 species) among 20 vegetable crop types in three regions of Central Vietnam. The species composition of the parasitoid species varied in the different areas. Extensive surveys for natural enemies of agromyzid leafminers have been made in many countries (Konishi, 1998; Murphy and LaSalle, 1999; Thang, 1999; Rauf *et al*., 2000; Petcharat *et al.*, 2002; Chen *et al.*, 2003), but parasitoid complexes differed from one another. The spatial distribution of species and the factors limiting them are less well understood. Some species have restricted distributions whilst others have a very wide distribution in the New World (Murphy and LaSalle, 1999). In Japan, the parasitoid fauna of *L. trifolii* was different between Shizuoka and Okinawa Prefectures because of the great difference in geographic and climatic conditions (Saito *et al.*, 1996; Arakaki and Kinjo, 1998). Arakaki and Kinjo (1998) also recorded a difference in parasitoid fauna of *L. trifolii* on bean, tomato and eggplant in the open fields and greenhouses in different local agro-ecological regions of Okinawa Island, Miyako Island and Ishigaki Island, Okinawa Prefecture. Thus, it seems that climatic biotypes exist within the distribution of leafminer parasitoid species (Murphy and LaSalle, 1999).

Most of the parasitoids found in this investigation belong to the family Eulophidae. *Neochrysocharis okazakii*, *N. formos*a and *H. varicornis* predominated in the north central and south central coast regions. This result is consistent with research in Japan indicating that those species predominate in open field crops (Saito *et al.*, 1996; Arakaki and Kinjo, 1998). On the other hand, the dominant species in the central highland region were *C. pentheus* and *A. delucchii*. There is little evidence that *Liriomyza* parasitoids display any high degree of host specificity (Murphy and LaSalle, 1999; Chen *et al.*, 2003). However, a variation of the parasitoid complexes of *L. sativae* and *L. chinensis* was found in this study. It could be influenced by high level of insecticide applied to onion fields (Tran and Takagi, 2005). Since the native polyphagous parasitoids have the capacity to quickly adopt new hosts (Chen *et al.*, 2003), the species complex and abundance of these parasitoids on

vegetable crops in the different three regions could be a fundamental importance for development of biological control strategies for any agromyzid leafminer species.

Among the parasitoid complex of the leafminers on welsh onion, cantaloupe and Indian mustard, *N. okazakii* was the predominant species. *Neochrysocharis formosa* was the most abundant parasitoid associated with leafminer species in yardlong bean, and the second most abundant species in garden tomato, Indian mustard and welsh onion. Numerous studies have indicated that *N. formosa* is a dominant species in a range of ecosystems and it has been recognized as an effective biological control agents of leafminers in tomato, bean and eggplants (Saito *et al.*, 1996; Arakaki and Kinjo, 1998; Maryana, 2000). The most common parasitoid reared from tomato foliage was *C. pentheus*. Arakaki and Kinjo (1998) also reported C. *pentheus* was the second most abundant parasitoid species associated with *L. trifolii* in tomato in Okinawa, Southern Japan. The present results that *N. okazakii*, *N. formosa* and *C. pentheus* are abundant in Central Vietnam suggests that they can be nominated as potential agents for biological control of leafminers by augmentation or conservation on vegetable crops. They richly deserve further study with respect to their biology and ecology. To maximize the potential for parasitoid establishment via colonization, it would probably be best to match up the parasitoids in question with those crops from with they have demonstrated high rate of leafminer parasitism (Johnson and Hara, 1987). Thus, it would be advisable to attempt colonization of *N. okazakii* in welsh onion, cantaloupe and Indian mustard; *N. formosa* in yardlong bean, garden tomato, Indian mustard and onion; and *C. pentheus* in garden tomato.

In Central Vietnam, *D. isaea* was reared from onion leaves infested by *L. chinensis*. Previously, this species was found abundantly on green bean associated with *L. huidobrensis* in Lam Dong province (northeast south region) (Tran *et al.*, 2006). *Diglyphus isaea* is well-known parasitoid that is currently reared on a commercial basis for introduction in greenhouses. Native to Europe, the species is widely distributed and is released for biological control of a wide range of agromyzid leafminers in many countries (Van der Linden, 2004). Given that some new exotic leafminers (e.g. *L. bryoniae*, *L. huidobrensi*s) established and spread within Vietnam, it is appropriate to consider further research with respect to biology and ecology of *D. isaea* for use as a biological control agent of these leafminers.

CONCLUSION

Vegetable crops in Central Vietnam were under threat by five species of agromizid leafminers. The leafminers had rich natural enemy communities. The species composition and abundance of parasitoids varied with plants and regions.

Vegetable growers probably over-react to the present of the leafminers due to the prominence of mines in the leaves, leading too-frequent and unnecessary use of insecticides. To achieve maximum effectiveness of a leafminer integrated management program, participating farmers and extension agents will need to understand the concepts of conserving natural enemies existed or released in their localities, via reductions of pesticide use, to provide the greatest opportunities for suppression of leafminers by biological control agents. The results indicating the important of different species of leafminers and their parasitoids in vegetables could be a fundamental importance for development of strategies for farmer education in the IPM programs.

ACKNOWLEDGEMENT

I thank Dr. Akeo Iwasaki for his identification of leafminers, Dr. Kazuhiko Konishi, Dr. Kazuaki Kamijo and Dr. Kaoru Maeto for their help with identification of parasitoids. I also thank to Dr. Nguyen Thi Lan and to the numerous Vietnamese officers of Plant Protection Departments, for

their assistance in the fields and the laboratory. I extend our thanks to our farmer cooperators for their assistance and collaboration on survey making in their fields. I gratefully acknowledge the constructive comments by Dr. Peter Ridland and Dr. Elske van de Fliert, to an earlier version of this manuscript.

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J. ISSAAS Vol. 15, No. 2:34-41 (2009)

EFFICACY OF PLANT EXTRACT FORMULATIONS TO SUPPRESS STEM ROT DISEASE ON VANILLA SEEDLINGS

Dewa Ngurah Suprapta and Khamdan Khalimi

Laboratory of Biopesticide, Faculty of Agriculture Udayana University
Jl. PB. Sudirman, Denpasar Bali Indonesia
E-mail : biop@dps.centrin.net.id

(Received: March 24, 2009; Accepted: September 1, 2009)

ABSTRACT

Four plant species, i.e. *Eugenia aromatica* (Family Myrtaceae), *Piper betle* (Family Piperaceae), *Alpinia galanga* (Family Zingiberaceae) and *Sphaeranthus indicus* (Family Compositae) were used to develop extract formulations to confirm their antifungal activity. Of the six formulations tested, four formulation, F1,F2,F3 and F4, contained each extract of above mentioned plants, while F5 and F6 were consisted of the mixtures of *E.aromatica* and *P.betle* extract and *A.galanga* and *P.betle* extract, respectively. Treatment with 5% solution of F5 formulation showed the highest inhibitory effect against the radial growth of *F. oxysporum* f.sp. *vanillae* on PDA medium. Diameter of 5 days fungal colony on PDA treated with F5 was only 6.7 mm, while 87.9 mm on the non amended control. The development of stem rot disease was obviously suppressed on vanilla seedlings grown in the soil treated with 5% solution of each plant extract. The lowest disease incidence was attained by the treatment of F5, in which only 7% of the vanilla seedlings were infected. The low disease incidence in the plot treated with F5 was in line with the low population density of *F. oxysporum* f.sp. *vanillae* in the soil. Results of present study displayed that an extract formulation containing the mixture of *E. aromatica* and *P. betle* extracts was the most effective treatment to suppress the population growth of *F. oxysporum* f.sp. *vanillae* in the soil and in turn to suppress the stem rot disease on vanilla seedlings. This formulation can be used as an alternative measure to control stem rot disease on vanilla seedlings preparation.

Key words : Antifungal activity, disease incidence, fungal growth.

INTRODUCTION

Vanilla is a crop of highly economic value for its pleasant flavor and the second expensive spice after saffron (Anonymous, 2004). The crop is grown in several parts of the world such as India, Indonesia, Madagascar, Comoros, Reunion and Mexico.

Bali Island is known as one of the important vanilla-growing areas in Indonesia that produces vanilla beans of the bourdon-like type. The total area of vanilla cultivation and vanilla production were 4,093 hectares and 279.7 tons in 1991, respectivbely. However, because of the devastating stem rot disease caused by a pathogenic fungus, *Fusarium oxysporum* f.sp. *vanilae*, the total cultivating area and the production of vanilla beans gradually decreased since 1992, and in 2001 the total area of vanilla plantation and the vanilla bean production were only 365 hectares and 5.5 tons, respectively (Anonymous, 2002). Stem rot disease is one of the important constraints for the vanilla cultivation, and responsible for the decreasing of vanilla production (Suprapta et al., 2006; Semangun, 2000; Jayasekar et al., 2008; Sulistyani, 2004).

Survey done by Suprapta et al. (2006) in three main vanilla-cultivating areas in Bali (Tabanan, Jembrana and Buleleng Regencies) showed that the stem rot disease caused by *F. oxysporum* f.sp. *vanillae* was the main disease on vanilla with the average disease incidence by 54.7%. The disease was also found to cause severe destruction on vanilla seedlings preparation with average disease incidence by 33.6%. Even the use of synthetic fungicides, the disease can not be controlled properly yet in Bali.

Several higher plants have been tested for their antifungal activities such as *Pometia pinnata* which is active against *Phytophthora infestans*, the causal agent of potato late blight disease (Suprapta et al., 2002), *Carica papaya* leaf extract active against *Ceratocystis* sp. (Suprapta et al., 2001), while *Piper betle*, *Alpinia galanga* and *C. papaya* extracts were found to be effective to suppress banana wilt disease in the field (Arya et al., 2001).

Jayawijaya (2003) showed that the 0.5% (w/v) of *Piper betle* leaf extract suppressed the growth of *F. oxysporum* f.sp. *vanillae* both on PDA medium and in vanilla seedlings effectively. Suprapta et al. (2006) also proved that the extracts of four plant species of 45 species inhabiting in Bali tested, namely *E.aromatica*, *Alpinia galanga*, *S. indicus* and *Piper betle*, inhibited the radial growth of *F. oxysporum* f.sp. *vanillae* on PDA more than 51%. Six extract formulations were developed and tested for their efficacy to suppress the growth of *F. oxysporum* f.sp. *vanillae* both on PDA medium and in the soil of vanilla seedlings.

MATERIALS AND METHODS

Extraction

Four plant species were used in this study to develop extract formulation, namely *E. aromatica* (flower bud), *A.galanga* (rhizome), *S.indicus* (leaf) and *P. betle* (leaf). All of these plants have been proven to posses antifungal activity against *F. oxysporum* f.sp. *vanillae* in previous works (Suprapta et al., 2006). Plant parts were chopped off into small pieces and air-dried for three days and then extracted using methanol three times, followed by filtration through No.2 Whatman filter paper prior to epavoration using a rotary vaccum evaporator (Iwaki, Tokyo). These extracts were used to develop formulations.

Formulations

Extract formulations were developed using plant extracts, Tween-80, sticker and water. Six formulations were developed and tested in this study, those are :

1. Formulation 1 (F1), containing 10% (w/v) flower bud extract of *E.aromatica*, 5% (v/v) Tween-80 acting as emulsifier and distilled water.
2. Formulation 2 (F2), containing 10% (w/v) rhizome extract of *A.galanga*, 5% (v/v) Tween-80, and distilled water.
3. Formulation 3 (F3), containing 10% (w/v) leaf extract of *P.betle*, 5% (v/v) Tween-80, and distilled water.
4. Formulation 4 (F4), containing 10% (w/v) leaf extract of *S.indicus*, 5% Tween-80, and distilled water.
5. Formulation 5 (F5), containing 5% (w/v) flower bud extract of *E. aromatica*, 5% (w/v) leaf extract of *Piper betle*, 5% (v/v) Tween-80, and distilled water.
6. Formulation 6 (F6), containing 5% (w/v) rhizome extract of *A. galanga*, 5% (w/v) leaf extract of *Piper betle*, 5% (v/v) Tween-80 , and distilled water.

All formulations were packaged in 1-liter plastic bottles and stored in the dark at room temperature before use.

Bioassay on PDA

Treatment with extract formulation was done as follows: extract formulation (500 □l) was amended into 10 ml of melted PDA medium. PDA without extract formulation but with 500 □l distilled water with 5% (v/v) Tween-80 was prepared for control. After the PDA medium become solid, a mycelial plug (5 mm diam.) of *F. oxysporum* f.sp. *vanillae* taken from the edge of a 4-day old culture was put in the center of a Petri dish and incubated at room temperature for 5 days in the dark. Five Petri dishes were prepared for each formulation. Each diameter of fungal colony was measured everyday and the inhibitory activity was calculated by the data of colony diameter at the fifth day, according to the formula as follows :

$$\text{Inhibitory activity (\%)} = \frac{\text{Colony diam. on non-amended control - Colony diam.on amended medium}}{\text{Colony diameter on non-amended control}} \times 100\%$$

Application of Extract Formulations

Stems of vanilla for seedlings were obtained from the vanilla collection in a green house of the Laboratory of Biopesticide, Faculty of Agriculture, Udayana University, located at Denpasar, Bali. Firstly, the stems were washed in tap water and then with distilled water to remove all surface contaminants. Stem cuttings consisting of two nodes (approximately 20 cm length) were prepared by sharp scissor prior to the treatment with extract formulations. The stem cuttings were then soaked in each 5 % (v/v) water solution of the formulations for an hour. Stem cuttings soaked with 5% (v/v) distilled water solution of Tween-80 were prepared for control (F0). These stem cuttings were planted into the soil in polyethylene bags containing mixtures of sterile fertile soil: cow manure and saw dust (3:1:1) based on weight and inoculated with 10 ml spore suspension of *F. oxysporum* f.sp. *vanillae* (10^6 spores/ml). Average spore~~s~~ density was 2 x 10^3 spores/gram of soil. Treatments with extract formulations were done five times, at 3 to 15 days after planting with three days interval, by dressing each 5% (v/v) of 100-ml extract formulation into the soil at the bottom of each stem-cutting in polyethylene bags. These cultures were maintained in a green house, with average daily temperature 29.4^{o}C and relative humidity 86.7% for 90 days.

This experiment was designed according to the randomized block design (RBD) with seven treatments (F0, F1, F2, F3, F4, F5 and F6). Each treatment was replicated five times, thus, there were 35 experimental units in this experiment. Each experimental unit was consisting of 20 vanilla seedlings.

Disease incidence of stem rot was observed every week and the population of *F. oxysporum* f.sp. *vanillae* in the soil was determined at the end of experiment (90 days after planting). Data obtained in this experiment was subjected to the statistical analysis, and the significance among the treatments were determined according to the least significant difference (LSD) test at 5%.

RESULTS AND DISCUSSION

Treatment with plant extract formulations significantly ($P<0.05$) inhibited the growth of *F. oxysporum* f.sp. *vanilae* on PDA medium at formulation concentration 5% (v/v) with inhibitory activities varying from 52.5% to 92.4% (Table 1). F5 that consisted of the extracts of *E.aromatica* flower buds and *P.betle* leaves showed the strongest inhibitory activity among the all formulations tested. The radial fungal growth was suppressed 92.4% by this treatment. Fungal growth treated with F1 (containing the extract of *E. aromatica*) was significantly lower than those treated with F3 (containing extract of *P. betle*), suggesting that extract of *E. aromatica* possessed stronger fungicidal activity against *F. oxysporum* f.sp. *vanillae* than that of extract of *P. betle*. However, the mixture of the extracts of *E.aromatica* and *Piper betle* (F5) showed highly inhibiting activity than F1

and F3 independently. This data indicated that there must be synergy effect between extracts of *E. aromatica* and *Piper betle*. Similar phenomenon was observed by Suprapta et al. (2005) in which the mixture of *A. galanga* and *Piper betle* extracts could suppress banana wilt disease on banana seedlings better than that of *A. galanga* or *P. betle* alone.

Table 1. Inhibitory activities of plant extract formulations toward the growth of *Fusarium oxysporum* f.sp. *vanillae* on PDA medium.

No.	Formulations	Diameter of colony at 5-day old (mm)	Inhibitory activity (%)
1	F0	87.9 a*	-
2	F1	8.5 e	90.3
3	F2	20.1 c	77.1
4	F3	11.6 d	86.8
5	F4	41.8 b	52.5
6	F5	6.7 f	92.4
7	F6	11.9 d	86.5

*Figures with the same letter in the same column are not significantly different according to the least significant difference (LSD) test 5%.

Several substances present in the plant materials have been reported to posses antifungal activities against several plant pathogenic fungi. The essential oil of clove contained 87% eugenol,; 8.01% eugenyl acetate and 3.56% beta caryophyllene (Alma et al., 2007). A study done by Nalina and Rahim (2007) showed that the extract of *P. betle* contained hydroxychavicol, fatty acids (stearic and palmitic) and hydroxyl fatty acid esters (stearic, palmitic and myristic). The important constituents of essential oil of *P. betle* are the phenols, eugenol, chavicol, methyl chavicol and betelphenol (van der Vossen and Wessel, 2000). The leaf extract of this plant has not only antibacterial but also antifungal activity that is related with its containing of eugenol (van der Vossen and Wessel, 2000). The presence of eugenol as the major constituent of *E. aromatica* and *P. betle* may be closely related to their antifungal activity against *F. oxysporum* f.sp. *vanillae*.

Alpinia galanga rhizhomes are commonly used as one of the most important spices in many Balinese traditional meat dishes. Rhizome of this plant contains several essential oils such as cineol, eugenol, galangin, galangol, pinene, camphor and methylcinamate (Anonymous, 1986). Dadang (1999) found that *A. galanga* contains 1-acetoxychavicol acetate. Bandara et al. (1989) tested the effect of the crude extract of rhizome of *Acorus calamus* (Araceae) and *Zingiber zerumbet* (Zingiberaceae) against the growth and sporulation of several pathogenic fungi. These plant extracts significantly inhibited the growth of *Cladosporium* sp., *Botryodiplodia theobromae*, *Fusarium solani*, *Phythophthora infestans*, *Phythium* sp., and *Pyricularia oryzae*. The inhibitory activity of *A. calamus* extract against the growth of *F. solani* was higher than that of benomyl, a synthetic fungicide.

Mares et al. (2005) studied the extract from the root of common vegetable, *Chichorium intybus* L. (Asteraceae) for its antifungal activity against various fungi isolated from various environments, including five plant pathogens namely *Botrytis cinerea*, *Fusarium moniliforme*, *Phoma betae Pythium ultimum* and *Alternaria* sp. The growth of *Pythium ultimum* and *Alternaria* sp. were inhibited by the extract treatment. The alcoholic extract of *Aloe vera* leaves was confirmed to inhibit

mycelial growth of *Botrytis gladiolorum*, *F.oxysporum* f.sp. *gladioli*, *Heterosporium pruneti* and *Penicillium gladioli*.

Several substances were identified and were thought to be responsible for the antifungal activity, namely 3-(4-hydroxyphenyl)-2(E)-propenoate isolated from *Costus specious* (Bandara et al., 1989); isobutyric acid, butyric acid, valeric acid and caproic acid from *Portulaca oleracea* (Park et al., 1986); tiliacorine from *Tiliacora racemosa* (Tripathi and Dwivedi, 1989); guaianolides from *Chichorium intybus* (Mares et al., 2005); acetoxychavicold acetate from *Alpinia galanga* (Janssen and Scheffer, 1985).

When the plant extract formulations were applied into the soils of vanilla seedlings, the disease incidence development became slow indicating the capacity of the extract to protect the seedling from fungal infection (Fig.1). The stem rot disease on vanilla seedlings in non treated control (F0) occured at two weeks after planting, while at 4 and 8 weeks after planting in F4 and F5 treated plots, respectively. The highest disease incidence was consistently displayed in the control plot while the lowest in the plot treated with F5.At the end of experiment (12 weeks after planting), the disease incidence in the control plot was 91%. The disease incidence in F5 treated plot was the lowest and only 7% of the vanilla seedlings were infected (Table 2).

Table 2. Incidence of stem rot disease on vanilla seedlings with or without treatment of plant extract formulations

No.	Formulations	Disease incidence (%)	Inhibitory activity (%)
1	F0	91 a*	-
2	F1	14 e	84.6
3	F2	30 c	67.0
4	F3	21 d	76.9
5	F4	57 b	37.4
6	F5	7 f	92.3
7	F6	18 de	80.2

*Values with the same letter in the same column are not significantly different according to the significant difference (LSD) test 5%.

The low disease incidence on vanilla seedlings treated with F5 was in accordance with the low population density of *F. oxysporum* f.sp. *vanillae* in the soil (Table 3). The population density of this fungus in the soil treated with F5 was only 3 x 10^3 CFU/g of soil, and significantly ($P<0.05$) lower than the others, respectively. These results suggested that treatment with F5, containing the mixture of *E. aromatica* and *Piper betle* extracts, was significantly effective to suppress the population growth of *F. oxysporum* f.sp. *vanillae* in the soil as well as the incidence of stem rot disease on vanilla seedlings. This formulation can be used as an alternative measure to control stem rot disease on vanilla seedlings preparation.

Table 3. Population of *Fusarium. oxysporum* f.sp. *vanillae* in the soil with or without treatment of plant extract formulations

No.	Formulations	Fungal population (CFU/g soil) x 10^3	Inhibitory activity (%)
1	F0	40.3 a	-
2	F1	7.8 d	80.6
3	F2	11.4 c	71.7
4	F3	8.7 cd	78.4
5	F4	14.7 b	63.5
6	F5	3.0 e	92.6
7	F6	9.2 cd	77.2

*Values with the same letter in the same column are not significantly different according to the least significant difference (LSD) test 5%.

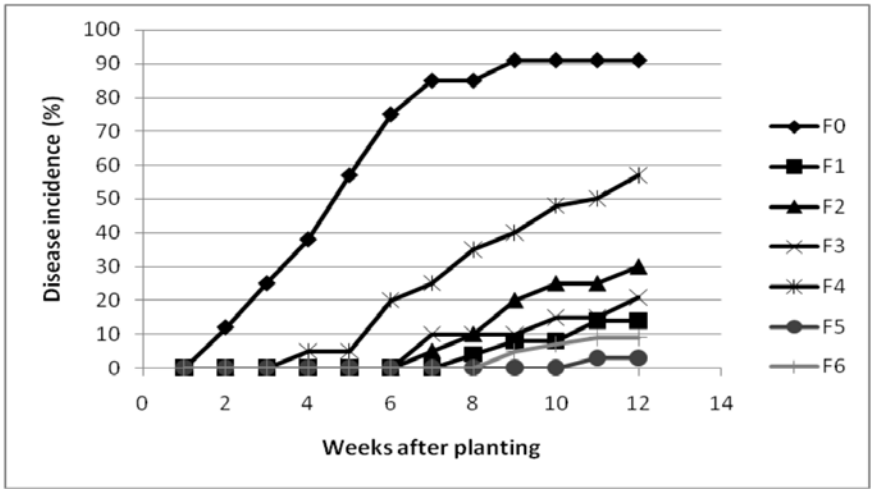

Fig. 1. Development of stem rot disease incidence on vanilla seedlings with or without extract formulation treatment. F0 is control plot, while F1, F2, F3, F4, F5 and F6 are treated plots.

CONCLUSION

Plant extract formulation containing a mixture of *E. aromatica* and *Piper betle* extracts significantly suppressed the radial growth of *F. oxysprum* f.sp. *vanillae* on PDA medium, and in the soil of vanilla seedlings. This extract formulation resulted in the highest inhibitory activity toward stem rot disease incidence on vanilla seedlings. Most of the vanilla seedlings treated with this extract formulation were healthy, indicating that extract formulation containing a mixture of *E. aromatica* and *Piper betle* extracts effectively controlled the stem rot disease and can be used to produce healthy vanilla seedlings.

ACKNOWLEDGEMENT

The authors wish to express our sincere appreciation to the Provincial Government of Bali, Indonesia, for financial support that made this study possible.

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J. ISSAAS Vol. 15, No. 2:42-55 (2009)

SUSTAINABILITY ASSESSMENT OF ORGANIC VEGETABLE CULTIVATION IN CHIANG MAI, THAILAND

Jintana Kawasaki and Akimi Fujimoto

Tokyo University of Agriculture

(Received: September 10, 2009; Accepted: November 16, 2009)

ABSTRACT

Thai farmers are interested in alternative vegetable farming such as safe use farming, natural farming, chemical pesticide free farming and organic farming. They strongly believe that alternative farming can provide economic feasibility due to the high prices of their products, while reducing the burden on the environment. Based on a questionnaire survey of 142 vegetable growers under different production systems in Chiang Mai Province in 2008, this paper aims to clarify whether or not organic farming is a feasible form of sustainable agriculture under small farm size conditions. Sustainability of organic farming is analyzed in terms of farm income, and environmental and social impact in comparison with other production systems.

There was diversified farming of rice, vegetables, fruits and livestock in Mae Rim District, Chiang Mai Province. In the villages studied, average overall cost of environmental and social impacts of kale production was estimated to be 350 USD per year (one rai is equivalent to 0.16 ha; one USD is equal to 34.35 Baht at the time of study in 2008). The environmental and social impacts were the most important factor in improvement of production efficiency among four vegetable farming systems. The conventional kale production appeared to have the highest negative environmental and social impact, while the lowest was attained by organic farming. Only in the case of organic production, the average cost decreased due to the reduced negative impact, and organic growers could raise farm income per ha per year to 7,150 USD. This situation demonstrates that organic farming had the sustainable manner due to the highest profit with higher prices contributing to the highest income, and the lowest negative impacts for environmental and social sectors in comparison with other production system in Chiang Mai.

Key words: environmental and social benefit, environmental impact, farm income, regression analysis.

INTRODUCTION

Total planted area of vegetables in Chiang Mai was approximately 37,997 ha or nearly 14% of total planted area in 2007 (Chiang Mai Department of Agriculture, 2008). There are various vegetable production systems in Chiang Mai, including conventional, safe use, chemical pesticide free, and organic production systems.

This paper attempts to clarify the sustainability of these systems from the environmental impact viewpoint, while an earlier paper analyzed the economics of the production systems (Kawasaki and Fujimoto, 2009). The conventional system heavily depends on the use of synthetic chemical materials, while organic farming uses only organic inputs. Both safe use and chemical pesticide free systems refer to the attempts to reduce the dependency on the use of synthetic chemical inputs. The safe use system refers to the limited use of chemical fertilizer and pesticide, while the chemical pesticide free system does not use any synthetic chemical pesticide, although chemical fertilizer is applied. The farming systems in Thailand concerned with health and environmental

quality are popularly called alternative farming systems (Department of Agricultural Extension, 2002). The alternative farming systems discussed in this study are organic, chemical pesticide free, and safe use farming systems.

From the 1980s there emerged a new type of farming system in Chiang Mai, as many of the small farmers transformed their conventional farms to organic farms (Reunglertpanyakul, 2002). Organic vegetables seemed to have a good chance of marketing due to the increased demand, both domestically and internationally (Jongworakitwattana, 2002). Organic farming would reduce the environmental and social impacts, and enable the development of the agricultural sector in a sustainable manner (Jitsanguan, 2000). However, it is not easy to convince farmers that they have been using too much synthetic chemical inputs (Syaukat, 2003).

Some studies on environmental and social impacts of organic farmers in Thailand clarified the better livelihood and higher welfare from their better health condition, leisure time, farm environment and greater biodiversity of the farms (Jitsanguan, 2008). Organic farmers participating in the Royal Project had achieved an average annual income of 100,064 Baht per household which was substantially higher than the national average of 39,193 Baht (Jayamangkala, 2008). However, the literature on comparative impacts of organic vegetable farming with other farming systems in Thailand remains quite limited.

Specific objectives of this paper are: (1) to clarify the sustainability of organic farming in comparison with other production systems through an examination of household income, and environmental and social benefits, and (2) to identify the level of environmental and social impacts under different farming systems by socio-environmental index and total product.

ANALYTICAL FRAMEWORK

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 whom 32, 32, 38 and 40 farmers were organic, chemical pesticide free, safe use, and conventional vegetable farmers, respectively. The survey data were evaluated by statistical analysis, in order to clarify the sustainability under different farming systems.

The conversion to organic farming from conventional farming may create production inefficiency during the transition period. The production efficiency of organic vegetable cultivation in Chiang Mai is analyzed by examining yield, level of material input use (area, labor, seed, fertilizers, and pesticides), and socioeconomic factors (education, credit, environmental and social benefits). It is expected that a good farming system would increase yields and provide positive environmental and social impacts.

The level of environmental and social impacts depended on the type of farming system. It is assumed that organic farming has the lowest negative impact on farm environment and rural communities, while other farming systems have higher negative impact because of the application of synthetic chemical materials and poor management.

The environmental and social impacts can be considered to be the result of environmental and social factors, presented in Table 1. The environmental factors were composed of three dimensional factors: the reduction of the quantity of pollutants in the environment, the increase in aesthetic quality of environmental and scenic values of farms, and the provision of ecological linkages and biodiversity of farms. The social factors relate to increasing habitat conservation, reduction in health cost by farming system, and creating and strengthening communities through participation in the farmers' groups.

Table 1. Scale of socio-environmental impacts of kale production in Mae Rim District, Chiang Mai Province

Items	Scale
Environmental Aspect (Ei):	
1. Reduction of the quantity of pollutants in the environment	
1.1 **E1**: Cost of waste water treatment in farming: 1/	1-5
1.2 **E2**: Nitrogen residue:2/	1-5
1.3 **E3**: Nonburning weeds after harvesting: (Yes=1 and No=5)	1-5
2. Bringing about aesthetic quality of environmental and scenic values of farms	
2.1 **E4**: Per capita health cost of neighbors breathing toxic fumes used in farming: 4/	1-5
2.2 **E5**: Knowledge of natural resource management: (Have=1 and None=5)	1-5
3. Provision of ecological linkages and biodiversity of farms	
3.1 **E6**: Providing habitat for small animals and local plants as natural foods: (Have=1 and None=5)	1-5
3.2 **E7**: Use of simple skill for reduced production cost in farming: (Have=1 and None=5)	1-5
3.3 **E8**: Controlling insects and pests by crop rotation: (Have=1 and None=5)	1-5
Social Aspect (Si):	
4. Increasing habitat conservation	
4.1 **S1**: Per capita food expenditure of households:3/	1-5
5. Reduction in health cost by farming system	
5.1 **S2**: Per capita health cost of farmers:4/	1-5
6. Creating and strengthening communities by participation in the farmers` groups	
6.1 **S3**: Frequency of gambling in leisure:5/	1-5
6.2 **S4**: Total debts:3/	1-5
6.3 **S5**: Shares technical knowhow with other farmers:(Have=1 and None=5)	1-5
6.4 **S6**: Shares family labor with other farms:(Have=1 and None=5)	1-5
6.5 **S7**: Participation in the farmers' groups: (Have=1 and None=5)	1-5
Minimum-Maximum Score	15-75

Source: Survey January-March, 2008
Note: One rai is equal to 0.16 ha.
One USD is equal to 34.35 Baht.

1/ Scale:
1 = Less than 5 Baht per rai
2 = 5-10 Baht per rai
3 = 11 - 15 Baht per rai
4 = 16 - 20 Baht per rai
5 = More than 20 Baht per rai

2/ Scale:
1 = Less than 20 grams per rai
2 = 20-29 grams per rai
3 = 30-39 grams per rai
4 = 40-50 grams per rai
5 = More than 50 grams per rai

3/ Scale:
1 = Less than 15,000 Baht per capita per year
2 = 15,000-20,000 Baht per capita per year
3 = 20,001-25,000 Baht per capita per year
4 = 25,001-30,000 Baht per capita per year
5 = More than 30,000 Baht per capita per year

4/ Scale:
1 = Less than 500 Baht per capita per year
2 = 500-1,000 Baht per capita per year
3 = 1,001-1,500 Baht per capita per year
4 = 1,501-2,000 Baht per capita per year
5 = More than 2,000 Baht per capita per year

5/ Scale:
1 = Never
2 = Very seldom
3 = Seldom
4 = Often
5 = Very often

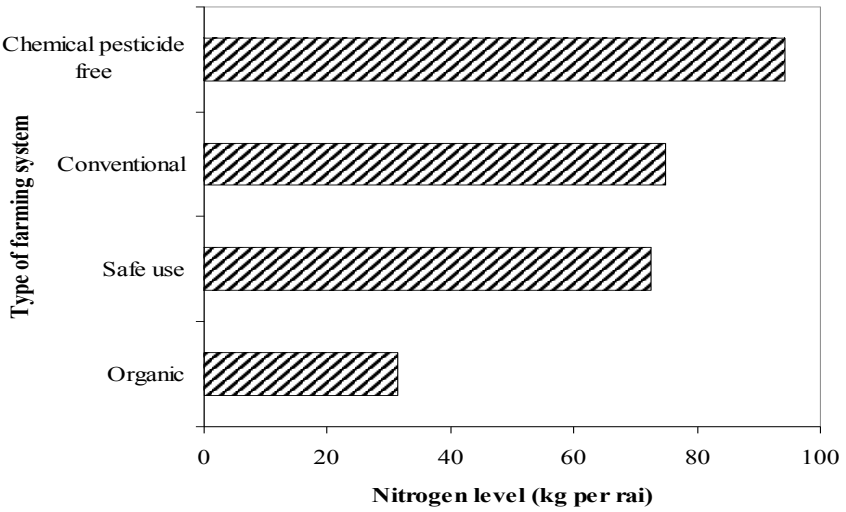
As the environmental factor, the following eight variables were used: cost of waste water treatment in farming (E1), nitrogen residue in farming (E2), nonburning of weeds after harvesting (E3), health cost of neighbors breathing toxic fumes used in farming (E4), knowledge of natural resource management (E5), providing habitat for small animals and local plants (E6), use of simple skill for reduced production cost in farming (E7), and controlling insects and pests by crop rotation (E8). The social factor was comprised of seven variables: decrease in food expenditure (S1), decrease in health cost of farmers (S2), decrease in frequency of gambling in leisure (S3), decrease in total debts (S4), sharing technical knowhow with other farmers (S5), sharing family labor with other farmers (S6), and participation in the farmers' groups (S7).

An estimation of environmental and social impacts was carried out using the market and non-market evaluation approaches. Since the environmental and social impacts are not traded in the markets, their non-market values were defined based on interviews with local farmers and available information, as follows. First, concerning the environmental impact, a large quantity of chemical fertilizer and pesticide flowed into rivers and community reservoirs from vegetable fields (Chiang Mai Department of Environmental Station, 2007). The cost of intake wastewater treatment per liter was nearly 49.50 Baht for planting of vegetables (Kaewlon, 1994). Second, the increase in dust and smoke came from the burning of weeds and the use of chemical synthetic materials, which caused 15% of respiratory patients in Chiang Mai (Chiang Mai Provincial Public Heath Office, 2007). This also caused an increase in medical expenses among neighbors of vegetable growers as a negative impact on public health. Therefore, the public health expense of neighborhoods could be taken as an environmental impact caused by vegetable cultivation. Third, organic farming seemed to provide more habitat conservation, leading to the increase in biodiversity of farms. Thus the increase in habitats could be taken as a positive impact on environment.

Fourth, the amount of nitrogen input is one of the important factors in the assessment of the environmental impact. The difference in total input of nitrogen and the amount absorbed by vegetables was calculated for the four farming systems. The nitrogen of organic inputs was estimated from the use of compost and animal manure. The amount of nitrogen in organic inputs was estimated to be 38, 28, and 6 grams for a kilogram of chicken manure, pig manure, and rice straw compost respectively (Mihara and Fujimoto, 2007). Generally, the Effective Microorganisms (EM) were produced from available ingredients of fields and widely used in alternative farming. There were 7 grams of nitrogen per liter of the EM consisting of ingredients of golden apple snails (*Pomacea canaliculata*) and vegetable, while the corresponding figure was 9 grams for EM of only vegetable ingredients (Department of Agricultural Extension, 2002). Excess nitrogen from chemical fertilizer became the cause of pollution in river and soil and so damaged biodiversity.

Nitrogen absorption by vegetables was estimated to be 30, 29, 23 and 13 grams out of each kilogram applied for chili, pak choy, kale and yard long bean respectively (Department of Agricultural Extension, 2002; Nikornpun, 2000). Among the major vegetables in the villages studied, kale appeared to be most wide spread, therefore, we selected kale for further examination. As shown in Figure 1, chemical pesticide free farming used the largest amount of nitrogen per rai, and the input of nitrogen was lowest in organic farming.

Lastly, other indicators of environmental impacts in the estimation were qualitative. They included nonburning of weeds after harvesting, controlling insects and pests by crop rotation, use of simple skills for reduced production cost, and knowledge of natural resource management.



Source: Survey January-March, 2008
Note: One rai is equal to 0.16 ha

Fig . 1. Estimated nitrogen input per rai for kale production in Chiang Mai Province

Regarding the social impact, farm biodiversity could provide natural foods to farm households, reducing food expense of the household. This saving of food expense was assumed to be a value of social impact. Second, alternative farmers believed their health became better than when they were engaged in conventional vegetable farming, which heavily used synthetic chemical materials. This led to a decrease in medical fees among alternative farmers. Third, organic farming seemed to require more intensive use of family labor, causing their attention to be directed to their farm activities. This could reduce their interest in gambling, leading to the decrease in gambling cost and debts. Lastly, most alternative farmers shared their family labor and technical know how with other farmers in their farmers groups, leading to strengthening of the communities (Tong-ngam and Chaosilp, 1999; Kramol, et al., 2006).

GENERAL INFORMATION OF STUDIED FARMERS

As mentioned in detail in our earlier paper (Kawasaki and Fujimoto, 2009), the average age of the alternative farmers was older than those in conventional farming, and they were mostly Buddhists. Generally, the average farm experience was more than 30 years, while alternative farming experience ranged from 3 to 5 years. While the majority of farmers graduated only from primary school, there were some farmers of alternative farming system who graduated from university, indicating that alternative farmers had higher education backgrounds. Some farmers were Hmong hill tribe people, and both Thai and Hmong farmers in the villages studied were bound together by kinship, and respected their elders. The support of government reached rural farmers through the heads of villages as the elders.

However, the development of the Hmong community was limited by low education. Many Hmong farmers were found to have inadequate knowledge for the efficient management of their farms and for marketing. About two decades ago, they became strongly interested in the planting of opium, a time when many of them were sick due to the use of agrochemicals in the planting of vegetables. His Majesty the King launched the projects of organic vegetable farming to encourage Hmong

farmers to convert their opium area to organic vegetables, and to reduce the use of chemical inputs in the Hmong community (Wiboonpongse, et al., 1989). Hmong people still believed in gods and ghosts of forest and river, and then there was good management of forest and river in their community. However, Thai vegetable growers, except for organic farmers, used all kinds of chemical inputs, and there were chemical residues in river and soil (Wiroonsri, 1988).

Average operated land of the households 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. A small proportion of organic farmers cultivated rented 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 due to the current rapid tourism sector expansion.

There were six types of enterprise combinations 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 by 27 farmers for organic farming, while 19, 14 and 13 farmers under conventional, safe use and chemical pesticide free farming respectively grew rice in combination with vegetables during the rainy season. Most of the household income came from farm activities, and all family members were still living together in their villages. In fact, most organic vegetable growers in the villages studied utilized all of their land resources to produce vegetables, and the kinds of vegetables planted depended on the Royal Project Foundation. The entire organic farming area under the project was certified by the Department of Agriculture (DOA), while the Good Agricultural Practice (GAP) was used for production of chemical pesticide free and safe use farming systems.

ENVIRONMENTAL AND SOCIAL IMPACTS

Based on these assumptions, the evaluation of environmental and social impacts was carried out by the following scoring method. The indicators carried scores ranging from one to five, while total scores ranged from 15 to 75. The lower the score, the larger were the environmental and social benefits: if the score is close to 75, the larger the negative impact. The magnitude of socio-environmental index (SEI) shows that the average total score of the organic farming system was only 27, while that of the conventional system was 68, implying that organic kale production had a much lower negative impact in comparison with other farming systems (Table 2).

These variables of the socio-environmental factor were regressed on total kale production for four different farming systems in order to clarify the nature of their impact. The results are shown in Table 3. The four variables including E1, E2, E4 and S2 indicated a negative impact on kale production under the four farming systems, while other variables showed different impacts, depending on different farming systems. It is considered that although many of the fifteen variables did not significantly affect kale production independently, this does not necessarily mean that the socio-environmental factor as a whole was not a significant determinant of vegetable production. We will explore further the impact of the socio-environmental factor in a later section.

There were three types of cost in kale production, including production cost, environmental cost, and social cost. Production cost was measured by variable costs such as labor, seeds, fertilizers, and pest control cost, and fixed cost such as depreciation, interest on capital and payment of land rent. Environmental cost was obtained by the value of environmental impact, while social cost refers to the value of social impact. Total cost (TC) in this study is an aggregation of production cost, environmental cost and social cost, and it is assumed that the lower the TC, the more sustainable the farming. Economic values of environmental cost and social cost in this section were estimated by all indicators of environmental and social impacts, presented in Table 2.

Table 2. Average degrees of socio-environmental impact under different farming systems in Mae Rim District, Chiang Mai Province.

Characteristic Quality	Type of farming system								Overall	SD
	Organic	SD	Chemical pesticide free	SD	Safe use	SD	Conventional	SD		
Environmental issues:										
E1: Cost of waste water treatment in farming	1.0	0.4	2.9	2.1	3.1	3.9	4.4	4.2	2.9	1.8
E2: Nitrogen residue	2.5	2.7	3.7	3.9	4.3	3.8	4.4	4.1	3.7	2.4
E3: Nonburning weeds after harvesting	2.0	1.3	2.7	2.9	3.1	3.3	4.7	4.4	3.1	0.9
E4: Per capita health cost of neighbors breathing toxic fumes used in farming	1.8	1.2	2.8	2.4	3.1	3.6	4.9	4.3	3.2	1.7
E5: Knowledge of natural resource management	1.1	1.3	2.2	1.4	2.3	2.5	3.9	3.7	2.4	1.5
E6: Providing habitat for small animals and local plants as natural foods	1.0	1.4	3.4	3.4	3.8	3.4	4.7	4.9	3.2	1.5
E7: Use of simple skill for reduced production cost in farming	1.3	1.7	2.3	2.5	2.7	2.5	4.9	3.7	2.8	1.4
E8: Controlling insects and pests by crop rotation	1.0	0.4	2.2	2.1	2.4	2.7	3.8	3.7	2.4	1.1
Social issues:										
S1: Per capita food expenditure of households	3.1	3.5	3.7	3.2	4.5	3.7	4.8	4.9	4.0	3.6
S2: Per capita health cost of farmers	3.7	3.6	4.8	4.2	4.6	3.9	5.0	4.6	4.5	4.0
Creating and strengthening of community:										
S3: Frequency of gambling in leisure	1.1	1.4	1.2	1.3	3.8	3.7	4.9	4.4	2.7	2.8
S4: Total debts	2.1	2.2	4.8	4.4	5.0	4.8	5.0	4.6	4.2	3.8
S5: Shares technical knowhow with other farmers	1.9	1.3	1.5	1.8	1.8	1.1	3.9	3.5	2.3	1.2
S6: Shares family labor with other farms	2.2	2.8	2.8	2.4	3.7	3.9	5.0	4.6	3.4	1.5
S7: Participation in the farmers' groups	1.1	1.3	1.2	1.4	2.4	2.5	3.8	3.6	2.1	1.3
Total Score	27.0	21.4	42.4	30.4	50.5	35.3	68.1	38.2	47.0	30.4

Source: Survey January-March, 2008

Note: Standard deviation (SD) is a measure of the variability of a data.

The average overall cost of environmental and social impacts of kale production in Chiang Mai Province in 2008 was 12,050 Baht per year for a total planted area of 205 rai. Table 4 shows the average value per rai of environmental and social impacts. The lowest environmental and social impacts were attained by organic farming, while the cost of 98, 49 and 29 Baht for conventional, safe use and chemical pesticide free farming, respectively, were estimated as negative impacts. Average cost of organic kale production decreased from 18.33 Baht to 18.32 Baht per kg due to the reduced negative impact, while the average cost of conventional, safe use and chemical pesticide free farming increased to 10.58, 14.25, and 14.10 Baht per kg respectively due to the large negative impact.

The average income of the households studied was 218,198 Baht per year, comprising 162,899 Baht farm income and 55,299 Baht off farm income in 2008. Average incomes per rai for three major enterprise combinations in the villages studied, including only vegetables, rice-vegetables, vegetables-livestock under different farming systems, are presented in Table 5.

Net farm income per rai was highest (39,289 Baht) for planting of only vegetables under organic farming, followed by conventional farming (32,261 Baht). Under chemical pesticide free farming, planting of vegetables plus livestock was highest (20,374 Baht). For planting of rice-vegetables, it was highest (22,340 Baht) under organic farming, followed by safe use farming (17,099 Baht). Because planting of only vegetables appeared to be a dominant enterprise combination for all four production systems, we estimated the value of farm income by adding the socio-environmental cost. Assuming no differences in levels of environmental and social impacts for all vegetables, reduction in total cost due to the reduced negative impact could raise farm income per rai per year to 39,295 Baht for organic planting growers, while the increased total cost would lower the farm income of chemical pesticide free (15,549 Baht), safe use (16,685 Baht), and conventional farming systems (32,163 Baht), respectively (Table 6).

According to the Provincial Government (Chiang Mai Department of Environmental Station, 2007), the Government was operating a pollution control policy for the industrial sector, while this was not so clear for the agricultural sector because of limited information. Therefore, the total cost of the negative impact management may be subsidized by Government through taxes and/or price increases. If the government uses a price increase policy, the price of conventional vegetables may be increased to reach the same price as alternative vegetables. Therefore, the number of consumers for the alternative vegetables will increase, and more conventional farmers may convert to alternative farming.

Overall, there were differences in the levels of environmental and social impacts among the four vegetable farming systems in Chiang Mai, which could affect total product, income and community of small farmers. The relationship between crop total product and the environmental and social impacts is discussed in the next section.

Table 3. Regression analysis of environmental and social factors in kale production.

	Type of vegetable farming											
	Organic			Pesticide free chemical			Safe use			Conventional		
	Reg coff.		t value	Reg coff.		t value	Reg coff.		t value	Reg coff.		t value
Constant	-0.220		-1.518	-0.365	***	-3.524	0.127		1.121	-0.590	***	-5.660
E1: Cost of waste water treatment in farming	-0.024	*	-1.817	-0.026	**	-2.534	-0.106	***	-2.538	-0.066	**	-2.302
E2: Nitrogen residue	-0.044	***	-2.840	-0.001		-0.170	-0.060	**	-1.902	-0.018		-1.506
E3: Nonburning weeds after harvesting	0.008		0.715	0.022	**	2.106	0.011		0.993	0.022	**	2.401
E4: Per capita health cost of neighbors breathing toxic fumes used in farming	-0.015	**	-2.194	-0.002		-0.510	-0.006		-0.259	-0.039	**	-2.253
E5: Knowledge of natural resource management	0.008		0.414	0.055	***	4.325	0.016		0.813	0.011	*	1.493
E6: Providing habitat for small animals and local plants as natural foods	0.027	*	1.582	0.002		0.074	0.003		0.341	0.021		0.932
E7: Use of simple skill for reduced production cost in farming	0.002		0.115	0.049	***	2.890	0.010		0.425	0.005		0.214
E8: Controlling insects and pests by crop rotation	0.009		0.374	0.021	**	2.071	0.006		0.513	0.029	*	1.726
S1: Per capita food expenditure of households	0.073	***	4.309	0.004		1.119	0.002		0.401	0.019		0.508
S2: Per capita health cost of farmers	-0.011		-0.608	-0.005		-0.614	-0.082	**	-2.368	-0.008		-0.947
S3: Frequency of gambling in leisure	0.018	*	1.489	0.013	*	1.949	0.013	*	1.850	0.025		0.795
S4: Total debts	0.0001		0.008	-0.009		-0.740	0.011		1.056	0.000		0.021
S5: Shares technical knowhow with other farmers	0.013		1.279	0.000		0.019	0.008	**	2.181	0.001		0.093
S6: Shares family labor with other farms	0.001		0.086	0.003		0.601	0.003		0.631	-0.034	*	-1.851
S7: Participation in the farmers' groups	-0.141	***	-5.076	0.048	***	5.040	0.015	**	2.067	0.004		0.232
R square	0.866			0.965			0.600			0.531		
F value	18.974			72.312			55.893			21.639		
Durbin-watson value	2.411			2.125			1.831			2.345		
N	60			55			72			87		

Source: Survey January-March, 2008

To the expected production of each farm.

***Denotes significance at 1% level

** Denotes significance at 5% level

* Denotes significance at 10% level

Table 4. Economic value of socio-environmental cost in kale farming of Mae Rim District, Chiang Mai Province.

	Type of farming system			
	Organic	**Chemical pesticide free**	**Safe use**	**Conventional**
Baht per rai:				
(1) Production cost	21,625	18,258	15,670	15,503
(2) Socio-environmental cost	-6	29	49	98
(3) Total cost (1)+(2)	21,619	18,287	15,719	15,601
(4) Yield (kg)	1,180	1,297	1,103	1,474
Baht per kg:				
(5) Production cost (1)/(4)	18.33	14.08	14.20	10.52
(6) Total cost (3)/(4)	18.32	14.10	14.25	10.58
(7) Difference between (6) and (5)	-0.004	0.02	0.05	0.06
Price levels:				
Farm gate price	21	18	16	14
Market price	125	40	75	14-23

Source: Survey January-March, 2008

Note: One rai is equal to 0.16 ha.
One USD is equal to 34.35 Baht.

Table 5. Farm income per rai under different farming systems in Mea Rim District, Chiang Mai Province 2007.

Type of farming system	**Types of enterprise combinations (Baht per year)**		
	Only vegetables	**Rice + vegetables**	**Vegetables + livestock**
Organic	39,289	22,340	9,324
Chemical pesticide free	15,578	10,228	20,374
Safe use	16,734	17,099	16,786
Conventional	32,261	13,245	22,056

Source: Survey January-March, 2008

Note: One rai is equal to 0.16 ha.
One USD is equal to 34.35 Baht.

Table 6. Farm income in the planting of only vegetable in Mae Rim District, Chiang Mai Province.

Type of farming system	Gross Income (Baht/ rai) (1)	Expenditure (Baht/ rai) (2)	Socio-environmental Cost (Baht/rai) (3)	Net farm income (Baht/rai) Without Environmental and Social cost (1)-(2)	Net farm income (Baht/rai) With Environmental and Social cost (1)-(2)-(3)
Organic	58,570	19,281	-6	39,289	39,295
Chemical pesticide free	23,723	8,144	29	15,578	15,549
Safe use	28,752	12,018	49	16,734	16,685
Conventional	53,525	21,264	98	32,261	32,163

Source: Survey January-March, 2008
Note: One rai is equal to 0.16 ha.
One USD is equal to 34.35 Baht.
Socio-environmental costs of other vegetables are assumed to be the same as that of kale.

REGRESSION ANALYSIS OF ENVIRONMENTAL AND SOCIAL IMPACTS

The environmental and social impact of organic farming in comparison with other production systems in Chiang Mai can be measured through production function by adding the SEI. The production function of the Cobb-Douglas type was estimated for the farmers studied. Because kale appeared to be most wide spread and data were available for all 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 six independent variables were used: X_1 refers to kale's planted area (rai), X_2 is total labor inputs (man-days), X_3 refers to total amount of seed used (Baht), X_4 is amount of Nitrogen element in fertilizer (kg), X_5 refers to cost of pest control (Baht), and X_6 is socio-environmental index (SEI).

The production function without SEI was presented in our earlier paper (Kawasaki and Fujimoto, 2009), while the relation of the SEI and kale production among four farming systems is expected to be negative in that kale production will be reduced by an increase in negative environmental and social impact (Table 7).

Our study revealed that the environmental and social impacts were important factors in improvement of production efficiency among four vegetable farming systems. It is remarkable to note that the magnitude of the regression coefficient of SEI differed so clearly among the four farming systems: -1.014 for organic, -1.597 for chemical pesticide free, -1.818 for safe use, and -2.275 for conventional systems. The conventional kale production was most severely affected by the environmental and social impacts. Therefore, farmers may be able to increase their profitability and reduce the environmental and social impacts if they could improve their production efficiency by adopting an environmentally friendly farming system.

Table 7. Socio-environmental impacts of kale production function under different farming systems in Chiang Mai Province, 2007.

	Type of vegetable farming											
	Organic			Pesticide free chemical			Safe use			Conventional		
	Reg coeff.		t value	Reg coeff.		t value	Reg coeff.		t value	Reg coeff.		t value
Constant	5.417	**	2.512	7.796	***	6.324	3.609	***	4.596	3.814	***	8.067
Area (rai)	0.068	ns	0.829	0.142	***	3.032	0.212	**	2.238	0.125	**	1.998
Labor (man-day)	0.347	***	3.183	0.141	*	1.831	0.141	***	3.194	0.233	***	3.099
Seed (Baht)	0.253	***	3.401	0.023	ns	0.565	0.123	*	1.753	0.062	ns	0.975
Nitrogen element in fertilizer (kg)	0.101	*	1.674	0.056	*	1.809	0.166	**	2.182	0.056	*	1.885
Pest control cost(Baht)	0.165	**	2.413	0.157	*	1.863	0.161	***	3.429	0.165	***	3.106
Socio-environmental index (SEI)	-1.014	*	-1.872	-1.597	***	-4.621	-1.818	***	- 2.842	-2.275	***	-4.572
R square	0.546			0.740			0.836			0.737		
F value	10.604			22.776			55.107			37.321		
Durbin-Watson value	1.923			1.806			1.692			1.897		
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

CONCLUSION

Based on data obtained from the questionnaire survey of 142 farmers in Mae Rim District, Chiang Mai Province, this paper clarified the sustainability of organic farming through an examination of household income, and environmental and social benefits in comparison with other production systems: chemical pesticide free, safe use and conventional farming systems. Organic farming had the most beneficial impacts for environmental and social sectors among various vegetable production systems in Chiang Mai. There was a lower level of the environmental and social impact for chemical pesticide free system in comparison with conventional and safe use systems. Although organic farming still had the negative impacts for environment and community, it provided the highest income per rai (39,295 Baht).

A 10% increase in socio-economic index under organic farming would still reduce kale production by 10.14%. Therefore, the negative impacts should be controlled, irrespective of farming system. If the Government is promoting organic agriculture as a way to develop the agricultural sector in a sustainable manner, it is thus necessary to look into the actual conditions faced by organic farmers, in relation to their cultivation technology, socio-environmental impact and marketing practices.

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J. ISSAAS Vol. 15, No. 2:56-69 (2009)

THE ECONOMICS OF TRAMLINE TRANSPORT FACILITY IN THE UPLANDS

Rodelio G. Idago[1] and Roberto F. Rañola, Jr[2]

[1] Science Research Specialist II, Bureau of Postharvest Research and Extension
[2]Professor, College of Economics and Management, University of the Philippines, Los Baños

(Received: June 11, 2009; Accepted: November 16, 2009)

ABSTRACT

This paper discusses the financial and economic viability of putting up tramline transport facilities in the remote and mountainous uplands of Benguet province that have limited if any access roads. A tramline is an alternative means of transport of agricultural products in hard-to-reach mountainous production areas not accessible by farm-to-market roads that are very characteristic of many production areas in many countries in Asia. The viability of a tramline facility was assessed through accounting for the direct costs and benefits. These were considered from a private perspective, that is, a private investor and farmers' organization and societal perspective that treats it as a public investment.

The study shows that a tramline hauling facility is not a financially attractive investment for a private individual or farmers' cooperative in the Benguet Province. This is due to the high investment cost and low returns from a limited cluster of farms that are serviced in these areas if the existing hauling rates of the conventional hauling method are used. With an average seven-hectare service area, the limited volume of agricultural products that will be transported using the facility will not be sufficient to recover the investment. However, it is a good public investment given an economic rate of return of 33%. The main benefit from replacing the traditional method of manual transport with the tramline transport facility will generally come from the increase in yield and labor cost savings and in general, the improvement of the level of living of the target beneficiaries.

Key words: Feasibility, remote areas

INTRODUCTION

Throughout Asia, the increase in population and the resulting urbanization has forced the conversion of many agricultural lands to meet the requirements of a growing population for housing and other needs. This has resulted to the movement of the rural population to the more mountainous areas that are characterized by a rugged terrain, steep slopes and lack if not absence of access roads that makes it difficult and expensive to transport agricultural products to the markets.

In the Philippines, more than half of the vast agricultural areas can still be considered as either idle or unproductive. This can be attributed to the country's mountainous topography and the inherent problems associated with it. PCARRD (1992) reported that more than half of the country's land area is classified as uplands with slopes exceeding 18 percent. De Jesus (undated) reported that 28.7 percent of the country's land area or 8,557,479 hectares are steeply sloping while 6 million hectares have 30 to 50 percent slopes and over 2 million hectares have slopes greater than 50 percent. About 4 million hectares currently under cultivation are already severely eroded and only marginally

productive. Among the different needs of the country's mountainous regions, the most immediate is for farm-to-market roads (FMR) which would connect the production areas to local and regional markets (Ramos, 1998). To bring their farm products to the market, upland farmers would manually carry their produce on their backs and traverse the treacherous terrain of the mountainous slopes to the nearest road accessible by vehicle, before they can transport them to the nearest market centers (Figure 1). In the same way, they would also manually carry the farm inputs from the nearest road to the production areas. Given the drudgery of manual hauling, the cost of transporting the farm produce from the production area to the nearest road is quite expensive. The transport cost would range from 20 to 30 percent of the value of the produce (Paz, 2003). For production inputs, transport costs from the nearest road to the production areas range from PhP20-50 per bag, depending on the distance. At times, the available manpower for transporting the goods is scarce, especially during the peak season of harvest and farm operations.

In an effort to address this problem, the Department of Agriculture (DA) through the Agriculture and Fishery Modernization Program (AFMP) provided additional transport infrastructures such as FMR's, and in year 2000 to the present, they constructed 11 tramline transport facilities. The Bureau of Postharvest Research and Extension in collaboration with the Department of Agriculture spearheaded the program. The estimated cost of putting up the tramline system for every kilometer span ranges from P0.5M to P1M. The facility is easy to construct since majority of its parts are readily available in the local market.

A tramline utilizes a series of steel cables and post structures to haul products in remote areas not accessible through the road networks. These aerial tramways have a great advantage over most methods of transport in regions or areas where topography is extremely rough or down steep slopes. It is more environmentally friendly because the natural physical condition of the area is not altered. No vegetation cutting is necessary as long as the structures are properly or strategically positioned and selected.

A

B

Fig. 1. Manual hauling of produce from production area (A) to the nearest road accessible by vehicle (B).

The Benguet province has been an ideal location for the use of tramline facilities given the rugged condition and terrain (Fig. 2). These facilities have been effectively and popularly employed for hauling of production inputs and vegetable produce in the area. In a study of postharvest practices of 137 farmers in Benguet, Ramos (1996) reported that 70 percent were serviced by a tramline facility. Although there is limited documentation of the spread of the use of tramline facilities in the country, it is believed that majority of these tramline facilities today evolved from the tramlines in the Benguet province. Miners and loggers in the province who were displaced from their work because of log bans and closure of mining operations shifted to farming and custom-designed the tramline facility for application in agriculture.

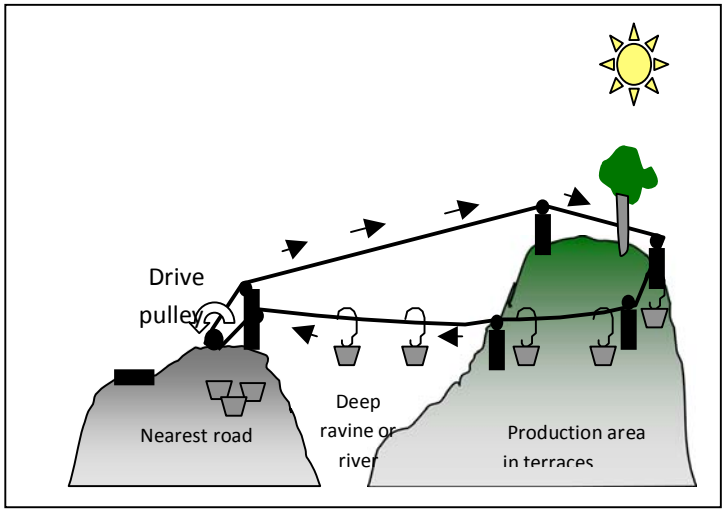

Fig. 2. The tramline facility used for hauling vegetables from the production area to the nearest farm-to-market road.

The tramline transport facility has gained some popularity given the potential contribution to the development of the mountainous hard-to-reach regions that represents a substantial percentage of the agricultural land of the country. However, to date, majority of the people in agriculture are not yet aware of its existence and application. There has been very limited documentation of this technology, more especially the economic viability of this kind of system. This is important if this technology is going to be introduced in other areas in the country with similar conditions.

This paper discusses the results of the assessment of the financial and economic viability of operating tramline facilities in Benguet. It considers specifically the minimum efficient level of service area that would make the operation of the tramline facilities viable and the most efficient scheme for operating these facilities.

THE STUDY AREAS AND DATA COLLECTED

The study was conducted in the top two temperate vegetable producing municipalities of Benguet Province with the highest number of existing tramline facilities, the municipalities of Atok and Buguias. Atok is a vast farming community located at the heart of Benguet Province and is situated 44 kms. away from Baguio City. Atok is quite popularly known as the top producer of potato in the province of Benguet because of its high elevation and favorable climatic condition. Buguias, another vast farming community, is located on the northern part of the province, 80 kms

away from Baguio City. Currently, it is regarded as the top temperate vegetable (cabbage, carrot and lettuce) producing municipality in terms of volume and area of production among the 13 municipalities of Benguet Province. The province of Benguet contributes 64 percent of the vegetables produced in the Cordillera Admistrative Region (CAR). On the other hand, CAR is considered as the major producer of highland temperate vegetables in the country.

The tramline facility in Atok that was installed sometime in 1988 was a pilot project of BPRE and DA-CAR. Its operation and maintenance was turned over to the farmer-cooperators upon completion of the research project in 2000. The tramline facilities in Buguias on the other hand were completed later in 2003 and were among the first batches of the tramline projects under the national tramline program that was funded by the infrastructure and facility assistance of the Department of Agriculture. After completion of construction, these tramline facilities were turned over and had been independently operated and managed by the beneficiaries.

The study utilized cross-section data from the two municipalities covering the wet and dry seasons. The data included information on the production aspects of the direct ("WITH") and potential ("WITHOUT") beneficiaries of the tramline facility. Farmers "WITHOUT" tramline transport facility were those that came from remote farms that utilized only conventional methods of hauling their produce. Farmers "WITH" tramline transport facility referred to remote farms that utilized tramline transport facility. A sample of 15 percent of the farmers in Benguet with farms serviced by tramlines was selected for the interviews. Of the 180 respondents of the study, 116 respondents were from Atok and the rest from Buguias. The total number of respondents was equally divided between the "with" and "without" tramlines facilities. The study sites and respondents were chosen from production areas that were not serviceable by farm-to-market roads. The need for tramline facilities were based on: a) the distance of the farm to the nearest road; b) travel time; c) cost of hauling or transport; and d) ruggedness of area/steepness of slope. These production areas were not accessible by farm-to-market roads and typically employed labor for the transport of their products from the farm to the nearest road accessible by vehicle.

Data were gathered using a structured survey questionnaire, Key informant interviews (KII) and focused group discussions (FGDs).

COST-BENEFIT FRAMEWORK

The cost-benefit framework that was used for analyzing changes in the streams of costs and benefits is illustrated in Figure 3. The financial and economic viability of the tramline facility were evaluated by comparing the "WITH" and the "WITHOUT" tramline situations.

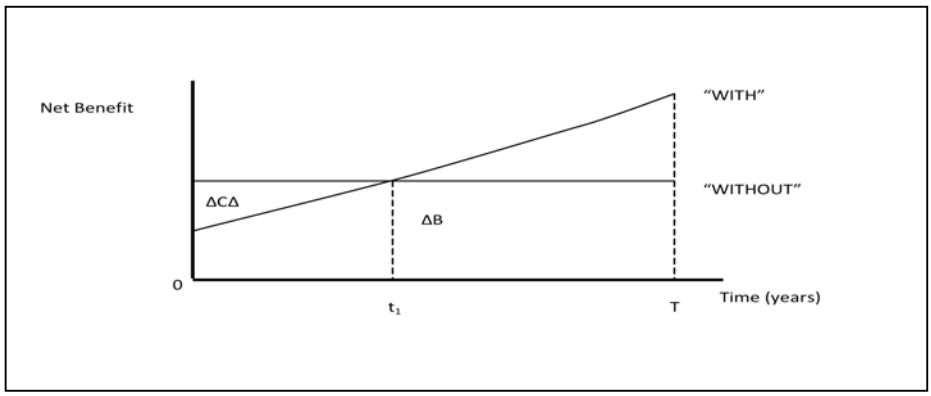

Fig. 3. Net benefits for "With" and "Without" tramline situations.

Mathematically, the relationships can be presented as follows: (Boardman et.al, 1996)

$\square B = \sum B_{n\,(with)} - \sum B_{n\,(w/o)}$; $\square C = \sum C_{n\,(with)} - \sum C_{n\,(w/o)}$

$NPV = [\square B/(1+i)^n] - [\square C/(1+i)^n]$;

if NPV > 0, accept "WITH" if NPV ≤ 0, retain "WITHOUT"

where:

NPV = net present value of incremental net benefit, in pesos

$\square C$ = incremental costs, in pesos

$\square B$ = incremental benefits, in pesos

B_n = benefits occurring at time period n, in pesos

C_n = costs occurring at time period n, in pesos

n = time period, in years

i = % discount rate

Without the tramline facility, it was assumed that the amount of net benefit across time period T, the effective life span of the tramline facility, was generally fixed or constant. With the tramline facility, it was assumed that there would be changes in the streams of costs and benefits. Costs would generally include the direct costs of putting up the facility and the negative impacts associated with it. Benefits, on the other hand, would include the value of the increase in the level of production. During the early part of the project life before time t_1, the net benefit of "WITH" situation would be lower than the "WITHOUT" tramline situation because the bulk of the costs, i.e. the cost of putting up the tramline facility would be incurred during this period. After t_1 however, the benefits for the "with" is greater than the "without" tramline situation.

Financial and Economic Analysis

The financial analysis was used to determine the financial viability of operating the tramline. The objective of the analysis was to determine whether it would be worthwhile or profitable for a private individual or group to engage in the operation of a tramline facility. This was analyzed using the data on the cost of tramline installation, operating costs, capacities, repair and maintenance required, hauling rates, inputs utilization and volume of production. The profitability parameters used were benefit-cost ratio (BCR), net present value (NPV), payback period (PB) and internal rate of return (IRR). The breakeven analysis was used to determine the minimum efficient level of operation of the tramline facility. On the other hand, sensitivity analysis was undertaken to determine the effects of size of service areas and interest rates on the viability of tramline operations.

Partial budget analysis was also used to assess the viability of adapting the tramline facility as an alternative means of transport for farm products and farm inputs over the traditional manual hauling. In the analysis, all incremental costs and returns and reduced cost and returns were considered on a per-hectare, per-cropping season basis. A positive change in income meant that the farmer was better off using the tramline facility over the traditional manual method of transport.

On the other hand, the economic analysis was undertaken to determine whether the tramline facility was a worthwhile public investment. Table 1 shows the associated benefits and costs for the "with" and "without" tramline situation. The benefits included the increase in yield, improved quality of the farm product and labor savings while the additional costs were related to the installation, operation and maintenance of the facility. For this purpose, the necessary adjustments to convert the financial prices into the opportunity cost or efficiency prices using the shadow exchange rate (SER) method was done. This way, the stream of economic costs and benefits over different time periods could be determined and compared. The effect of SER method was to make traded items relatively more expensive in domestic currency by the amount of foreign exchange premium.

The SER was computed using the following formula:

$$SER = OER\ (1 + fep)$$

where: OER = official exchange rate, in pesos

fep = foreign exchange premium, in percent; based on the tariff rate imposed by Bureau of Customs on some of the traded components of the tramline facility i.e. engine, cables and its accessories

The Economic Rate of Return (ERR) and Net Present Value (NPV) were used as indicators of the economic viability of the project. The ERR is a measure of the economic returns to society of a public investment.

Financial Viability of Tramline Facility

The amount of investment on a tramline facility is affected by the following factors: (1) distance covered given that the longer the tramline the higher the investment; (2) terrain, slope and topographic characteristics of the area to determine the number of posts/structures which affect investment cost; and (c) hauling capacity given that higher hauling capacities require higher levels of investment from the bigger sizes of structures and power requirement.

Table 1. Economic benefits and costs components of "WITH" and "WITHOUT" tramline transport facility .

VARIABLES	ECONOMIC VALUES	
	"With"	**"Without"**
Benefits		
Vegetable produce *(P1Q1)*	√	√
Additional yield *(P2Q2)*	√	X
Preservation of quality/averted postharvest loss from delay in transport *(P3Q3)*	√	X
Savings from manual hauling *(P4W1)*	√	X
Labor saved, man-days/ha/year *(P5W2)*	√	X
Total Benefits ("with") = $\sum (PiQi) + \sum(PiWi)$		
Total Benefits ("without") = *P1Q1*		
Cost		
Transport cost		
Tramline hauling *(C1)*	√	X
Manual hauling *(C2)*	X	√
Production cost *(C3)*	√	√
Tramline establishment *(C4)*	√	X
Operation and repair & maintenance cost of tramline facility *(C5)*	√	X
Additional use of fertilizer inputs *(C6)*	√	X
Additional use of labor for application of inputs and increase in yield *(C7)*	√	X
Total Cost (with) = *C1+C3+C4+C5+C6*		
Total Cost (without) = *C2+C3*		
Net benefit (with) = Total benefits (with) –Total Cost(with)		
Net Benefit (without) = Total Benefits (without) –Total cost (without)		
Incremental net benefit =Net benefit (with) –Net benefit (without)		

The study considered an average size/length of tramline that commonly exists in Benguet as the basis for estimating the amount of investment for the tramline facility. The average length of this common tramline facility is 400 meters with a hauling capacity of 200-250kg/trip. As shown in Table 2, the approximate cost of this tramline is PhP700,000. The bulk of this cost includes the labor cost for hauling and installation (27%); the cost of service cables (19%); prime mover (16%); and towers (15%).

Table 2. Investment cost of a tramline facility with a 400-meter length, 2008.

MAJOR ITEMS	PERCENTAGE SHARE OF COST	COST (PhP)
1. Service cables, IWRC	19	133000
2. Primemover, diesel engine, 70hp	16	112000
3. Powerhouse	7	49000
4. Towers and anchors	15	105000
5. Accessories	2	14000
6. Labor, hauling and installation	27	189000
7. Contractors profit	14	98000
Total	**100**	**700,000**

The study considered the following key questions. Is the tramline a financially viable operation? What would be a good arrangement for managing the operation? Two different arrangements were considered and evaluated: (1) Private Investor Operating the Tramline Facility and (b) Farmer-Beneficiaries Owning and Operating the Tramline Facility. If the arrangement is financially attractive to the operator of the tramline facility, will it also be financially attractive to the farmers who will be using it? Would farmers be better off with the provision of a tramline facility? Would it be a worthwhile public investment?

Arrangements for Operating the Tramline Facility

The first arrangement is for a private individual investor to own and operate the tramline facility. Under this arrangement, a private individual would invest in the facility and operate it to replace manual hauling in a location where the cluster of farms has at least a total aggregated area of seven hectares. The seven-hectare service area is the average size of a cluster of farms in Benguet. Assuming two croppings of vegetables a year, the tramline facility would be utilized for hauling production inputs and vegetables during the 10-year life span of the facility.

A sensitivity analysis was undertaken to determine the effect of a change in tramline hauling fees on the minimum service area that is still financially viable, on the payback period, and the financial rates of return. The minimum hauling fees considered in the sensitivity analysis were P12.50/bag and P0.34/kg for farm inputs and vegetables respectively, corresponding to the existing tramline fees paid using the tramline facility. Financial analysis using these rates showed that it would not be financially viable since the investment of PhP700,000 would not be recovered within the project life of the facility and given a negative NPV (Table 3).

The result of the sensitivity analysis on the other hand showed that tramline facility would be financially viable if the hauling fee charged was P50/bag and P1.50/kg for inputs and vegetables, respectively. At this rate of hauling fees, the investment would be recovered in 4 years. The BCR for the project under this arrangement would be 2.94 while the IRR and NPV would be 32% and PhP2,068,772, respectively.

Table 3. Financial analysis of a 7-ha., private investor operated tramline facility using existing tramline and recommended hauling rates, Benguet, 2008.

Existing Tramline Rate P12.50/bag; P0.34/kg				**Sensitivity Analysis P50/bag; P1.50/kg**			
7 Hectares				7 Hectares			
Benefits (Php)		Costs (Php)		Benefits (Php)		Costs (Php)	
Period (Yrs.)	Amount (Php)	Period (Yrs.)	Amount (Php)	Period (Yrs.)	Amount (Php)	Period (Yrs.)	Amount (Php)
1 to 10	140,543	1 to 2	286,042	1 to 10	562,174	1 to 2	286,042
		3	590,390			3	590,390
		4 to 5	90,042			4 to 5	90,042
		6	202,042			6	202,042
		7	90,042			7	90,042
		8 to 10	104,042			8 to 10	104,042
Net Present Value = PhP (1,465,033) Payback Period = >10 years				Net Present Value= PhP2,068,772 Benefit Cost Ratio = 2.94 Internal Rate of Return = 32% Payback Period = 4 years			

The second kind of arrangement is for farmer-beneficiaries to own and operate the Tramline Facility. Although most of the tramlines in Benguet were established through government or international grants, some tramlines were established and financed by farmers. Assessment of the financial viability of this type of arrangement where farmer-beneficiaries would own and operate the tramline facility showed that it would also not be financially attractive if the existing tramline rate is used. Results of the sensitivity analysis showed that to be financially viable under this kind of arrangement, the hauling fees should at least be P37.5/bag and P1.05/kg for inputs and vegetables, respectively (Table 4). Given this rate, the investment could be recovered in 4.97 years with a BCR of 1.91 and an NPV and IRR of PhP1,345,697 and 20.68%, respectively.

Table 4. Financial analysis of a 7-ha., farmer-beneficiary operated tramline facility using existing tramline and recommended rates, Benguet, 2008.

Existing Tramline Rate P12.50/bag; P0.34/kg				**Recommended Rate P37.50/bag, P1.05/kg**			
7 Hectares				7 Hectares			
Benefits (Php)		Costs (Php)		Benefits (Php)		Costs (Php)	
Period (Yrs.)	Amt./yr. (Php)	Period (Yrs.)	Amt./yr. (Php)	Period (Yrs.)	Amt./yr (Php)	Period (Yrs.)	Amt./yr (Php)
1 to 10	140,543	1 to 2	254,542	1 to 10	421,630	1 to 2	188,042
		3	202,690			3	512,116
		4 to 5	156,542			4 to 5	90,042
		6	268,542			6	202,042
		7	156,542			7	90,042
		8 to 10	170,542			8 to 10	104,042
Net Present Value = PhP (410,376) Benefit Cost Ratio = 0.76 Payback Period = >10 years				Net Present Value= PhP1,345,697 Benefit Cost Ratio = 1.91 Internal Rate of Return = 20.68% Payback Period = 4.97 years			

The difference of the first arrangement with this kind of arrangement is attributable to the difference in the interest rates imposed by the banks on loans for individual investor and farmers' organization or cooperative. The interest rate imposed by bank on facility loan for private individual is higher at 30% compared to a farmers' cooperative at only 18%. This is intended to support the cooperative movement in the Philippines. Thus, the hauling fees that can be charged by farmers' cooperative for the services of the tramline facility can be lower than that of an individual operator.

Effect of size of service area on the viability of tramline operations

The effect of the size of service area on the viability of operating a tramline facility by a farmers' cooperative and private investor is shown in Table 5. To be viable, a tramline facility operated by a farmers' group should be able to service at least 23 hectares of farm area given the existing tramline rate. Given this level of operation, the investment can be recovered in about 8 years with an IRR and NPV of 5.2% and P365T, respectively. If however the recommended tramline rate is charged, the minimum service area will be reduced to 15 hectares with a shorter payback period of about 4 years and an IRR and NPV of 34.31% and P1,368T, respectively.

With a private investor, the minimum service area to be financially viable assuming that the existing rate is used is also 23 hectares with a payback period of 9.29 years and an IRR and NPV of 1.91% and P146T, respectively. However, if the recommended tramline rate is used, the minimum service area is 15 hectares with payback period of 4.28 years, IRR of 28.80% and NPV of P1,179T, respectively.

Considering that the difference between the farmers' coop and private individual is in their cost of investment, then the implication of the result of the sensitivity analysis is that viability of the operation is greatly affected by the interest rate, size of service area and tramline rate. To be able to lower the tramline rate, it will be necessary to increase the service area and vice-versa. However, given the size of the farms in Baguio, the only alternative for the operation to be viable is to increase the tramline rates. In addition, it will greatly help if the cost of investment or money is reduced since this also has an impact on the financial viability of the operation.

Table 5. Sensitivity to changes in service areas given existing and recommended tramline rates for farmers' coop and private investor, Benguet, 2008.

Indicators of Financial Viability	**Existing Tramline Rate (P12.50/bag & P0.34/kg) Service area (has)**				**Recommended Tramline Rate (P37.50/bag & P0.65/kg) Service area (has)**			
Farmer's Coop (Interest rate of 18%)	7	15	23	31	7	15	23	31
NPV ('000)	-1,296	-716	365	441	88	1,368	3,059	4,750
IRR	*	*	5.20	16.64	1.29	34.31	67.89	103.6
Payback Period (years)	**	**	8.23	5.77	9.50	3.79	1.46	0.84
Private Investor (Interest rate at 30%)								
NPV('000)	-1.484	-905	146	253	-129	1,179	2,870	4,561
IRR	*	*	1.91	12.54	*	28.80	60	94
Payback Period (years)	**	**	9.29	6.57	**	4.28	2.04	0.94

* not calculable

** Investment cannot be recouped within the 10-year project life

Financial Attractiveness to Farmers

The financial analysis was undertaken to determine whether the tramline facility would be attractive enough for farmers to use considering the minimum hauling rate that should be charged to ensure a viable hauling operation under different management arrangements. The partial budget analysis showed that if farmers shifted from conventional to tramline hauling assuming that a private individual would operate it, the estimated change was a net loss of Php6,887/ha/season (Table 6). The assumption here was that the private investor would charge hauling rates of P50/bag and P1.50/kg for inputs and vegetables, respectively. On the other hand, if a farmers' cooperative would operate it and charge P37.50/bag and P1.05/kg for inputs and vegetables, respectively, the net loss would be P2,972/ha/season (Table 7). Thus, it can be concluded that without subsidy, the tramline hauling operation would not be financially viable to operate. It would be more expensive for farmers to use the tramline hauling than the manual hauling method. Farmers thus would have no incentive to use the tramline facility.

Table 6. Partial budget analysis for manual vs. tramline hauling, per hectare per cropping season, private investor operation, Benguet, 2008.

PROPOSED TECHNOLOGY: MANUAL VS. TRAMLINE HAULING			
ADDED COSTS (A)		ADDED RETURNS (B)	
1 Additional Fertilizer	11,250	Increased yield of various vegetables	
-Organic 75 bags @ PhP150/bag		7,942kg @PhP8/kg	63,536
-Inorganic, 2.5bags @PhP900/bag	2,250		
2. Transportation by bus of additional fertilizer, 78bags @ PhP50/bag	3,900		
3. Hauling Cost of fertilizer using Tramline, 290 bags @ PhP50/bag	14,500		
4. Labor cost of fertilizer application, 78 bags @PhP50/bag	3,900		
5. Labor, handling & hauling cost of harvesting additional yield,7,942kg PhP4.00/kg	31,768		
6. Opportunity cost, 8%	5,405		
REDUCED RETURNS		REDUCED COSTS	
None			
		Time saved from manual hauling 17man-days @PhP150/man-day	2,550
Subtotal A	72,973	Subtotal B	66,086
		Estimated change in income (B-A) = PhP-6,887/ha/season	

Table 7. Partial budget analysis for manual vs. tramline hauling, per hectare per cropping season, farmers' group operation, Benguet, 2008.

PROPOSED TECHNOLOGY: MANUAL HAULING PRACTICE VS. TRAMLINE TRANSPORT FACILITY			
ADDED COSTS (A)		ADDED RETURNS (B)	
1 Additional Fertilizer	11,250	Increased yield of various vegetables 7,942kg @PhP8/kg	63,536
-Organic 75 bags @ PhP150/bag			
-Inorganic, 2.5bags @PhP900/bag	2,250		
2. Transportation by bus of additional fertilizer, 78bags @ PhP50/bag	3,900		
3. Hauling Cost of fertilizer using Tramline, 290 bags @ PhP37.50/bag	10,875		
4. Labor cost of fertilizer application, 78 bags @PhP50/bag	3,900		
5. Labor, handling & hauling cost of harvesting additional yield,7,942kg PhP4.00/kg	31,768		
6. Opportunity cost, 8%	5,115		
REDUCED RETURNS		REDUCED COSTS	
None			
		Time saved from manual hauling 17man-days @PhP150/man-day	2,550
Subtotal A	69,058	Subtotal B	66,086
		Estimated change in income (B-A) = PhP-2,972/ha/season	

ECONOMIC ANALYSES

Economic Viability of Putting Up Tramline Facility as Public Investment

The economic analysis was undertaken to determine whether the tramline facility would be a worthwhile public investment, that is, whether the societal benefits would be greater than the societal costs. In the economic analyses, immediate costs and benefits were identified and their corresponding economic costs and benefits were quantified. Streams of benefits and costs were projected over the 10-year project life of the hauling facility.

In the analysis, the shadow exchange rate (SER) method was used to adjust the values of costs and benefits. SER was used because some of the materials and parts used for the establishment

of the tramline transport facility were traded items. These traded items included service cable, prime mover and accessories. The foreign exchange premium used for the computation of SER was 12 percent, a rate that is usually used by the National Economic Development Authority (NEDA) in their economic evaluations. Given the foreign exchange adjustment, the investment would be adjusted from PhP700,000 using the financial prices to PhP731,080 using its efficiency prices (Table 8). Thus, from the point of view of the society, the cost of putting up a tramline facility would be more expensive than looking at it from the point of view of a private investor because of the foreign exchange premium.

Table 8. Adjustment of tramline investment costs from financial to economic prices, 2008.

MAJOR ITEMS	MARKET SOURCE	FINANCIAL COST (PhP)	ECONOMIC COST (PhP)
1. Service cables, IWRC	Imported	133000	148960
2. Primemover, diesel engine, 70hp	Imported	112000	125440
3. Powerhouse	Local	49000	49000
4. Towers & anchors	Local	105000	105000
5. Accessories	Imported	14000	15680
6. Labor, hauling and installation	Local	189000	189000
7. Contractors Profit	Local	98000	98000
	Total	700,000	731,080

Note: Imported items were multiplied by 1.4 to adjust for the 40% tariff rate.

In the "WITHOUT" scenario, the benefits were derived mainly from the value of the crops produced while the costs were estimated based on the current cost of production. For the "WITH" scenario, the benefits included the: a) additional yield; b) savings from manual hauling; c) preservation of quality/averted postharvest loss, and d) labor saved. On the other hand, the costs included the costs of: a) additional fertilizer; b) additional labor; c) payment for the tramline operator; d) repair and maintenance of tramline facility; e) fuel, oil and grease, and f) depreciation of the tramline facility.

The incremental net benefit was estimated by subtracting the total net benefits of the "WITHOUT" scenario from the "WITH" scenario. Based on the result of the BCA, putting up a tramline facility serving a seven hectare area and treating it as public investment will give an Economic Rate of Return of 37% and a Net Present Value of PhP2,035,845.62 assuming an interest rate of 12% (Table 9). The result of the break-even analysis also showed that there should at least be 5 hectares that should be serviced by the tramline facility to be economically viable. With a minimum area of 5 hectares, the economic rate of return (ERR) for this public investment would be 16% with a net present value (NPV) of PhP1,244,118.46.

Table 9. Economic analysis of putting up tramline transport facility to replace manual method of transport, 7 and 5 ha. farm areas, Benguet, 2008.

SERVICE AREA							
7 Hectares				5 Hectares			
Benefits (PhP)		Costs (PhP)		Benefits (PhP)		Costs (PhP)	
Period (Yrs.)	Amount (Php)	Period (Yrs.)	Amount (Php)	Period (Yrs.)	Amount (Php)	Period (Yrs.)	Amount (Php
1 to 3	1,146,600	1 to 10		1 to 3	788,640	1 to 2	188,042
4 to 5	1,130,528			4 to 5	772,568	3	512,116
6	1,001,952			6	643,992	4 to 5	90,042
7	1,130,528			7	772,568	6	202,042
8 to 10	1,114,456			8 to 10	756,496	7	90,042
						8 to 10	104,042
ERR = 37 NPV = PhP2,035,845				ERR = 16 NPV = PhP1,244,118			

CONCLUSION

The introduction of tramline facilities is a welcome development for farmers in the remote and inaccessible upland areas considering the difficulty and cost of transporting the farm products to the market using the conventional method of manual hauling. Farmers have been using these facilities in areas where they have been introduced. However, the returns to investment for a private investor or a farmers' cooperative in a tramline facility will not be attractive if the existing rates for conventional hauling are applied. If the rates however are increased to ensure a viable operation of the tramline facility, then it will be more expensive for farmers who may not patronize it.

The tramline facility however can be treated as a public investment. The result of the economic analysis showed that the economic returns to investment would be high and from the viewpoint of society would be a worthwhile investment. The returns to society would justify investment of public money for such facilities. It will be worthwhile for government to put more funds into putting up such facilities that would link the farmers in these remote areas to the market and help uplift their economic conditions.

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J. ISSAAS Vol. 15, No. 2:70 -80 (2009)

REHABILITATION AND NATURAL RESOURCE MANAGEMENT IN CHANGED AGRICULTURAL LANDSCAPES AS A RESULT OF DISASTERS

Simplicio M. Medina[1], Virgilio T. Villancio[1], Jose Nestor M. Garcia[1], Hospicio G. Natural, Jr[1], Joana Rose M. Vergara[1], Eduardo P. Paningbatan, Jr.[1], and Aladino A. Reguyal[2]

[1] Agricultural Systems Cluster, College of Agriculture, University of the Philippines Los Baños, College, Laguna, Philippines
[2] Social Action Center, Prelature of Infanta, Quezon, Philippines

(Received: March 30, 2009; Accepted: November 8, 2009)

ABSTRACT

In November 2004, a portion of Quezon and Aurora provinces in the Philippines was the scene of unprecedented loss of lives and properties due to flashfloods and mudflows resulting from heavy torrential rains that induced mountain soil erosion, landslides and overflowing of river systems. The disaster damaged prime agricultural lands causing once productive paddy rice lands to be covered by upland soil and diverse grassland species afterwards. The soil's physical and chemical characteristics of the area, together with the production systems have changed, which in many ways have become a challenge to the affected communities. To address the challenge, a multi-stakeholder partnership was forged where one of the main tasks is to restore and make productive the damaged ecosystem, and to develop an integrated farming system suitable to the area, considering the available resources, the knowledge and capability of the people.

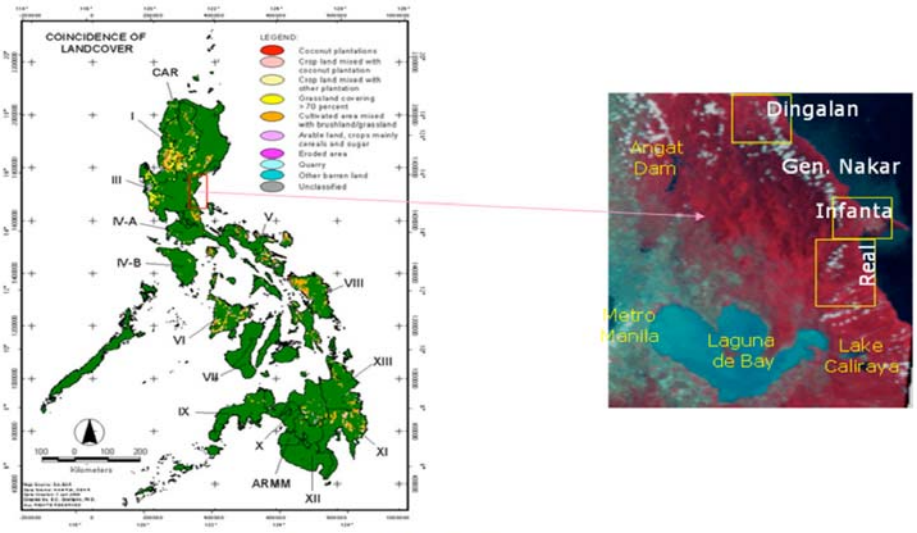
Key words: multi-stakeholder partnership, integrated farming systems, extension delivery system, participatory mechanisms, disaster-affected communities

INTRODUCTION

Disasters, whether natural or man-made can cause destruction to human, social and physical capital and derail economic development of any country (Jovel 1989). In many instances, though, aside from being naturally predisposed, environmental conditions in a country would determine the impact of disasters. Countries with severe deforestation, over-cultivation even of unsuitable areas and over-grazing, tend to be hardest hit when disasters occur (Cuny 1983).

The Philippines is one of the disaster-prone countries in the world, ranking 4th in the number of people killed by floods, tsunamis, typhoons, landslides, volcanic eruptions and man-made disasters. Being located along the usual path of tropical storms, the country is visited annually by more than 20 typhoons.

In one occasion on November 29, 2004, flashfloods and mudflows resulting from heavy torrential rains that induced mountain soil erosion, landslides and overflowing of river systems caused an unprecedented loss of lives and properties in the towns of Real, Infanta and General Nakar (REINA area) in Quezon Province and Dingalan in Aurora Province. These areas are located at the periphery of Luzon Island near the Philippine Sea (Fig. 1). The calamity caused the displacement of more than 1 million people and death to more than 2,000. More than 300,000 hectares of prime agricultural land, mainly lowland rice, were seriously affected and had become upland areas due to the massive landslides (SAC 2005).



Source: E.C. Godilano

Fig. 1. Site of the flashfloods and mudflows in Quezon Province and Aurora Province, Philippines

In the aftermath of responses to the calamity by relief agencies and concerned individuals, it was recognized that "relief assistance" alone does not strengthen the capacity of the affected communities to cope with the next emergency (WFP 2002). Hence, this study and paper aims to establish and develop working arrangements for a multi-stakeholder partnership and strengthen linkages to institutionalize support services and extension delivery system including monitoring and evaluation. Also, it aims to develop collaborative and participatory mechanisms in designing and testing integrated farming system technologies appropriate to disaster-affected communities.

METHODOLOGY

The Study Site

Barangay Boboin, one of the heavily affected villages in the town of Infanta, Quezon was chosen as the study site. As of 2004, it has a population of 1, 589 persons and 266 households. It only occupies a small area, roughly 266 hectares. The village has a Type II climate, characterized by no dry season and with a pronounced maximum rain period from November to January. Average annual rainfall (1971 – 2000) is 4,150.1 millimeters. December is the wettest month while April is the driest (Fig. 2).

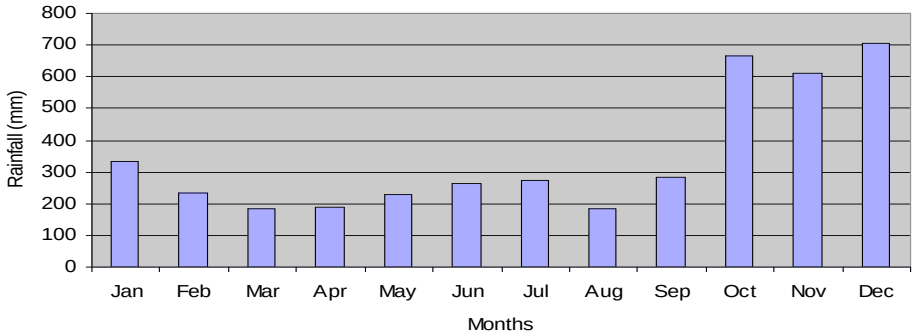


Fig. 2. Rainfall pattern in Boboin, Infanta, Quezon, Philippines

Framework of the Study

The study adopted the concept of "complex adaptive systems" developed by Comfort et. al. (2004) as a theoretical framework to explain the dynamic processes involved in achieving coordinated action among multi-entities to manage complex technical operations in environments vulnerable to risks (Fig. 3).

Following the framework, the multi-stakeholder partnership is an attempt to achieve a coordinated response in rehabilitating the affected farmlands. As more organizations are involved in the system, more interactions will ensue among stakeholders or individuals with different levels of responsibility but focused on a common goal. Under this context, the goal designing technology to support coordinated action requires both technical and organizational planning. Such planning needs to create an awareness of risk in order to define effective action within and among organizations. For agricultural rehabilitation focus, coordination may be achieved more easily with the appropriate design of a socio-technical system, that is, a system that supports the exchange of significant information among technical and organizational entities.

The model can be demonstrated by the general features of the process, to wit:

1. Rehabilitation focus and rebuilding activities are essential in the calamity-stricken areas because the biophysical and socio-economic conditions have abruptly changed in a short period of time;

2. A church-based NGO is at the forefront with spiritual-based transformation as the focal point for strong community participation and action;

3. Implementing integrated agri-livestock-livelihood systems and support mechanisms are necessary since whole/adjacent communities are affected to address a holistic approach of change;

4. There is a need for strong and multi-disciplinary database/information base to ensure multi-functionality of recommendations to be derived;

5. Target beneficiaries have suffered not only loss of agricultural produce as major source of income but also have suffered emotional stress and traumatic experience that affected their total well-being, hence the need for integrated approach at all levels;

6. Partnership at all levels is seen as a strong enabling strategy inasmuch as the target beneficiaries and the affected areas need a holistic assessment and integrated support systems for institutional mobilization;

7. Adaptive mechanisms are provided to cope up with the availability of technology, information resources and favorable conditions. However, the project has to provide adjustment to accomplish desirable output even at less than optimum but substantial level to attain project's goals even at a reduced scale or prolonged duration;

8. The target areas pose risk of recurrence of source of problem, hence, there is a need to integrate coping mechanisms in the strategies;

9. Learning mechanisms are provided not only at the community level but also at institutional levels as well.;

10. Sustainability mechanisms are integrated for enhancing internal capacity and developing strong external linkages. These include linkage mechanisms at all levels with respect to disaster management and rehabilitation of affected areas.

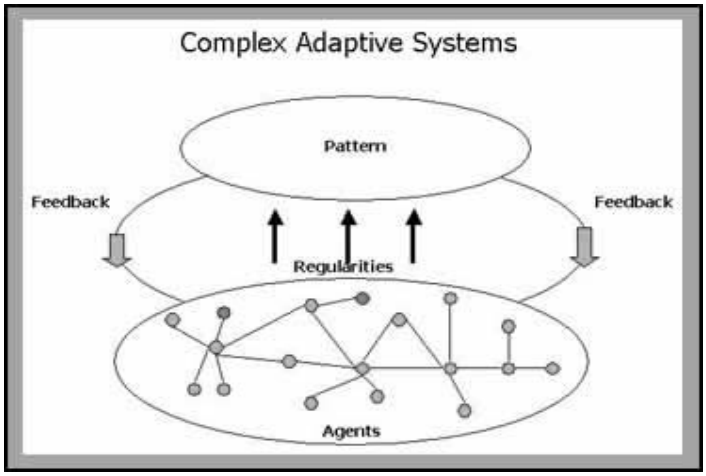


Fig. 3. Theoretical framework adopted by the study from the "complex adaptive systems" developed by Comfort et al

Development of Multi-Stakeholder Partnership

The partnership builds upon collaborative undertakings with defined roles and responsibilities in implementing people-centered rehabilitation and restoration of damaged ecosystem. With this premise, the Social Action Center (SAC), a church-based NGO based in Infanta, Quezon, Philippines, feeling the need for a scientific rehabilitation of the affected area, sought technical assistance from the Commission on Higher Education (CHED), which also referred the matter to the Philippine Council for Agriculture, Forestry and Resources Research and Development (PCARRD). PCARRD then seek collaboration with the University of the Philippines Los Baños (UPLB) for technical assistance (Fig. 4).

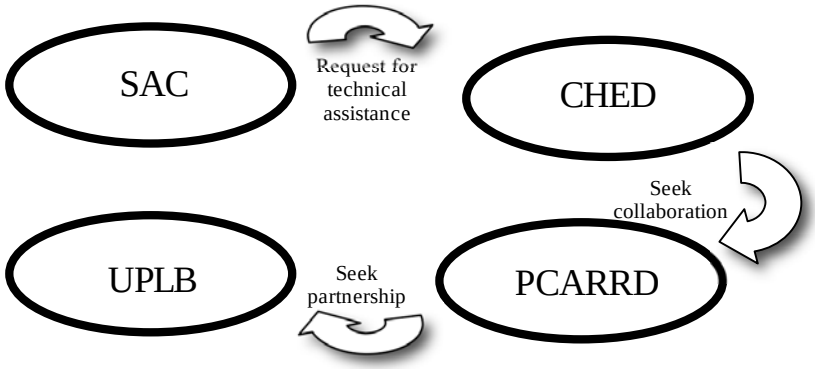


Fig. 4.

Relationships and involvement of the different project partners

The first meeting of the project partners was done on September 16, 2006 to discuss areas of collaboration to respond to the request of SAC for assistance in the rehabilitation of affected areas in Infanta, Quezon, Philippines. Being vital parts of the partnership, the Local Government Unit (LGU) of Infanta, Quezon, Philippines, the village council of Barangay Boboin and the community were consulted and involved in the ensuing activities which is a means of strengthening the partnership. Also, identification of the roles of the different partners in the rehabilitation of the area had been done through a series of planning and project inception meetings.

Design and Testing of Integrated Farming Systems Technologies

To facilitate crop production in the new agricultural landscape, crop suitability, particularly for upland rice, and soil nutrient management studies were done in the area. Different varieties of upland rice were introduced and planted in farmers' fields (Table 1**)**. Coupled with this, different fertilizer rates and sources (Table 2) were integrated into the upland rice varietal trial. Fertilizer sources include inorganic and organic (guano and compost) materials. A two-season trial was done before coming up with the suitable upland rice varieties and fertilization that could give acceptable yield levels. Through continuous consultation, farmers also identified other crops aside from upland rice which included corn, vegetables, honeydew melon and watermelon. Latter part of the study had some farmers wanting to integrate *Jatropha curcas* in their production system.

Table 1. Upland rice varieties used during the dry and wet season and days to maturity. Boboin, Infanta, Quezon, Philippines.

Variety	Days to Maturity
V1 - PSB Rc-9	115-123
V2 - AG-5	95-105
V3 - M-45	110-115
V4 - M-108	115-120
V5 - UPL Ri-5	125-130
V6 - UPL Ri-7	116-120
V7 - Red Borong	120-125

Table 2. Fertilizer treatments (rate and kind) used for the dry and wet cropping seasons, Boboin, Infanta, Quezon, Philippines.

Treatment Number	Treatment Description (rate and kind of fertilizer)
T1	Control (no fertilizer)
T2	90+60+60 kg NPK/ha
T3	45+30+30 kg NPK/ha
T4	45+30+30 kg NPK/ha + 2 tons/ha organic fertilizer
T5	45+30+30 kg NPK/ha + foliar fertilizer spray
T6	4 tons/ha organic fertilizer
T7	6 tons/ha organic fertilizer

RESULTS AND DISCUSSION

Development of Multi-Stakeholder Partnership

As a result of consultations among the partners and stakeholders, the roles of those actually involved in the rehabilitation of the area were identified **(**Figure 5**).** This enabled a smooth project implementation and a more focused conduct of activities of each entity. While this is so, continuous consultation, planning and monitoring are regularly done so that any problem that may arise could be readily addressed (ASC and SAC, 2008).

The different stakeholders involved in the flow of information, energy and materials have varying roles and responsibilities, converging to some extent towards a collective gain. The specific and collective outputs are then translated to impacts in terms of the development of sustainable agricultural systems, food security and safety, poverty alleviation, environmental rehabilitation and protection and people empowerment leading to sustainable development. These synergistic relationships involving iterative processes are captured in the system and served as critical inputs to the agricultural rehabilitation project. The convergence on the ground by the different actors (i.e. farmers, local government units, academic institutions, NGOs etc.) through information sharing and pooling of resources (i.e. human, financial and material) resulted in utilizing knowledge adaptable to the local context.

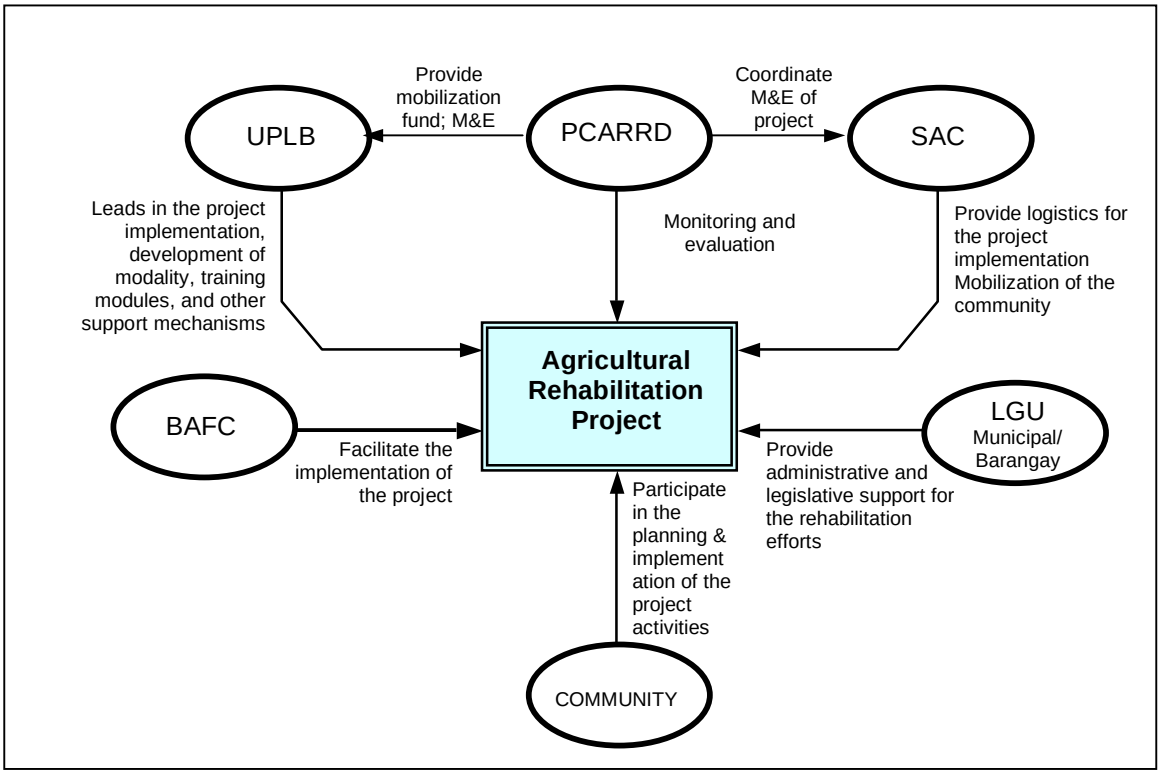


Fig. 5. Roles of the different actors in the project implementation.

Bio-physical and socio-economic assessment of the study site

A detailed assessment was done to ascertain the biophysical and socio-economic characteristics of the affected farmers. Initial activity of the partnership was assessing the area and the agricultural resource base particularly the soil, in order to determine the feasibility of planting food crops in the community through a participatory rural appraisal (PRA).

Assessment activities also involved determining the extent and depth of soil deposition in the village and the soil pH across the area which will be important inputs in identifying what crops can be grown and what strategy to employ to rehabilitate the damaged soil ecosystem. Socio-economic characterization delves more on determining the local farm practices, size of landholdings, status of land ownership, credit sources, input and output market sources and demographic features of the farmers affected by the landslide. Of the area, it was found that about 78 hectares were badly affected with mud deposition ranging from 30-105 centimeters (Fig. 6). It has high infiltration rate because the deposition does not contain enough clay which could increase water holding capacity, making it not suitable for paddy rice production. Also, with the use of a soil test kit to determine soil fertility status in the area, it was found that the soil is mostly acidic and low in NPK (Fig. 7**)**. One year after the calamity, grasses, shrubs and trees dominated the agricultural lands of Barangay Boboin, Infanta, Quezon. Very few patches can be planted to paddy rice and vegetables.

With regards to the depth of soil deposition in the village, a post-calamity land management strategy was developed (Fig. 8) as guide in choosing appropriate interventions and basis in the selection of suitable crops to plant. For areas with thin soil deposition, lowland rice cultivation can still be continued but with some soil amelioration measures including the application of organic fertilizer. For areas with thick soil deposition, where water cannot be impounded because of high infiltration rate, the planting of upland crops was recommended. Upland crops identified include: upland rice, corn, watermelon, and vegetables. The criteria for selecting the crops were: a) farmers' preference, b) can thrive under low soil fertility, c) with ready market, and d) high return.

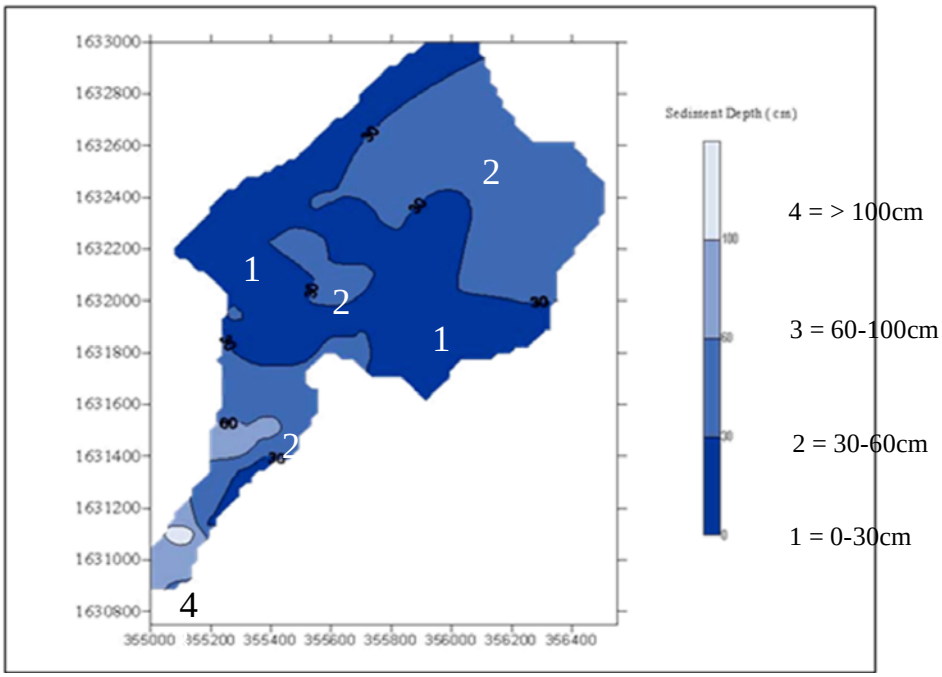


Fig. 6. Depth of soil deposition in Boboin, Infanta, Quezon, Philippines after the landslide.

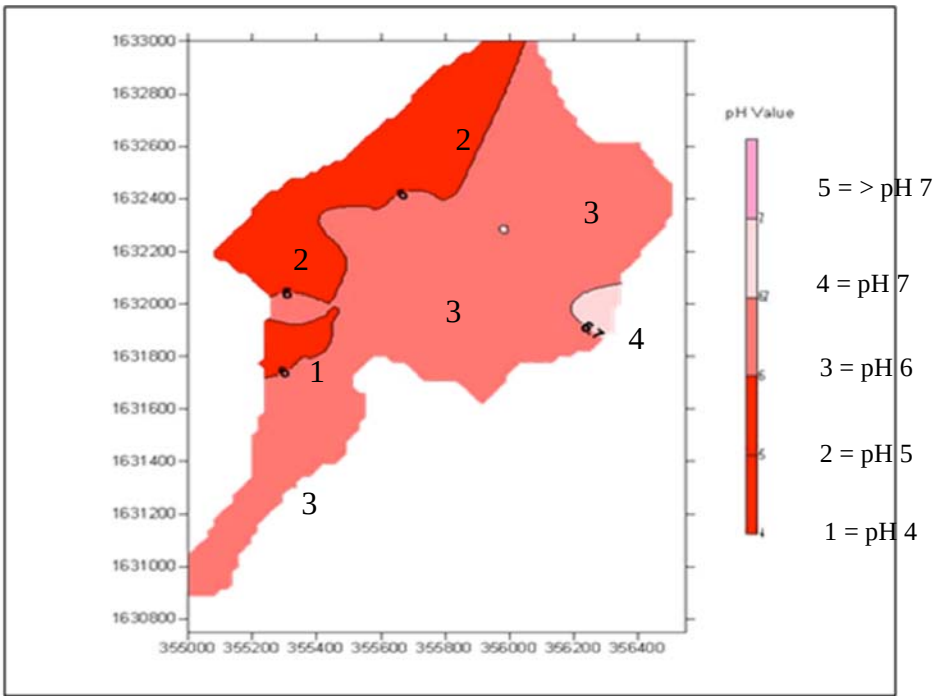


Fig. 7. Soil pH in Boboin, Infanta, Quezon, Philippines after the landslide.

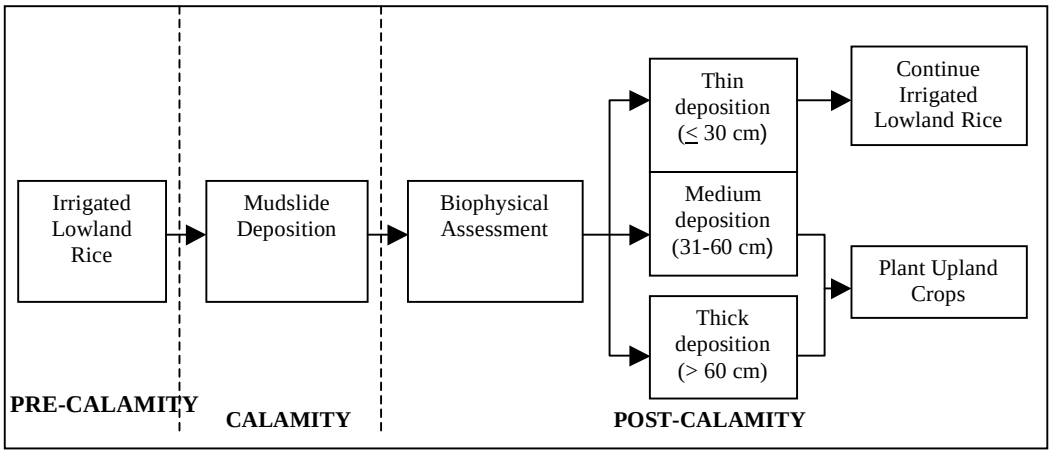


Fig. 8. Post-calamity land management strategy for Boboin, Infanta, Quezon, Philippines.

On-farm Trials of Integrated Farming Systems Technologies

With the new agricultural landscape (change from lowland to upland agro-ecosystem), a lot of things in the community's agriculture also changed: soil pH and fertility were altered and new crops and varieties have to be planted. From these perspectives, the integrated farming systems being

designed for the area started with these parameters which included testing the pH of the "new" soil, determining what upland rice varieties could grow in the area and knowing optimum fertilization levels where these crop varieties can give acceptable yields. Hence, various trials were conducted.

For the fertilizer trial, the average upland rice yield for two cropping seasons is presented in Table 3. In general, yields obtained are low compared to average yields that can be obtained under normal conditions, indicating low soil fertility in the area. Plots without fertilizer gave a very negligible yield. Hence, increasing soil fertility will have to undergo a process through time with the use and addition of appropriate fertilizer materials. The data show that the use of inorganic fertilizer gave the highest yield which could be due to faster nutrient availability to the plants. While this is so, it can also be seen from the table that addition of organic fertilizer and incorporating higher rates in the soil can approximate the yield when using pure inorganic fertilizer. Given the availability of organic fertilizer materials in the area and with increasing cost of inorganic fertilizer, the rehabilitation of the soil's fertility can be done in a more-environment friendly way and at less cost if part of the fertilizer requirement usually obtained from inorganic sources will be replaced by organic materials.

Table 3. Average yield of upland rice for two cropping seasons under different fertilizer treatments.

Fertilizer Treatment	Yield (tons/ha)*
T1 - Control (no fertilizer)	0.75 [c]
T2 - 90+60+60 kg NPK/ha	4.00 [a]
T3 - 45+30+30 kg NPK/ha	2.97 [ab]
T4 - 45+30+30 kg NPK/ha + 2 tons/ha organic fertilizer	3.35 [ab]
T5 - 45+30+30 kg NPK/ha + foliar fertilizer spray	2.04 [b]
T6 - 4 tons/ha organic fertilizer	2.34 [b]
T7 - 6 tons/ha organic fertilizer	2.57 [ab]

***** Means followed by the same letter are not significantly different at 5% level of the DMRT test

Upland rice yields from the varietal trial conducted for two seasons to find the variety suited to the area and those preferred by the farmers are shown in Table 4. During the first cropping, variety M-108 gave the highest yield, though not statistically different from the rest except Red Borong. In the second cropping, the farmers selected only four of the original seven varieties for planting. Aside from yield levels, the farmers selected the varieties based on their observations on crop stand, grain size, panicle length and eating quality. Succeeding cropping by the farmers in the village involved only the variety PSB Rc-9. The variety gave the highest average yield during the second cropping and the farmers further observed that it has good grain filling characteristics and tolerance to lodging.

Table 4. Average yield of upland rice varieties tested in Barangay Boboin, Infanta, Quezon, Philippines (tons/hectare).

Variety	1st Cropping (DS) **	2nd Cropping (WS) **
V1 - PSB Rc-9 *	4.98 [ab]	3.0 [a]
V2 - AG-5 *	3.59 [ab]	2.1 [a]
V3 - M-45	3.69 [ab]	-
V4 - M-108 *	5.16 [a]	2.9 [a]
V5 - UPL Ri-5 *	3.52 [ab]	2.3 [a]
V6 - UPL Ri-7	4.30 [ab]	-
V7 - Red Borong	1.75 [b]	-

*****Upland rice varieties selected by the farmers for planting during the 2nd cropping (WS)

******Means followed by the same letter are not significantly different at 5% level of the DMRT test

Every rice cropping season, one of the most important problems encountered by the farmers were weeds. Controlling weeds through hand weeding required high labor input because of heavy weed infestation. A trial on weed control using herbicide was also conducted to help solve the problem. Herbicide applications using herbicides metsulfuron and bispyribac sodium were compared with hand weeding (Table 5).

Table 5. Comparison of upland rice yield under different weed control treatments. Boboin, Infanta, Quezon, Philippines

Treatments	Rice Yield (t/ha)*
T1 - Bispyribac sodium	5.21 [a]
T2 - Metsulfuron	3.36 [b]
T3 - Hand weeding	3.30 [b]

***** Means followed by the same letter are not significantly different at 5% level

Metsulfuron is a herbicide used to control sedges and broadleaves and can be applied either as a pre-emergence or as post-emergence herbicide. It works through both contact and residual soil activity and is not prone to volatilization. Bispyribac sodium on the other hand, is suitable for annual grasses, sedges and broadleaves. It is selective and systemic post-emergence type of herbicide. Bispyribac sodium-treated plots gave the highest yield of 5.2 t/ha, which is significantly higher than the metsulfuron and hand-weeded plots, which have comparable yields. Hence, the herbicide trial has presented to the farmers a tangible option of controlling weeds that will not only reduce time and labor requirements in weeding but will provide a better environment to the rice plant for increased yield levels.

CONCLUSIONS

Disaster response and rehabilitation could be an enormous task both for the affected community and for those who would extend assistance. However, the task is made easier if a multi-stakeholder approach is adopted coupled with the presence of a local organization or group that can immediately respond to the various concerns of the rehabilitation process. Moreover, provision of viable options to the community in terms of livelihood, technologies and other support services is crucial. In so doing, developing the community's capability to respond to the next disaster rather than making them dependent on any kind of assistance extended should be a vital responsibility of any entity providing assistance for disaster rehabilitation. Furthermore, the need for a champion becomes a key component in rehabilitating calamity-stricken areas. This in essence, would lay the foundations of the rehabilitation process, allowing the affected individuals or communities to mount a cohesive effort in restoring their confidence and bringing back to their feet to produce their own food and rebuild their livelihoods. Bringing in appropriate agricultural technologies that can help sustain or alleviate food production is another vital component of the rehabilitation process.

ACKNOWLEDGEMENT

We would like to acknowledge the funding support of the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) and the Social Action Center (SAC) in the overall conduct of the project. We would also wish to thank the Agricultural Systems Cluster, College of Agriculture, U.P. Los Baños for providing administrative assistance to the project.

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J. ISSAAS Vol. 15, No. 2:81 -92 (2009)

EMPLOYMENT STRUCTURE IN A RICE FARMING VILLAGE IN MALAYSIA：A CASE STUDY IN SEBRANG PRAI

Rika Terano and Akimi Fujimoto

Tokyo University of Agriculture

(Received: April 3, 2009; Accepted: November 12, 2009)

ABSTRACT

Malaysia achieved dramatic economic growth through foreign investment in the industrial sector from the 80s. This led to the creation and expansion of employment opportunities in multi-national companies and factories built mostly on the west coast of Peninsular Malaysia. People started to be employed full-time or part-time in the industrial sector located in rural or urban areas. In the rural area this has created great impact on the employment structure of the traditional rice farming villages. It is possible to assume a deagrarianization process in villages which lie closely connected to the impact of industrialization. The impact of industrialization might have caused deagrarianization of the traditional employment structure, especially among paddy farmers in the west cost of Peninsular Malaysia.

This paper aims to examine the actual changes and influential factors in employment structure, based on a case study in Kampung Permatang Tinggi Bakar Bata, Sebrang Prai. A survey was conducted in 2006 among 42 Malay paddy farmers and 58 workers using a structured questionnaire. Kampung Permatang Tinggi Bakar Bata, Sebrang Prai is located in one of the main rice granaries and is adjacent to the industrial zone in the north of Penang. In order to discriminate types of job, quantification method type II was used in the analysis to discriminate outside variables by qualitative data. The results of the study indicated that there was a clear change in employment structure among the paddy farmers. The number of full-time farmers decreased and the number of part-time farmers increased in this area from the 1980s to 2000s. The study also revealed that age was the most important factor in choosing between on-farm and off-farm work, and between full-time and part-time work in the study village.

Key words: industrialization, deagrarianization, part-time farming, off-farm employment, quantification method Type II

INTRODUCTION

In recent decades, the industrial sector in Malaysia has been growing rapidly through foreign direct investment. During the 1970s-1980s, the Malaysian economy developed dramatically due to export-oriented growth and import-substituting industrialization. Since 1986, outward industrialization started with investment promotion measures (Ishizutu 1998). Penang has been in the vanguard of development and industrialization due to electronics and electrical appliance companies in Malaysia's leading industrial zone. These companies have been supported by such incentives as Pioneer Status and Free Trade Zone policies which had a strong capacity for labour absorption (Arai 1996). A large number of East Asian, European and American electrical and electronic companies built their factories in Prai, Bayan Lepas Free Trade Zone and Mak Mandin industrial parks in Penang. These multi-national companies provided job opportunities for rice growing villages. The development of infrastructure such as highway, bridges and byways facilitated commuting between urban and suburban areas. Thus it provided ample opportunities for villagers in Sebrang Prai to seek jobs in the suburban area.

While Penang has been well recognized as an urban area, it has played an important role in the agricultural sector. The granary, called Sebrang Prai, has contributed with relatively high productivity to domestic production of the staple food of the country. In fact, it is one of the eight major rice granaries in Malaysia; Muda(MADA), Kemubu(KADA), Kerian-Sg.Manik, Barat Laut Selangor, Sebrang Perak, Ketara(Benut), Sebrang Prai and Kumasin Semerak. Total cultivated area was 4,666.9 hectares including 4,652.9 hectares of wetland and 13.8 hectares of dry land in Penang state (Agriculture Census 2006). Paddy fields in Penang state were mostly irrigated, at the level of 98.5%. Since 1987, mini-estates became a popular system in northern and middle Sebrang Prai with an average size of 499.9 hectares (Fujimoto 1994). According to PPK, currently 2,543.4 hectares of fields are organized as mini-estates in 2005. Even though paddy area and the total production seemed to be low, the yield is one of the highest among the eight granaries in Malaysia.

Penang state is characterized by two contrasting dimensions: the important rice farming area in Sebrang Prai and a developed industrial zone. Some studies in the past focused on technological innovation in rice farming from the 1960s to 1980s (Purcal 1971;Fujimoto 1994), while one study was directed to changes in employment structure caused by industrialization in Sebrang Prai (Fujimoto 1995). Employment structure was further affected by the opening of expressways and increase in factories during the 1990s. It is therefore possible to assume the process of deagrarianization in this village (Rigg 2001). This paper aims to clarify the details of the employment structure in a rice farming village in Sebrang Prai by specifying the determinative factors on occupational choice, examine particular groups which have been strongly affected by industrialization, and identify what types of farmer tended to work in the off-farm sector. Specific aims of this paper are as follows: (1) to identify the employment structure of paddy farmers and their family members; (2) to analyze the determinant factors which influenced occupational choice between on-farm and off-farm work among employed villagers; and (3) to clarify determinant factors which also affected occupational choice between full-time and part-time farming among paddy farmers.

In order to clarify the difference between on-farm and off-farm work and between full-time and part-time farming, the quantification method Type II was applied by setting these groups as outside variables for the purpose of analyzing the contribution of each item to the choice of job (Nagahama 1987). This method is based on the multidimensional data analysis developed by Chikio Hayashi in Japan. The quantification aims to make numerical representation of intercorrelated response pattern (qualitative data) with validity (Hayashi 1967). It quantifies outside variables and items with canonical correlation analysis, and utilizes Lagrange's theorem resulting in eigenvalue problem in the following manner.

When each item m has category of C_1, C_2, …, C_m, variable function on item y will become the following linear equation.

$$y = a_{11}x_{11} + \ldots + a_{1c1}x_{1c1} + a_{21}x_{21} + \ldots + a_{2c2}x_{2c2} + \ldots + a_{m1}x_{m1} + \ldots + a_{mcm}x_{mcm}$$

$x_{ij}=1$: i item and j category, $x_{ij}=0$: others ($i=1,\ldots,m$: $j=1,\ldots,c_i$)

Category score a_{ij} normalizes to average out at 0 within each item. When outside variable is discriminated into k groups, variable function on outside variable z will be the following linear equation.

$$z = b_1z_1 + b_2z_2 + \ldots + b_kz_k$$

$z_i=1$:outside variable among groups , $z_i=0$: others ($i=1, \ldots, k$)

Category score of outside variable b_i to each group equals the average of the item score on each group. Correlation will indicate how much outside variable k groups were precisely discriminated. Correlation r represents the range of values from 0 to 1 (Yanai 2005).

CHARACTERISTICS OF THE AREA AND RESPONDENTS STUDIED

Penang state consists of Penang island and a nearby region, Sebrang Prai of Peninsular Malaysia. We focus on a rice farming village in Sebrang Prai. As shown in Figure 1, the study village is located north of Kepala Batas, 2km from Muda River on the border of Kedah state, and approximately 20km from Butterworth. Kampung Permatang Tinggi area involves a total of four villages, which are named Permatang Tinggi A, B, C and Bakar Bata. The survey was conducted in Kampung Permatang Tinggi Bakar Bata (hereafter, abbreviated as Kg.PTBB) from May to July, 2006

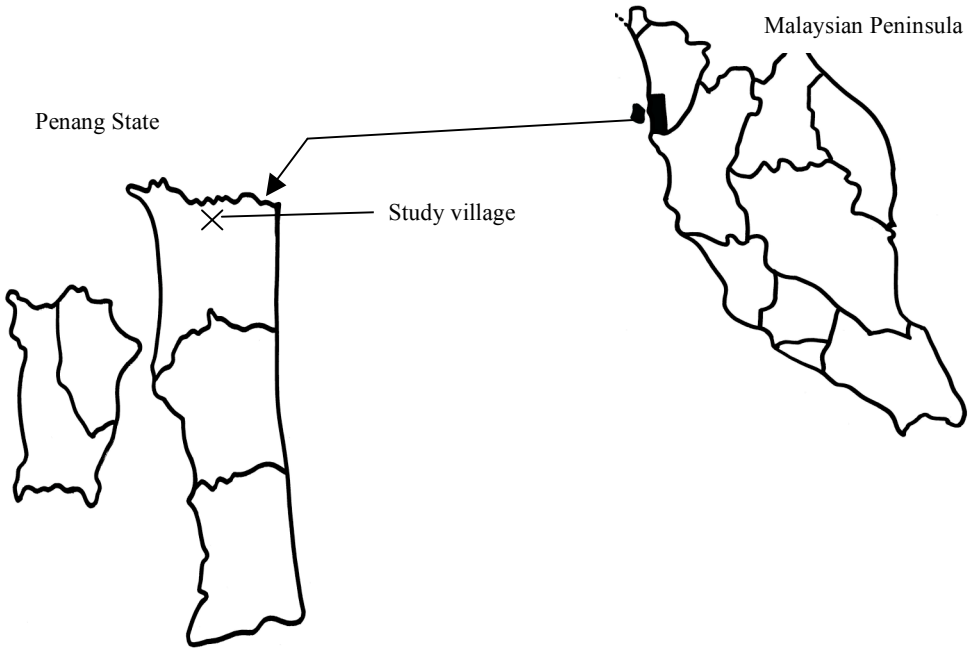

Fig. 1. Map of the study village

Table1 presents the outline of the study village. The data were collected through interviews with heads of households who all worked as paddy farmers in the village. Total number of respondents was 42, consisting of 17 full-time, and 25 part-time farmers. It is clear that half of the farmers, 21 respondents, only operated less than a hectare of paddy land. There were five farmers cultivating more than two hectares, and the average operated area was 1.1 hectares per household, but rented in land occupied 0.36 hectare on average. The interview with 42 heads of households collected data on 100 family members who were engaged in some employment.

Table 2 shows the number of workers by main occupation and gender in Kg.PTBB. On-farm employment is a category for paddy farmers, consisting of full-time farmers and part-time farmers. There are only three women who helped their husbands in rice farming with limited working hours among 42 households. Off-farm employment meant seasonal wage work in rice farming and other jobs in the off-farm sectors such as the government, industrial, agricultural and informal sectors (Table 2). More than half the workers in the off-farm sectors belonged to the industrial sector. Employed workers in the off-farm sector included part-time farmers among household heads, their wives, sons and daughters.

Table 1. The outline of the study village, 2006.

Items	
Total households	137
Number of households studied	42
Average family size (persons)	6
Total number of workers	100
Number of HHH	42
Full-time	17
Part-time	25
Number of farmers by tenurial status	
Owner farmers	21
Owner-tenant farmers	16
Tenant farmers	5
Average farm size (relong)	2.1
Number of households by farm size (relong)	
Less than 1.0	9
1.0-1.9	12
2.0-2.9	6
3.0-3.9	9
More than 4.0	6

Source: Survey, 2006

Note: 1relong in Sebrang Prai = 1.3acres = 0.4ha

Table 2. Number of workers by main occupation in the study village.

Type of job	**Men**	**Women**	**Total**
On-farm			
Full-time farmer	16	1	17
Part-time farmer	25	-	25
Off-farm			
Government sector	14	6	20
Industrial sector	30	21	51
Service sector	9	6	15
Side worker on farm	-	3	3

Source: Survey, 2006

Note: Multiple counting

Agricultural share of GDP declined from 37.8% in 1970 to 14.9% in 2005, while the industrial sector became the fastest growing sector in the Malaysian economy. Changes in agricultural structure in the various economic phases resulted in labour movement with rising demand in the manufacturing sector. There was almost no change in the domestic labour force in the agricultural sector, while the labor force in the industrial sector has continued to increase over two decades. In comparison with 2004, the labour force in the industrial sector more than doubled in the 1980s.

This section focuses on the employment situation in Penang state in order to identify some aspects of the chronological situation of labour utilization and actual employment. Since early times, work in the rural area has consisted mostly of seasonal work in on-farm and off-farm jobs. In the 1960s, there was a period of transition from paddy single cropping to double–cropping with the diffusion of irrigation facilities in the northern part of Penang State. Employment activities were classified into on-farm and off-farm for both genders. Working patterns in on-farm and off-farm employment related to paddy activities clearly depended on the season (Purcal 1971). The seasonal variation of the cycle of activities centered around the harvesting months of July and January, and the transplanting months of September and April. This made a difference in monthly work pattern and working hours. In the case of farms smaller than the 0.5-1.1 hectares group, farmers were underemployed up to 35% of their available time over the years (Purcal 1971). In the case of female respondents, only a few of them helped in paddy farming and the rest did not take part in any farm activities. Transplanting and harvesting were very heavy and important activities for women, however this work was only temporary and seasonal, and women were underemployed for 57% of the time in the whole year, as shown in Table 3. Main on-farm jobs were paddy work, rubber work, and mat-making. Mat-making and other activities were generally low in productivity, although they were important activities during the slack season of paddy farming. Off-farm activity for women was paddy work in double-cropping area, but no activity in single cropping area. In the 1960s, women were generally not allowed to seek jobs outside the village, which was a centrally important environment for them. The exceptions were women from landless households or widows, who were less inhibited by social constrictions on wage-work. This study shows that working pattern and characteristics are connected to gender, season, landholding size and social custom.

Table 3 Under employment of men and women in a year.

	Male	**Female**
Time available for productive work(hrs) (A)	2,200	1,650
Working time (hrs) (B)	1,463	713
Available time (%) (C=B/A*100)	67	43
Underemployed workers (% of villagers)	33	57

Source: J.T.Purcal 1971, pp.26 and 57

After an investment promotion measure was established, the characteristics of employment structure on the west coast have recently been transformed, with factories being built in manufacturing quarters. The increase of companies and factories in free trade zones accelerated the influx of labour force from the agricultural to the manufacturing sectors, from 1986. Furthermore, in the 1970s and 1980s, there was a new trend in labour saving technology in paddy work. The introduction of direct-seeding instead of transplanting by hand, and mechanization with combine harvesters transformed the work of crop establishment, harvesting, threshing and transportation. These were very important technological changes in the rice farming sector. Traditional contract activities and exchange labour custom could not persist in the face of labour-saving technology, which deprived women of employment opportunities in rice farming (Fujimoto 1994). From 1978 to 1987,

the number of full-time rice farming households decreased, and family members increasingly tended to work in the off-farm sector. One of the key changes was that women became supplementary workers after the introduction of labour-saving technology, while men played a vital role in mechanized rice farming. From 1986 and specifically in the 1990s, expanded employment opportunities promoted the employment of the younger generation in the industrial sector.

Employment structure in the study area

Table 4 shows the time-series data of two different villages in Seberang Prai: Kg.PTBB and Kampung Guak Tok Said (Kg.GTS). Since both villages are rice growing villages, located only 3 km from each other, these data were accepted to examine changes in rice farm occupation in Sebrang Prai. It then becomes clear that the ratio of full-time farmers decreased from 83% in 1978 to 67% in 1987, and drastically to 31% in 2006. On the other hand, the ratio of part-time farmers has gradually increased from 12% in 1978 to 55% in 2006. It is possible to assume the number of part-time farmers increased rapidly due to the introduction of the commuting bus from company and factory to the neighboring villages on the highway and its junction. The percentage of part-time farmers has gradually escalated in both villages by this transformation in the surrounding environment. At the same time, as Table 4 indicates, there is a clear trend of aging of farmers, from 40 years old to 49 years old in 1978, and to 56 years old in 2006. In the case of full-time farmers, the trend is more obvious: 30 years in 1978 to 62 years in 2006. This implies the lack of successors in rice farming in the area.

DETERMINATION OF OCCUPATIONAL CHOICE

Occupational Choices and Determinants

This section is devoted to a quantitative analysis of determinants of occupational choice in Kg.PTBB, based on Analysis of Accidents at Railroad Crossing by The Quantification Method. It should be noted that although this method is unrelated to agriculture, it is actually highly relevant in revealing the determinant factors affecting the choice of job. The quantification method Type II is able to analyze the contribution of each item to job choice by setting the following two groups to the outside variable. Let us consider two kinds of grouping, firstly on-farm and off-farm work. The group of on-farm work includes full-time and part-time farmers, and the other group involves off-farm workers in the non-agricultural sector. The second grouping of 42 farms is determined by whether he/she is a full-time or part-time farmer.

Through these two sets of outside variable, influential factors having an impact on occupational choice will be analyzed for 100 workers for on-farm and off-farm work, and for 42 farmers to be full-time or part-time farmers. Off-farm workers consist of hired workers and self employed workers, including part-time farmers. Possible determinant factors taken into consideration are gender, age, educational background and landholding.

Between On-Farm and Off-Farm Work as Outside Variable

Independent variable of on-farm work is 1, and off-farm work is 2. The items are as follows: variable k_1 is a dummy variable for sex (man=1, woman=2). Variable k_2 is a categorical data for educational background level (no schooling =1, elementary school=2, junior high school=3, high school=4, University=5). Variable k_3 is also categorical data for age (18-39 =1, 40-69=2, more than 70=3), and k_4 is a dummy variable for land tenurial status with or without land ownership (no land holding=1, land holding=2).

Table 4. Changes in farm occupation status, 1978-2006.

	1978[1)]				1987[2)]				2006[3)]			
Employment pattern	**No.**	**%**	**Paddy land (relong)**	**Average age of HHH**	**No.**	**%**	**Paddy land (relong)**	**Average age of HHH**	**No.**	**%**	**Paddy land (relong)**	**Average age of HHH**
Rice farming	43	83	2.9	39	35	67	3.7	52	13	31	3.0	62
Rice + other crop farming	1	2	2.3	55	0	0	-	-	3	7	2.2	60
Rice farming + wage labour	6	12	2.1	31	14	27	2.7	41	23	55	2.4	52
Rice farming + self employed	2	4	1.9	53	3	6	1.2	49	3	7	5.1	52
Total	52	100	2.8	40	52	100	3.3	49	42	100	2.73	56

Source:1) and 2) Fujimoto,1994

3) Survey, 2006

Note: Figures for 1978 and 1987 refer to Kg. G.T.Said

The results of the estimation are presented in Table 5. As correlation coefficient r = 0.7661 indicates, the discrimination of 100 workers in the analysis is reasonably good. The positive value of the category score represents the extent of contribution of the category to on-farm work, and the negative value to off-farm work. In Table 5, the extent of the contribution of each item is shown by a score range, while the order for the score ranges is indicated in parentheses. This method was used to obtain category scores and score ranges for two groups (on-farm work and off-farm work), so as to elucidate the dependence of those groups on particular items.

Table 5. Values of category scores for employment choice factors obtained for two groups (on-farm and off-farm workers).

Items	Number of workers		Category score	Score range
	On-farm	Off-farm		
Gender				
Man	41	26	0.2657	0.8053
Woman	1	32	-0.5395	(2)
Education				
No schooling	3	2	-0.3093	
Elementary school	20	8	0.1921	0.5013
Junior high school	7	2	0.0885	(4)
High school	11	31	-0.0747	
University	1	15	-0.0933	
Age				
18-39	1	43	-0.5758	1.14837
40-59	25	13	0.3955	(1)
More than 60	16	2	0.5725	
Tenurial status				
Tenant	17	58	-0.1989	0.7956
Owner	25	0	0.5967	(3)

Source: Survey, 2006

Note: Owner includes tenant-owner

r = 0.7661

The largest score range was obtained for the factor of "age", followed by "gender", "tenurial status" and "educational background". The category giving the largest positive score was "tenurial status" because land owner has the character of being occupied in rice farming as on-farm worker. The second highest score was for the category "generation: younger than 40", but with a negative sign, indicating that the younger generation preferred to be employed in off-farm work. The largest score range is seen for the generation, and interestingly the category score increases with the increase in age. The generation from 18 to 39 had a maximum category score, indicating that membership in this age group clearly affected choice of job between on-farm and off-farm works.

The score range for gender is the second largest. It is clear that the effect of gender is an important factor in job choice with men tending to work on-farm and women off-farm. The score range for tenurial status was the third largest among the four score ranges. It is interesting to note that the score range for educational background is the smallest, and so are the category scores. However,

there is a clear tendency for the workers who studied at high school and university to prefer working in the off- farm sector. In this case, off-farm work involved governmental or private companies. On the other hand, the workers with no-schooling tended to work in self-employed sector or in temporary wage work in the off-farm sector.

The Outside Variables between Full-Time and Part-Time Farmers

In order to clarify the choice between full-time and part-time work from factors including "education", "age", "pension", "farming experience" and "size of planted area", an analysis was also conducted by the quantification method Type II with these two groups being the outside variables. As is indicated by correlation coefficient r = 0.5440, the discrimination in the analysis may be adequate. The positive value of the category score represents the extent of contribution of the category to being full-time farmer, and the negative value part-time farmers.

Independent variable of full-time farmer is 1, and part-time farmer is 2. The items are as follows: variable k_1 is a dummy variable for education (no schooling and elementary=1, secondary=2, high school and university=3). Variable k_2 is a categorical data for age (18-49 years old=1, 50-69 years old=2, elder than 70 years old=3). Variable k_3 is also categorical data for pension (no pension =1, pension=2). Variable k_4 is categorical data for farming experience (0-19 years=1, 20-39 years=2, more than 40 years=3), and k_5 is categorical data for planted area (0.0-0.9 relong=1, 1.0-1.9 relong=2, 2.0-2.9 relong=3, 3.0-3.9 relong=4, more than 4.0 relong=5). For all of these items, positive contributions are expected on the choice of being full-time farmers.

Table 6 presents the results of the analysis, from which the following points deserve mentioning. First, the largest score range was obtained for the factor of "age", followed by "size of planted area", "pension", "farming experience" and "education". The category giving the largest positive score was "older than 70 years old", indicating that older farmers were likely to be full-time farmers.

The second highest score for the category was "pension", suggesting that farmers older than 56 years old who had previously worked in the governmental sector were most likely to be full-time farmers. It should be noted that only workers in the governmental sector can receive pension after retirement at 56 years old. Second, the score range of age was the largest and the category score increases with the increase in age. Age of more than 70 years old gave a maximum category score, indicating that the choice of becoming full-time farmers was most strongly affected in this age group.

Third, the score range of the planted area was the second largest, and farmers in the size of 0.0-0.9 relong, 2.0-2.9 relong and 3.0-3.9 relong tended to be full-time farmers. On the other hand, farmers in the size of 1.0-1.9 relong and more than 4.0 relong tended to be part-time farmers with negative category scores. Most of the farmers in both groups worked in the informal sector as self-employed workers, by which they could manage the time schedule for daily work of on-farm and off-farm labour hours. Fourth, the score range of pension was the third largest, and indicated that farmers with pension tended to be full-time farmers, which is consistent with the earlier discussion.

Lastly, the score range of the period of farming experience revealed that farmers with more than 40 years of experience in rice farming tended to be full-time farmers, while farmers with less experience tended to be part-time farmers. This again is consistent with the earlier finding that the older farmers tended to remain as full-time farmers.

Table 6. Values of category scores for employment choice factors obtained for two groups. (full and part time farmers).

Item	Number of farmers		Category score	Score range
	Full-time	Part-time		
Education				
No schooling and elementary	11	12	-0.0888	0.2287 (5)
Junior high school	3	4	0.1398	
High school and university	3	9	0.0887	
Age (years)				
18-49	0	11	-1.0911	
50-70	14	13	0.2747	2.2374 (1)
More than 70	3	1	1.1463	
Pension				
None	10	24	-0.2676	1.4051 (3)
Have	7	1	1.1375	
Farming experience (years)				
Less than 20	6	10	-0.1087	0.3749 (4)
20-40 years	6	13	-0.0065	
More than 40	5	2	0.2662	
Planted land (relong)				
Less than 1.0	4	5	0.2815	1.6547 (2)
1.0-1.9	4	8	-0.8679	
2.0-2.9	3	3	0.7868	
3.0-3.9	5	4	0.4470	
More than 4.0	1	5	-0.1438	

Source: Survey, 2006

Note: r = 0.544

CONCLUSION

Concerning the employment structure of paddy farmers and their family members, there was an interesting pattern in the study village. First, we can point out a large increase in the number of part-time farmers during the past decades. At the same time, there was a clear trend of the increase in aged farmers. Second, four factors of age, sex, land holding and educational background were discovered to be the determinants of the occupational choice of the head of the farm households to be engaged in on-farm or off-farm employment. Third, five factors involving age, size of planted area, with or without pension, period of rice farming experience, and educational background were seen to affect the occupational choice of being full-time or part-time farmers.

The quantification method Type II revealed that age was a crucial factor for determining the job

choice between on–farm and off-farm employment, as well as being full-time or part-time farmers. Gender also appeared to be a very important factor in determining whether to be engaged in on-farm or off-farm employment, while farm size played a key role in determining to be full-time or part-time farmers. It was clearly shown that the younger generation preferred working off-farm, and younger farmers chose to be part-time farmers. This tendency is attributed to the characteristics of the area, which is located within commuting distance of an industrial zone.

It is clear that employment structure in the study village has been affected by its geographical advantage of location within commuting distance of the industrial zone. In addition, improved infrastructure such as roads and highways brought about a huge impact to the study village by commuting bus of companies and factories. This traditional rice village on the west coast of Malaysia demonstrated a typical case of the deagrarianization in employment structure caused by industrialization.

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J. ISSAAS Vol. 15, No. 2:93-106 (2009)

THE PHILIPPINES' REGULATORY POLICY ON COCONUT CUTTING: AN ASSESSMENT INCORPORATING ENVIRONMENTAL CONSIDERATION

Isabelita M. Pabuayon[1], Simplicio M. Medina[2], Cynthia M. Medina[2] and Erlene C. Manohar[3]

[1] Department of Agricultural Economics, College of Economics and Management
University of the Philippines Los Banos (UPLB)
College, Laguna 4031 Philippines
[2] Agricultural Systems Cluster, College of Agriculture, UPLB
[3] Philippine Coconut Authority
Diliman, Quezon City, Philippines

(Received: September 2, 2009; Accepted: November 2009)

ABSTRACT

This paper investigates the environmental issues associated with the cutting of coconut trees in the Philippines with the end in view of identifying possible revisions in the current regulatory policy. The analysis is based on primary and secondary data gathered from case coconut farms, farmer leaders, and community development officers of the coconut government agency in Quezon province, the largest coconut producing area in the country.

A policy to regulate the cutting of coconut trees in the Philippines is currently implemented to ensure a sustainable resource base for the coconut industry. However, indiscriminate and illegal cutting of coconut trees has continued. This has raised serious concerns not only on the economic viability of the industry but also on possible adverse impact on the environment since many coconut farms are in the sloping and mountainous areas. Findings reveal that farmers do not consider the environmental threat as serious in their coconut farms even as they admit illegal cutting of coconut trees happening in their areas. However, there are already erosion incidents in some sloping farms. Moreover, the community development officers and even some farmers agree that the environmental threat could be real if uncontrolled cutting without replanting and unsustainable farm management practices in the uplands persists. A prudent course of action requires a more effective implementation and revisions of the policy to address the following: (a) environmental clearance for sloping and critical areas in issuing cutting permits, (b) concentrating coconut replanting in flatlands and less critical slopes, (c) planting of denuded coconut plantations in critical areas with appropriate forest species, and (d) capacity building through farmers' training on ecological awareness and demonstration of appropriate farming systems and production possibilities that address both ecological and economic concerns.

Key words: Environment, sloping coconut farms

INTRODUCTION

Due to the scarcity of wood in the Philippines, cutting of coconut trees for commercial sale of coco lumber (coco wood) or coconut logging has become widespread (Pabuayon and Medina 2007). This has raised sustainability concerns both on the economic viability and competitiveness of the coconut industry and the environment considering that an estimated 30% of the coconut lands in the country are in mountainous areas (Manalo, no date). Such concerns are valid because the coconut industry is significant to the Philippine economy as a major provider of income, employment and foreign exchange. Any problem, whether economic or environmental, can bring about hardships

particularly to dependent impoverished coconut communities. Pabuayon, et al. (2009) argued that market development through value-addition and improved marketing system could help alleviate poverty among coconut farmers. As shown by Aragon (2008), the proportion of poor households in selected coconut communities has remained high at 52% even after the implementation of the government's poverty reduction program.

This paper focuses on the environmental considerations affecting the coconut industry. Environmental risks in the uplands are associated with the loss of the soils' water-holding capacity particularly during persistent torrential rains when trees are cut on large scale basis. A study in Quezon province, the largest coconut-producing area in the Philippines, showed that although erosion rate is lower in coconut plantation farms compared to other cases such as coconut with corn intercrop, bare area and fallow area, it generally increases with slope in all cases (Josue 1999). Cutting of coconut trees without replanting exposes the soils to adverse weather conditions and makes them vulnerable to erosion. In extreme cases, soil erosion in hilly and sloping areas causes landslides and flashfloods.[1] Medina (2005) estimated that, taking into account the economic and ecological contributions of coconut, the net environmental benefit of coconut logging without replanting over a 10-year period is negative PhP416,722 per hectare.

Cutting of coconut trees in the Philippines is generally prohibited, and allowed only under certain conditions, after payment of mandatory fees and planting of replenishment seedlings, in which case a permit-to-cut (PTC) is issued by the authorized government agency. However, indiscriminate and illegal cutting of coconut trees continues in many areas (Medina 2005, Aranas 2006 and Esguerra 2007). While the policy also aims "to promote the growth of the national industry by embarking on a sustainable and efficient replanting program", success rate of the program is limited. The main question is whether or not there is scope and urgency to revise the regulatory policy for cutting coconut trees based on environmental considerations.

This paper (1) analyzes the coconut cutting regulatory policy in the Philippines in terms of specific guidelines and extent of implementation, (2) provides evidence on the environmental situation in selected coconut areas, and (3) recommends possible revision of the coconut regulatory policy to take into account environmental consideration.

METHODOLOGY

This paper forms part of the 2008 research project "Economic and Environmental Concerns in Philippine Upland Coconut Farms: An Analysis of Policy, Farming Systems and Socioeconomic Issues" funded by the Economy and Environment Program for Southeast Asia (EEPSEA) under the International Development Research Centre (IDRC). The study used both primary and secondary data. Primary data include information about the environmental situation in the case coconut farms and implementation of the coconut cutting regulatory policy in Quezon province. Secondary data cover the extent of coconut cutting and policy guidelines.

Data were collected through (a) field visits and ocular observations in 15 case coconut farms in three municipalities, namely, Mauban, Tayabas and San Antonio; (b) focus group discussions (FGDs) with the case coconut farm owners, farmer leaders and other community members; (c) key informant interviews (KIIs) with coconut development officers (CDOs) of the Philippine Coconut

[1] The Philippines experienced massive destruction of lives and properties from natural catastrophes (land/mudslides and flashfloods due to strong typhoons) in Ormoc, Leyte (1991), Southern Leyte and Surigao (2003), and Aurora and Quezon (2004) which are all coconut-producing areas. Nevertheless, cutting of coconut trees was not singled out as the main cause.

Authority (PCA); and (d) photo documentation of the bio-physical characteristics of the coconut farms. Data were analyzed using descriptive statistics (means, totals and percentages) and presented in tabular and graphical forms.

RESULTS AND DISCUSSION

Coconut Cutting Regulatory Policy

Enabling Laws and Policy Guidelines

The government's objective is to maintain a sustainable coconut resource base in order to ensure an adequate supply of raw materials and products for the coconut industry. This is supported by four enabling laws. The first is Republic Act (RA) 8048 or the Coconut Preservation Act of 1995 and its Implementing Rules and Regulations as defined in PCA Administrative Order 02 Series of 2005. The policy provides for the regulation of the cutting of coconut trees as well as growth of the national industry by embarking on a sustainable and efficient replanting program. The second is Executive Order (EO) 213 of 2000 constituting the National Enforcement Task Force or NETFORCE on Coconut Tree Conservation whose main function is to formulate and execute action plans to control the rampant cutting of coconut trees. It supports RA 8048 by ensuring an effective and timely coordination among the concerned agencies, local government units (LGUs) and private sector in implementing its provisions. The third is Executive Order (EO) 015 Series of 2007 of the Office of Quezon Provincial Governor which reconstituted the Quezon Coconut Industry Development Council. It is a provincial ordinance specifying the creation of a Task Force that would monitor the illegal cutting of coconut trees pursuant to RA 8048. The fourth is Memorandum Circular (MC) 02 Series of 2008 or the Moratorium on the Issuance of Permit to Cut Coconut Trees. It is a national directive from PCA stating that "all issuances of permit to cut coconut trees and the corresponding transport/transshipment clearances are suspended nationwide except on a limited exception and under certain circumstances". It was issued to arrest the ever-increasing and unabated incidence of illegal cutting of coconut trees.

Under RA 8048, the cutting of coconut trees is prohibited except under certain requisites where cutting is allowed based on a permit issued by PCA. Among others, these requisites include (1) existence of a valid ground which could be any of the following: (a) the tree is 60 years old or more; (b) the tree is no longer economically productive; (c) the tree is severely disease-infected and/or pest-infested; (d) the tree is damaged by typhoon or lightning; (e) the coconut land shall have been approved for conversion into residential, commercial or industrial areas; (f) the coconut land shall be converted into other agricultural-related activities; and (g) the tree would cause hazard to life and property; and (2) planting of the required equivalent number of coconut seedlings. However, RA 8048 is silent on whether cutting may be disallowed if the removal of coconut trees in a given area, whether partial or clear cutting, could potentially bring about environmental problems. Such problems are likely to occur when trees are cut large scale in sloping and marginalized areas without guarantee of replanting, reforestation, or soil conservation measures. As shown below, cutting is done both in upland and lowland coconut farms. Topography of the area is not considered in evaluating cutting applications.

Since replanting is part of the process, theoretically, every tree cut is to be replaced. However this is not the case for those involving land conversions wherein seed nuts are simply certified as being available for distribution to farmers. Whether they are actually planted elsewhere or not is not fully monitored. Spot checking of actual cutting operations is not compulsory and post-cutting report is not required. After issuance of the PTC, transport monitoring rests with the police agency.

Despite the existence of the NETFORCE, effective implementation of the coconut cutting policy remains a problem suggesting a structural weakness in the policy. One key informant from PCA indicates the following problems: (a) the agency is only involved in the farm-level implementation and not in the trading aspect of coco lumber, (b) it has no police powers to track down violators, and (c) approval of land conversion involving large scale cutting of coconut trees rests with other agencies. One observation is the seeming indirect role of the Department of Environment and Natural Resources (DENR). This role is largely in the monitoring of logs and lumber being transported rather than in ensuring that the environmental aspect of cutting coconut trees in the uplands and mountainous areas is taken into account. In fact, the DENR is not mentioned in RA 8048 and in its implementing rules and regulations.

Extent of Implementation

Since the implementation of the cutting policy in 1995, the number of coconut trees cut based on the permits issued by PCA until 2007 totaled 8,136,413 or an average of 625,878 trees per year. Cutting rose sharply by more than three times from 230,830 trees in 1995 to 982,713 trees the following year. It further increased to 1,088,896 trees in 1997, the highest ever during the last 13 years, before it showed a downward trend reaching a low level of 257,690 trees in 2005. Cutting increased again in the following two years which could partly be due to the large number of trees blown down by the destructive typhoon in 2006. Although showing great year-on-year variability, the number of trees cut grew at an average of 27% per year. Heaviest cutting occurred in the large coconut producing regions, notably Region 4A where Quezon province belongs.

Previous surveys reveal extensive cutting in Quezon (Medina 2005 and Pabuayon and Medina 2007). Among the case farmers interviewed in June-August 2008, 12 had cut their trees in the past at an average of 63 trees per farm. While more cutting was reported in Mauban, "clear cutting" (with PCA permit) was done in San Antonio in 2004 due to predominance of unproductive, low-yielding and old trees. A total of 693,024 trees were cut from 1995 until September of 2007 in Quezon 1 where Tayabas, Mauban and San Antonio belong. By topography, cutting is greater in sloping than in flat coconut farms, even though there were more flat *barangays* than sloping ones covered by the permits issued in 2006-2007 in Tayabas and Mauban (Table 1).

Table 1. Cutting and replanting in coconut *barangays* by topography, Tayabas and Mauban, Quezon, March 2006-2007.

Item	Tayabas		Mauban		Both	
	No.	%	No.	%	No.	%
Total number of *barangays* covered by permits issued[a]						
Sloping	15	38	13	45	28	41
Flat	25	62	16	55	41	59
Total	40	100	29	100	69	100
Total number of cut trees						
Sloping	12,498	55	16,499	53	28,997	54
Flat	10,402	45	14,594	47	24,996	46
Total	22,900	100	31,093	100	53,993	100
Total number of replanted trees						
Sloping	13,799	56	16,693	52	30,492	54
Flat	10,869	44	15,239	48	26,108	46
Total	24,668	100	31,932	100	56,600	100

[a] Topography of *barangays* was identified by PCA Coconut Development Officers (CDOs)
Source: PCA Provincial Office, Quezon

While the policy is to replant every tree that is cut, the national replanting rate is only 61.67% in the period 1995-2007 based on PCA data. Nevertheless, replanting rate has been increasing over time, from only 17.31% in 1997 (none recorded for 1995-1996) to as high as 93.56% in 2002. The number of replanted trees even exceeded those cut in 2005 (Figure 1). Replanting data however do not reflect actual survival rate since no post-cutting evaluation is being done by PCA. Moreover, illegally cut trees are not reflected in the data.

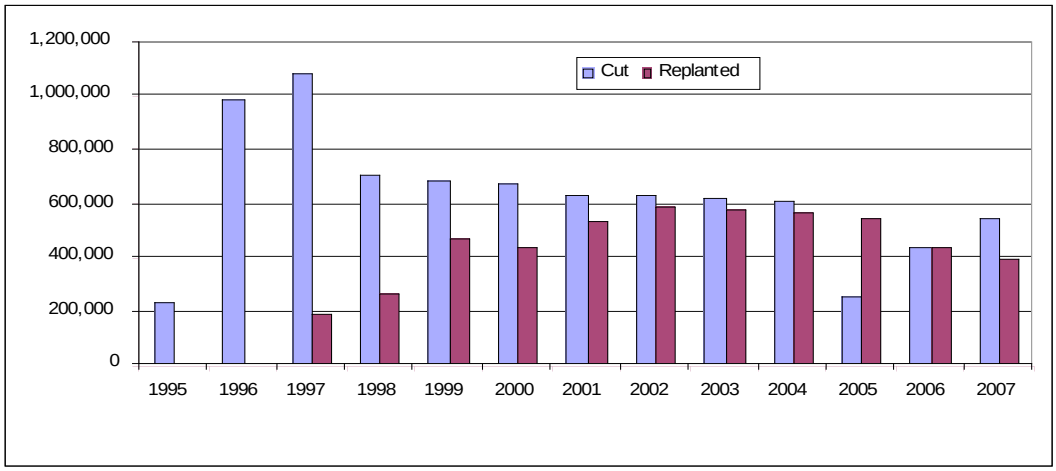

Fig. 1. Number of cut and replanted trees, Philippines, 1995-2007

Aside from inadequate replanting, the most common form of violation is cutting without PCA permit. For the period 1997-2008, the number of cases filed in Quezon totaled 76 with the highest in Tayabas, Sariaya and Mauban. More than half of these were filed in 2007 and 2008 when the moratorium of issuing cutting permits began to be implemented. According to key informants, however, conviction rate for the filed cases has been very low.

The Case Coconut Farms

Bio-Physical Characteristics

In general, Tayabas has a slope ranging from 5% to 8% with some rolling terrain while Mauban is more sloping with a range of 15-50% (Fig. 2). Many farms are in mountainous areas. The soil type in Tayabas ranges from clayey to loamy while it is mostly sandy loam to sandy clay in Mauban and San Antonio. Both soil types are suitable for coconut planting which requires light to medium textured soils (Table 2). When internal soil drainage is considered, though, the lighter soil texture in Mauban is more suitable to coconut.

Average farm size is 6.4 hectares with small portions as separate parcels in Tayabas and Mauban that are planted to other crops. These crops are rice or other annuals like vegetables cultivated in open and flat areas with planted area averaging 0.4 hectare. They are usually for home consumption since harvests are quite small. The smallest farm is 1.5 hectares; the largest is 15 hectares. However, there are several farms that are relatively large at 8 to 14 hectares.

Table 2. Information on case coconut farms in selected municipalities in Quezon, 2008

Farm Information	Municipality			
	Tayabas	**Mauban**	**San Antonio**	**Average**
Average distance of farm from *barangay* road (km)	0.84	1.32	3.6	1.92
Access to farm				
Walking	□	□	□	
Animal ride	□	□	□	
Motorcycle	□	□	□	
Jeepney	□		□	
Topography (% of total farm area)				
Flatland	96	21	77	65
Sloping	4	79	23	35
Soil texture	clay loam	sandy loam	sandy loam	
Rainfall pattern	rainy May – December	rainy September – January	rainy June – August	
Land utilization (hectares)				
Ave. land/farm area	5.4	6.7	7	6.4
Ave. land area planted to coconut and intercrops	4.4	6.5	7	6.0
Ave. land area planted to other crops[a]	1.0	0.2	0	0.4

[a] Refers to separate parcels of land planted to other crops (not planted under coconut)

Fig. 2. Sloping and mountainous coconut farms in Mauban, Quezon (left) and slightly rolling farms in Tayabas, Quezon (right) (Photo by the study team, July 2008)

Average annual coconut yield for all farms was 4,912 kg per hectare or approximately 49 nuts per tree per year (Table 3). Except for monocrop, coconut yields are higher in flat areas than in sloping farms. The farmers explained that the lower yields in sloping farms are due to the trees being much older and poor land fertility resulting from erosion of top soil. The average age of coconut trees in the study sites is 46 years. Coconut trees without intercrops are relatively younger with average age of 37 years. At ages of 20-40 years, coconut canopy covers much of the ground resulting in little sunlight penetration, making the condition relatively unsuitable for most intercrops.

Table 3. Average coconut yield by cropping system, topography and age of coconut trees, Quezon, 2008.

Cropping System	Yield (kg/ha/year)			Age (years) of Coconut Tree
	Flat	Sloping	Both	
Coconut monocrop	1,350	4,703	2,018	37
Coconut + banana	5,265	1,977	3,621	59
Coconut + banana + cassava	8,550	-	8,550	70
Coconut + banana + cassava + fruit trees	7,200	-	7,200	15
Coconut + banana + fruit trees	6,000	2,000	4,000	60
Coconut + lanzones + coffee + cacao + black pepper	3,266	817	4,083	35
Average	5,272	2,374	4,912	46

Environmental Threat

The farmers in Tayabas stated that there is no observed occurrence or threat of erosion in their area. A visual observation of the surroundings did not reveal any occurrence of erosion such as rill, gully or landslide. In Mauban, however, while the farmers did not confirm any occurrence of erosion in their area, a reconnaissance made by the study team around the place revealed presence of some rills and gullies on the ground surface (Figure 3). The CDO confirmed the occurrence of landslide during a strong typhoon in 1995. Of the 12 key informant CDOs from Quezon, eight admitted to occurrence of erosion in their respective areas of responsibilities (Table 4).

Fig. 3. Erosion (left) and logged-over coconut farms (right) in Mauban, Quezon (Photo by the study team, July 2008)

Considering the coconut agro-ecosystem in the sites, the more diverse and multi-storey type of canopy in Tayabas is more effective against any threat of erosion. The reason is that raindrop velocity and impact will be greatly reduced if it passes several layers of canopy before reaching the ground. In Mauban where coconut planting is denser, absence or fewer intercrops under coconut that intercept erosive raindrops allow a greater degree of vulnerability to erosion, considering its steeper slope. Except in the event of excessive rainfall brought about by strong typhoons, the amount of rainfall being received in Mauban and Tayabas (based on the number of rainy and dry months) may not be considered a major contributory factor to erosion. While Tayabas has more rainy months, its topography is not prone to erosion. On the other hand, while Mauban has a more sloping topography, it has lesser rain months presupposing less rainfall received in the area.

Table 4. Occurrence of soil erosion or environmental degradation according to PCA-CDOs, Quezon, 2008.

Municipality	Presence of Soil Erosion or Environmental Degradation	Type of Soil Erosion[a]	Date of Occurrence	No. of Farms Affected	No. of Barangays Affected
Burdeos/ Patnanungan	Yes	Gully erosion	June 2008	10	No knowledge
Candelaria	Yes	Rill erosion	During heavy downpours	No answer	Most of the *barangays*
Dolores	No	None	NA[b]	NA	NA
General Nakar/Jomalig	Yes	Landslide	2004	150	19
Infanta	Yes	Landslide	2004	No knowledge	No knowledge
Mauban	Yes	Landslide	1995	Minimal	4
Pagbilao	Yes	Rill erosion	Farms/ *barangays* not that affected	Farms/ *barangays* not that affected	Farms/ *barangays* not that affected
Panukulan/ Polillo	Yes	Rill erosion	2004	5	2
San Antonio	No	None	NA	NA	NA
Sariaya	Yes	Rill erosion and Landslide	Aug – Dec	No knowledge	5
Tayabas	No	None	NA	NA	NA
Tiaong	No	NA	NA	NA	NA

[a] Rill erosion refers to soil removal to form small but well-defined channels caused by surface run-off. Channels can be smoothed by normal tillage operations. Gully erosion is when surface channels have been eroded to the point that they cannot be smoothed over by normal tillage operations.

[b] NA means not applicable

The soil type in the sites could be considered not of the erodible type. The light to medium soil texture, sandy loam to sandy clay for Mauban and clayey to loamy for Tayabas have greater infiltration capacity which could reduce erosive surface runoff. However, a farmer in Mauban mentioned that the swaying of tall and old trees during typhoons accompanied by strong winds could trigger erosion. As the trees sway, the soil could loosen. The farmers were emphatic though that cutting of coconut trees without replanting is a major factor that could contribute to soil erosion. Given these considerations, the presence of coconuts (and other intercrops) with proper farming systems management, even under predisposing factors such as slope and other soil factors, can reduce the threat of soil erosion in the study sites.

Perceptions of the Different Stakeholders

On the Coconut Cutting and Replanting Guidelines

According to the LGU, the primary reason for the moratorium in issuing cutting permit is economic; the environmental concern is only secondary. Continuous cutting and inadequate replanting could lead to unsustainable supply of raw materials for the major coco-based industrial users such as oil mills and desiccated coconut processing plants in the province.

The PCA Regional Manager agrees that protection of the environment is secondary to the economic reason for the moratorium. This is so even when the CDOs believe that heavy cutting of coconut trees in at least two municipalities contributes to soil erosion (Table 5). While severe soil erosion in most coconut farms is not yet observed, the CDOs generally agree that further massive cutting of coconut trees particularly in sloping areas could be detrimental to the environment. Thus more than half of the CDOs stated that cutting should be stopped in sloping areas and there should be crop diversification using forest species and perennial crops.

Table 5. Causes of soil erosion and recommendations of the PCA-CDOs on its prevention, Quezon, 2008.

Item	Number Reporting[c]	Percent
Causes of soil erosion		
Heavy cutting of forest trees	6	50
Heavy cutting of coconut trees	2	17
Heavy rainfall	6	50
Intensive cultivation of coconut farms	1	8
Stone quarrying	1	8
Will continuous cutting of coconut trees result in soil erosion or other environmental problems?		
Yes, for the following reasons	9	75
Denudation of the area will occur	1	8
More surface run-off will occur due to absence of canopy and roots that will hold water	1	8
Trees planted in sloping areas have water holding capacity; if these are cut, flooding will occur	2	17
Heavy cutting results to landslide	1	8
Will not happen because there is always replanting of coconut trees	5	42
No response	2	17
Recommendations for the coconut farms in the sloping areas to avoid any possible environmental problem in the *barangays*		
No more cutting in sloping areas	7	58
Crop diversification		
Annuals		
Perennials[a]	5	42
Forest species[b]	10	83

[a] Perennials recommended include citrus, *lanzones, rambutan*, mangosteen, and *santo*l
[b] *Mahogany, narra, apitong, yakal, batino, antipolo, kamagong, mulawin, malapapaya* and other forest species
[c] Multiple responses

The CDOs are split about the effectiveness of the moratorium in controlling the cutting of coconut trees (Table 6). Indirectly, they agree that illegal cutting continues even with the moratorium and this manifests in the continuing sale of significant amounts of coco lumber in hardwares and retail outlets. Others explicitly stated that the moratorium is not effective in controlling illegal cutting of coconut trees. Instead they suggest that the moratorium be lifted but RA 8048 should be more effectively implemented. Since the CDOs cannot adequately monitor all the coconut areas assigned to them, the *barangay* officials should be stricter and ensure that illegal and indiscriminate cutting does not occur in their respective areas. If the moratorium will continue, they suggest that the same should apply in the trading operations for coco lumber. The argument is that controls, if to be used, should be imposed at all levels in the market chain of coco lumber.

Table 6. Responses of PCA-CDOs on the implementation of RA 8048 and moratorium, Quezon, 2008

Item	Number Reporting	Percent
Is the moratorium effective in preventing the cutting of coconut trees?		
Yes	6	50
No	6	50
Recommendations if moratorium is not effective		
Lift the moratorium and implement RA 8048 effectively with full force	2	33
Impose moratorium also on the buying/trading of coco lumber	1	17
Lift moratorium and do selective cutting of coconut trees only	1	17
Barangay officials in the area should not allow cutting	1	17
No response	1	17

Overall, there are more CDOs who believe that RA 8048 is already adequate for the preservation and development of the coconut farms in Quezon if it is effectively implemented (Table 7). In particular, the provision of issuing permits if the trees are already unproductive and/or diseased coupled with assurance of complete replanting is sound. Viable coconut-based farming and agroforestry systems should be promoted. To some, moratorium should be selective and implemented only in areas where rampant illegal cutting is uncontrolled. About one-third of the CDOs however believe that the moratorium should continue indefinitely coupled with effective replanting program. This is especially true in areas where it is considered necessary to control illegal cutting.

Table 7. Opinion of PCA-CDOs on the preservation and development of coconut farms, Quezon,

Item	Number Reporting [d]	Percent
Effectively implement RA 8048 and lift moratorium[a]	9	75
Continue moratorium indefinitely coupled with effective replanting program	4	33
Selective moratorium[b]	6	50
Promote viable coconut-based farming and agroforestry systems coupled with effective implementation of RA 8048 only[c]	6	50
Correct implementation of all the programs of the government	1	8

[a] Allow cutting unproductive/damaged/diseased trees and ensure complete replanting
[b] Only in provinces where there is rampant illegal cutting of coconut trees
[c] No moratorium
[d] Multiple responses

Farmers' Awareness and Suggestions

Not all coconut farmers who served as key informants are aware of the coconut cutting regulatory policy (Table 8). Only one farmer categorically said that the policy is effectively implemented. When asked about their knowledge regarding the form of violation against the policy, majority stated cutting without permit. This implies that farmers are aware of illegal cutting happening in their *barangays*. During informal discussions, they indicated that *barangay* officials allow them to cut their trees without a PCA permit. Although they are aware that violators are penalized through confiscation of illegally cut trees and power saws and payment of fines, two of them stated that cases filed are usually dismissed with no one eventually being convicted.

Except for two farmers who believe that total log ban (including forest species) should be implemented, the general perception is that the cutting regulatory policy is favorable but there is a need for proper implementation particularly the provision on replanting (Table 9). They believe that as long as only unproductive, diseased and damaged trees are cut and these are adequately replaced through new plantings, the coconut resource base will be sustainable. The PCA should coordinate closely with the *barangay* officials and violators should be penalized.

Table 8. Farmers' awareness of the Cutting Regulatory Policy, Quezon, 2008.

Item	Number Reporting	Percent
Aware of Republic Act 8048		
Yes	9	60
No	6	40
Source of Information		
Seminars by PCA/DA/LGU	6	40
Other farmers	3	20
Knowledge on RA 8048[a]		
Coconut rehabilitation	1	7
No permit no cutting	5	33
Penalty if cutting without permit	2	13
No cutting of trees below 60 yrs old	2	13
Policy is/was effective		
Yes	1	7
No	4	27
No response	7	47
Form of violations known		
Cutting without permit	13	87
Awareness on penalized violators [a]		
Confiscation of illegally cut trees	4	27
Confiscation of power saw	1	7
Payment of fine	1	7
Cased were filed but dismissed/no one was convicted	2	13

[a] Multiple responses

On the moratorium of issuing cutting permits, majority believe that it is being effectively implemented. Others think it is not effective since illegal cutting continues and thus should be lifted. Most farmers however understand that the moratorium was imposed due to rampant illegal cutting which could eventually lead to income loss among farmers. Some farmers even realize now that they

should not have cut their coconut trees since at the time of the field visits, coconut prices are favorable. They said that if they have more harvests (that is, if no cutting was done and more replanting was undertaken in the past), then their income would be much higher.

Table 9. Perceptions of farmers and suggestions on the Cutting Regulatory Policy, Quezon, 2008

Item	Number Reporting	Percent
On Coconut Preservation Act of 1995 (RA 8048)[a]		
The policy is good	3	20
Proper implementation of the policy	4	27
Coordination with the *barangay* LGU	2	13
Violators should be penalized	3	20
Total log ban	2	13
Strict implementation of coconut replanting	3	20
Creation of other livelihood programs	1	7
On moratorium of issuing cutting permits (MC 02)		
Moratorium is effective	8	53
Moratorium is not effective	2	13
Moratorium should be lifted	1	7
Reasons for the moratorium		
Illegal cutting was very rampant	2	13
Loss of income if coconut trees will be cut	7	47

[a] Multiple responses

The main reasons reported by those who have cut their trees in the past (before the moratorium) are those stated in the law since these are the conditions under which they were issued permits by the PCA (Table 10). A key motivation for not cutting the coconut trees is the good income coconut farming could provide to farmers. None mentioned about the environmental aspect of cutting the coconut trees until it was brought up by the research team during the FGDs. This is because none of the farmers present has experienced serious soil erosion in his coconut farm. In Tayabas where lands are mostly flat, farmers do not consider soil erosion as an environmental threat. Even in Mauban where most coconut farms are in the sloping areas, they appear silent about the soil erosion problem. Although they admitted having experienced flooding and landslides some time in the past, this was not attributed to soil erosion resulting from cutting of coconut trees. Rather, they claimed that this was due to unusually heavy downpour brought about by the typhoons in 2006.

Table 10. Farmers' Reasons for Cutting/Not cutting their coconut trees, Quezon, 2008.

Item	Number Reporting [a]	Percent
Reason for cutting		
Old and unproductive	5	42
Damaged by typhoon/lightning	4	33
Coco lumber is a good source of income	1	8
Ordered by the landowner	2	17
Land conversion	1	8
Reason for not cutting		
Good coconut production/high yields	2	17
Coconut is a good and stable source of income	2	17
Favorable price of copra especially at present	2	17

[a] Multiple responses

A revealing observation made during the FGDs that supports the cutting of unproductive old trees is the fact that these tall and slender trees if left uncut could actually trigger soil erosion when they are swayed and eventually uprooted by strong winds and typhoons. This is likely to occur in upland areas and especially when there is no crop cover or intercrops that could protect the soil from the heavy torrential rains and strong winds associated with destructive typhoons. In fact, if the old trees are cut with a portion of the base left intact, these could still hold the soil even while waiting for the full protection to be provided by the growing replanted coconut trees. Maintaining the old unproductive coconut trees is also not economically beneficial due to the high cost and difficulty of harvesting the few nuts of tall trees and then transporting them to the market.

CONCLUSION AND RECOMMENDATIONS

The current coconut cutting regulatory policy does not consider the topography of the coconut farm and possible environmental impact of large scale cutting in steep slopes and mountainous areas in evaluating permit applications. As it is, policy implementation is ineffective as evidenced by the continuing indiscriminate cutting of coconut trees both in flat and sloping farms. Although severe soil erosion is not apparent and widespread at the moment in the study sites, there are already erosion incidents in certain areas. However, it appears that the possible adverse environmental impact is not well understood and not yet felt at least in the case farms even as the financial benefits of cutting coconut trees is appreciated by farmers. Nevertheless, the community development officers and even some farmers agree that the environmental threat could be real if uncontrolled cutting without replanting and unsustainable farm management practices in the uplands persists. In view of this, a prudent course of action is to enhance public awareness on the social benefits and costs of indiscriminate cutting of coconut trees vis-à-vis sustainable production and agroforestry systems in the upland coconut farms. From the policy point of view, the measures described below may be considered. Innovative ways of ensuring more effective implementation of policy should be a major consideration for PCA.

(1) Environmental clearance from the environment regulatory agency in sloping and critical areas as part of the permit issuance process. This requires effective coordination of PCA with the DENR as well as improvement of data base on coconut areas to reflect slope gradient, soil type and rainfall patterns and intensity for determining erosion threats of cutting.

(2) Concentrating coconut replanting in flatlands and less critical slopes since coconut cover alone in steep slopes may no be able to provide sufficient soil stability during heavy rains. Some scientists and farmers argue that during typhoons and strong winds, the tall coconut trees in the uplands are even more prone to swaying and uprooting and thus could trigger soil erosion.

(3) Planting of denuded coconut plantations in critical areas with appropriate forest species. Similarly, this necessitates coordination with the DENR and technical assistance and financial support to farmers to enable them to undertake investments in forest plantation and agroforestry development.

(4) Capacity-building through farmers' training on ecological awareness and demonstration of appropriate farming systems and other production possibilities that address both economic and environmental concerns. This should form part of a more revitalized extension program to be undertaken by PCA in coordination with the LGUs and farmers' groups.

ACKNOWLEDGEMENT

We wish to acknowledge the financial support provided by the Economy and Environment Program for Southeast Asia (EEPSEA) for our research entitled "Economic and Environmental Concerns in Philippine Upland Coconut Farms: An Analysis of Policy, Farming Systems and Socioeconomic Issues".

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THE IMPACTS OF EXPORT TAX POLICY ON THE INDONESIAN CRUDE PALM OIL INDUSTRY

Joseph Obado[1], Yusman Syaukat[2] and Hermanto Siregar[3]

[1] Postgraduate Student, Bogor Agricultural University (IPB), Email: nyakwarchoda@yahoo.com
[2] Associate Professor, Department of Resource and Environmental Economics, IPB, Kampus IPB Darmaga, Bogor, Indonesia 16680. E-mail: ysyaukat2@yahoo.com
[3] Professor of Economics, Department of Economics, IPB. E-mail: hermanto@mma.ipb.ac.id

(Received: August 11, 2009; Accepted: November 16, 2009)

ABSTRACT

The impacts of the crude palm oil (CPO) export tax policy on the Indonesian CPO industry was assessed the 2SLS method which is an econometric model. The export tax was found to be negatively related to mature area of oil palm plantation, production, export, and domestic price of CPO and positively related to CPO consumption and stock. The export tax policy benefitted the domestic consumers of CPO. Clearly, the export tax policy reduces competitiveness of the Indonesian palm oil industry since it hurts producers of CPO. It is recommended that the export tax formulation with well considered and sound justifications is needed and from the study, 11.13 percent export tax on Indonesian CPO was recommended.

Key words: Competitiveness; effects of tax to local CPO producers, domestic consumers, consumers in importing countries; cooking oil price

INTRODUCTION

Agricultural products have a very important role to perform in the development of the Indonesian national economy. These commodities, and specifically crude palm oil (CPO), have contributed immensely to the gross domestic product (GDP) of Indonesia, led to growth in production and areal development, created various forms of employment for more than 3.5 million people in this sub-sector, increased international and national trade and improved the living standards as well as the financial status of the local people (Siregar and Sinaga, 2006). Indonesia is one of the highest CPO producers in the world. This can be attributed to the country's favorable climatic conditions, the large area of production potential, its investment in research and technology, as well as the availability of trained manpower that have necessary skills to bring about improvements in CPO production. Such improvements have uplifted the quality of Indonesian CPO to meet the specifications of the international market for crude palm oil (Siregar and Sinaga, 2006). The development of CPO needs to focus on the prospects and other means that would make it meet the basic customer requirements for the commodity for use in the food industry, industrial applications, and as an alternative source of energy.

The crude palm oil industry in Indonesia has evolved from government sponsorship and market interventions to a private sector initiative in response to international price signals and continuous market growth. Induced by the profitability in this sector, oil-palm plantations in Indonesia have expanded from 600 000 hectares in 1985 to more than 6 million hectares by early 2007, and are expected to reach 10 million hectares by 2010. At the same time, Indonesian palm-oil

production has increased from 157 000 metric tons to 16.4 million metric tons in the same period, while exports have increased from 126 000 metric tons to 12 million metric tons (Butler, 2007).

The world CPO production has grown steadily and relatively faster as compared to other oil yielding crops. During the period 2001-2005 the world CPO production grew on average 8.78 percent per year (Soeherman *et al.*, 2006). However, CPO production in Indonesia has been constantly lower than that in Malaysia. Export growth of Indonesian CPO can be attributed to three factors: world demand factor, product and market effects and competitiveness effects. The world demand factor reflects growth in exports that can be attributed to rising international demand, i.e. the stronger global import demand, the stronger the country's export growth (Susila, 2004). However, an increase in a country's share of world trade can only be explained by factors beyond world demand effects. The foreign currency contribution of CPO increases year by year (Tambunan, 2006).

The CPO industry is expected to play a greater role in the international market for oils and fats. Basiron (2002) and Pasquali (1993) projected that the growth rate of CPO production would be the fastest among edible oils. The market development of CPO will even be faster because of the success of the Uruguay Round (Susila *et al.*, 2004 and Barton, 1993). By engaging in trade, countries that specialize in producing goods in which they are relatively efficient will maximize their economic benefits. Trade therefore plays a very significant role in the economies and the developing countries like Indonesia are relatively small open-economies and therefore, rely on income earned from export to create jobs, buy imports, and maintain an overall healthy balance in external accounts (Aoki *et al.*, 1997 and Balassa, B. 1989).

Due to the importance of the crude palm oil to the Indonesian economy, and the world over, the Indonesian government decided to impose export tax on its CPO. This was intended to improve the benefits of the local CPO producers and consumers. The effect of this export tax needs to be critically studied to find out whether it has positively contributed to the Indonesian CPO sector or it has led to a deterioration of the sector. Therefore, the study wishes to find out the impact of the CPO export tax on Indonesian CPO industry and specifically on domestic price, investment, production, consumption, export, employment, added-value, cooking oil price, government revenue, producer surplus and consumer surplus.

This study sought to assess the impact of the export tax on the Indonesian CPO industry.

METHODOLOGY

Theoretical Framework

The government of Indonesia considers agriculture as a very important sector in the national economy. Agriculture provides job opportunities for majority of labor forces in Indonesia. At the same time, the government makes efforts to maintain the prices of basic needs including cooking oil to be affordable to low-income people. Therefore the price of cooking oil should remain at an affordable level. When the price of palm oil in international market went up in 1994, the price of cooking oil in domestic market experienced similar increase. In order to lower the price of cooking oil, the government applies export tax on crude palm oil and refined products. By export tax, the local price of the crude palm oil can be brought down to a considerable level which is affordable (Tambunan, 2006).

The effect of an export tax by a small country under a competitive market structure causes the price in the exporting country to fall below the world price (Reed, 2000). From the previous studies, Mohamad *et al.* (2001) found out that Indonesian palm oil's net export shares fell by 44.5 percent in October 1994 after the implementation of the export tax in September 1994. The effect of

the export tax on Indonesian palm oil reached a peak in December 1994, when it reduced net export shares by 64.4 percent.

The most devastating impact of the policy had been on the export and farm income. The tax policy when enacted results in the reduction in export and income resulting in substantial loss for farmers. On the other hand, this policy had been proven to be effective in controlling domestic cooking oil price. With this policy, the government had been successful to keep the cooking oil price down when the world CPO price increased or when rupiah was substantially depreciated. Moreover, from the government point of view, significant tax revenue is also considered to be a positive result of the policy (Susila, 2004).

Under the export tax policy, producers in the exporting country will lose because they receive lower prices and exports decline. Consumers in the exporting country gain through lower prices and the government generates revenue (Simeh, 2004). The effect of an export tax is different in the case of a large exporting country (i.e., when a country faces a downward sloping residual demand curve). Having market power on the world market, the export tax causes a reduction in domestic production; thus, exports decline and the world price increases. In this case, consumers, producers and the government in the exporting country can gain from this policy. The effect of an export tax by a small country under a competitive market structure causes the price in the exporting country to fall below the world price (Reed, 2000).

When Bartholomew (1997) analyzed the effect of an export tax for palm oil on the distribution of income in Indonesia using a static model, he found that an export tax reduced the price of palm oil products, ceteris paribus, thus, benefiting consumers. In addition, he found that the tax lowered profits earned by palm oil producers, and that processors lost slightly as well. The government gained revenue from the export tax, but lost more revenue in the government's role as owners of palm estates. Thus, the net result was that the government lost with an export tax on palm oil. This research extends their work by using a dynamic, time series model that assesses the short and long term consequences of the Indonesian palm oil export tax on competitiveness.

Clearly, the export tax policy reduces not only competitiveness of the Indonesian palm oil industry but also hurts producers of CPO, some of them are small-holder farmers, due to the lower price of CPO relative to the world market price. On the other hand, refiners that process CPO into various products such as cooking oil, margarine, shortening gain from this policy since they get CPO at lower prices (Mohamad *et al.*, 2001). The export tax policy also hinders the development of the cooking oil industry in Indonesia as a whole and does not encourage diversification in cooking oils. The imposition of an export tax diverts CPO from the export market to the domestic market, lowering all cooking oil prices. This causes more competition with the domestic coconut oil industry, which otherwise would provide the supply more of the raw material for domestic cooking oil (Soeherman, *et al.,* 2006).

Empirical Model of Indonesian Crude Palm Oil Industry

Simulation approaches on the econometric model of the industry was used to assess the impacts of CPO-export tax on various aspects of the Indonesian CPO industry. The use of a simultaneous equation system approach was expected to yield better estimates because this approach is considered more appropriate in dealing with a system of commodity market in which some variables are simultaneously related or interdependent (Koutsoyiannis, 1977). A simplified theoretical model illustrated in Figure 1 shows the hypothetical relationships between variables in the model.

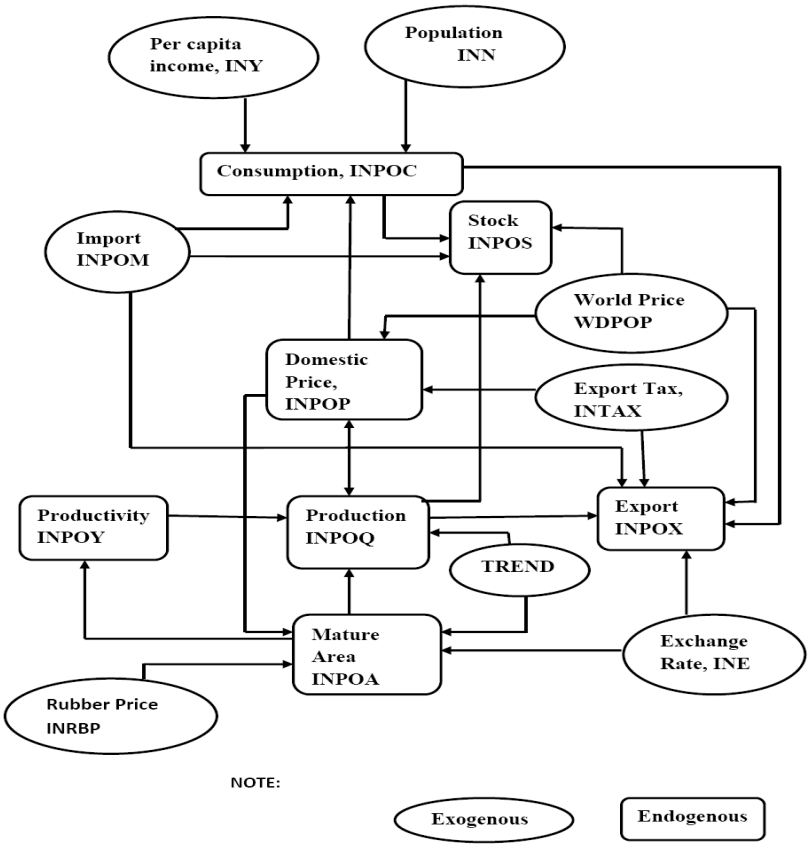

Fig. 1. General empirical model of Indonesian crude palm oil.

Indonesia equation-block consisted of seven equations as follows:

Identity equations

$INPOQ_t = INPOY_t * INPOA_t$

$INPOS_t = INPOQ_t - INPOC_t + INPOS_{t-1} + INPOM_t - INPOX_t$

Structural equations

$INPOA_t = a_0+a_1(INPOP/INRBP)_t + a_2TREND + U_1$ ……. (1)

Hypothesis: a_0, $a_1>0$; $a_2<0$

$INPOY_t = b_0 + b_1\ INPOA_t + b_2\ INPOY_{t-1} + U_2$ ……..... (2)

Hypothesis: b_0, $b_2>0$; $b_1<0$

$INPOC_t = c_0+c_1INPOP_t+c_2INY_t+ c_3INN+U_3$ …… (3)

Hypothesis: c_0, $c_1<0$; c_2, $c_3>0$

$INPOX_t = d_0+ d_1INPOQ_t + d_2INTAX_t + d_3WDPOP_t + d_4INE_t +$
$d_5INPOC_t+U_4$…….(4)

Hypothesis: d_0, d_2, $d_5<0$; d_1, d_3, $d_4>0$

$INPOP_t = f_0 + f_1WDPOP_t + f_2INPOS_t+ f_3INPOP_{t-1} + U_5$ …….. (5)

Hypothesis: f_0, $f_2<0$; f_1, $f_3>0$

Where: INPOA = oil palm mature area of Indonesia (1000 ha)
INPOQ = palm oil production of Indonesia (1000 t)
INPOC = palm oil consumption of Indonesia (1000 t)
INPOX = palm oil export of Indonesia (1000 t)
INPOS = palm oil stock of Indonesia (1000 t)
INPOP = domestic price of palm oil (Rp/kg)
INPOM = palm oil import of Indonesia (1000 t)
INPOY = palm oil yield of Indonesia (Ton/ha)
RPORBP = $INPOP_t$ /$INRBP_t$
= Price ratio of palm oil and rubber
WDPOP = world palm oil price (USD/t)
INTAX = CPO export tax (%)
ING = Indonesia gross domestic product (USD million)
INI = Indonesian lending interest rate (% per annum)
INN = Indonesian population (million)
INE = Indonesian exchange rate on average market rate (rupiah/USD)
INY = Indonesian income per capita (USD/capita)
INRBP = domestic rubber price (Rp/kg)

Model Identification, Estimation and Simulation

Model identification to be used in this study was found to be of order condition. With endogenous variables (equations), pre-determined variables, and explanatory variables in each equation and using order condition, the model qualified as definitely over-identified. The model was identified based on its order condition as follows: $(K-M) \geq (G-1)$
Where:
K = total variables in the model (endogen and exogen variables)
M= total endogen and exogen variables in the a given equation
G= Total equations that exist in the model excluding identity equations

If (K-M) is greater than (G-1), the problem is over-identified; if (K-M) is equal to (G-1), then it is exactly identified; while if (K-M) is less than (G-1), then the condition is unidentified. Based on the above definitions, the equations on the Indonesian block can be identified as follows.

Table 1. Model identification

No.	Equation	K	K-M	G-1	Condition
1	Mature area	15	12	6	Over identified
2	Productivity	15	13	6	Over identified
3	Crude Palm Oil consumption	15	12	6	Over identified
4	Crude Palm Oil export	15	10	6	Over identified
5	Crude Palm Oil Production	15	13	6	Over identified
6	Domestic price of palm oil	15	12	6	Over identified
7	Crude Palm Oil Stock	15	10	6	Over identified

Given that the model was over identified, the 2SLS method of estimation was applied. Koutsoyiannis (1977) stated that under the circumstance of the existence of model misspecification, missing of relevant variables, multicolinearity and autocorrelation error, 2SLS tends to yield more robust estimates. Moreover, 2SLS method is arguably the simplest method among methods suited to

over-identified model. Based on previous export tax rates, four scenarios associated with the tax rates were analyzed in this study, namely:

1. Scenario I was used as the basic scenario that is a scenario in which the values of the parameters were estimated and predicted means used as the true values for the model.
2. Scenarios II, III, and IV were further used to predict the impacts of export tax on various aspects of Indonesian CPO industry using time horizon of the year after 2007. Arbitrary values of export tax were used in scenario II, III and IV based on an assumption that the export tax rate in that time horizon increased with time. Scenario III was taken as 7.5 percent scenario IV as 15 percent and scenario V as 20 percent. These values were converted into effective export tax that makes the export tax to be based on the profit got not on the price of CPO.

Model Validation

Model validation was undertaken by using the standard t-tests, F-tests, and R^2 procedures where applicable in this analysis. Mean Squared Error (MSE) and Theil's inequality coefficient techniques were applied to assess the overall reliability of each model. MSE depends upon the units in which the variable is expressed. The magnitude of the error does not give any indication of how large the error is, therefore, this error can be assessed only by comparing it with the average size of the variable in question. However, the main advantage of MSE is that it can be decomposed into various components, which show the deviation between the simulated and actual values. Theil's method of decomposition was applied

Data Sources and Descriptions

In general, two groups of data were used in this study, namely, palm oil and macro-economic related data. The data sources for CPO included Oil world, 2007, Indonesia central bureau of statistics (BPS) 2007 and palm oil statistics 2007. Macro-economic related data were got from Bank of Indonesia and BPS, 2007. The econometric data covered the period from 2000 to the first quarter of 2007 hence the analysis was on the quarterly basis interval.

RESULTS AND DISCUSSION

Model Estimation

From the estimation of the results using econometric model, the mean values of the variables were found as reported in Table 2 below. Palm oil mature area was estimated as 871,160 tons while production was 322.5 tons.

Table 2. Model estimation.

Variable	Observations	Actual		Predicted		
		Mean	Std	Mean	Std	Label
INPOA	20	868.95	142.8	871.16	203.21	PO Area (000 ha)
INPOY	20	3.68	0.20	3.68	0.18	PO Yield (Tons/ha)
INPOC	20	849.85	66.53	849.84	65.03	PO Consmpn (000 tons)
INPOX	20	2353	624.53	2360	724.25	PO Export (000 tons)
INPOQ	20	3217	656.26	3225	839.15	PO Prodn (000 tons)
INPOC	20	849.85	66.53	849.84	65.03	PO Consmpn (000 tons)
INPOP	20	4088	515.98	4089	487.33	Dom. Price PO (Rp/Kg)

Model Validation

After estimating all the equations, the model was solved simultaneously in a simulation program using SAS (Statistical Analysis System v6.12). Historical simulation of the model's equations was used to validate the estimated model using the components of the Mean Squared Error (MSE) and the Theil inequality coefficients. Table 3 presents the decomposition of the MSE and Theil U coefficient. The decomposition of MSE provides two sets of statistics. The first decomposition suggested by Theil gives bias (UM), variance (US), and covariance (UC) statistics. The second decomposition, as suggested by Maddala, consists of bias (UM), regression (UR), and disturbance (UD) components.

An adequate model produces projections in which UM approaches zero, i.e. the model is without consistent bias; US approaches zero, implying variability of the predicted series closely resembles the variability of the actual series; and the random deviation (UC) is a large number. In the second decomposition, the bias and regression components capture the systematic divergence of the prediction from actual values. Therefore, for a model that fits the data well, the proportion of UM and UR should approach zero. The UD component, which captures the random divergence of the prediction from the actual values, should approach one. The Theil U coefficient should approach zero when the predicted series is close to the actual series.

Table 3**.** Model validation statistics.

Variable	RME %	Bias (UM)	Reg (UR)	Dist (UD)	Var (US)	Covar UC	U
INPOA	20.4975	0.000	0.515	0.485	0.133	0.867	0.0909
INPOY	1.8588	0.000	0.000	1.000	0.032	0.968	0.0092
INPOQ	20.7416	0.000	0.395	0.605	0.094	0.906	0.0882
INPOS	16.4653	0.000	0.243	0.757	0.001	0.999	0.0868
INPOC	1.6342	0.000	0.000	1.000	0.011	0.989	0.0081
INPOX	28.5781	0.000	0.302	0.697	0.032	0.967	0.1103
INPOP	3.5065	0.000	0.003	0.997	0.038	0.962	0.0174

The MSE and its decomposition reported in Table 3 show that the majority of the UM values are close to zero. This suggests that those simulated values are close to their actual values. Consequently, disturbance terms are low, which implies that errors of these simulated variables are not captured by the randomness contained in the actual data series. Contrary to UM and UD, some of the UR values are close to zero. In the second decomposition, US component performs well; however, UC values in some instances are fairly low. Compared to the decomposition of MSE statistic, almost all the Theil's U-Statistic are close to zero for the endogenous variables for the model. This suggests that overall the simulation model has reasonably good forecasting ability.

Evaluation of the Impacts of Crude Palm Oil Export Tax

From the study, it has been realized that the export tax policy has had significant impact on the CPO industry in Indonesia. For the period under study, 2002-2007, while the export tax fluctuated from 3 percent in the year 2002 to 1.5 percent in 2004, and then 6.5 percent in 2007, the average effective tax of the entire period stood at 2.31 percent for the entire period. For the time horizon of beyond 2007, the impacts of three export tax rates of 7.5, 15, and 20 percent were simulated. In this case, the export tax is not charged on the price but on the difference between the current world price

of CPO and the minimum price taxed locally in Indonesia so as to take into account the welfare of both consumers and producers.

The impact of these tax rates are summarized in Table 4. With export tax of 7.5 percent, the mature area will reduce by 0.521 percent. An increase in export tax has a negative impact on the mature area of oil palm in Indonesia. When the government increases export tax to 15 percent, there was a dramatic reduction in area under palm oil cultivation. The mature area reduced by 1.043 percent, indicating that 9 086 ha of land lost. This was low as compared to that of 20 percent increase in effective export tax that resulted in 1.38 percent reduction, and this implies that the imposition of the export tax has significantly depressed the development of oil palm plantation in Indonesia.

In addition to its negative impact on mature area, the export tax has also depressed production. The impact of export tax was evident on the quantity of CPO produced in Indonesia. With 7.5 percent export tax implemented, production reduced by 0.124 percent or 16 000 tons per year. In case the tax is increased to 20 percent by the government, the Indonesian CPO production reduced by 0.341 percent translating to 44 000 ton reduction in production level in a year.

The negative impact of this policy is more substantial in terms of export volume. If the government imposes more export tax on CPO, the export volume of CPO reduces significantly. From the simulation analysis, if the government imposes 7.5 percent export tax on CPO, export volume decreases by 3.263 percent that can be reported as 77 000 tons reduction in export, 15 percent export tax reduces the quantity by 6.271 percent or 148 000 tons reduction while 20 percent export tax would lead to 8.22 percent hence resulting in 194 000 tons less export to other countries by Indonesian CPO producers.

On the other hand, this export tax policy has provided substantial benefit to consumers. Table 4 shows that the implementation of this policy has caused domestic CPO price and by extension cooking oil price to be lower than they should be. For example, if the government imposes an export tax of 7.5 percent, then the domestic price of CPO will be about Rp 112/kg or 2.739 percent lower compared to that without export tax. A further increase in export tax on CPO would be beneficial to domestic consumers.

Table 4. Projection of impacts of export tax on crude palm oil industry.

	Estimate	**Predicted values (percent)**		
		7.5	**15**	**20**
Mature area (000 ha)	871.16	-0.52	-1.04	-1.38
CPO consumption (000 tons)	849.84	0.03	0.07	0.09
CPO Export (000 tons)	2360.00	-3.26	-6.27	-8.22
CPO Domestic price (Rp/kg)	4089.00	-2.74	-5.38	-7.04
Palm Oil Productivity (Ton/ha)	3.68	-0.02	-0.03	-0.04
CPO Stock (000 Tons)	930.79	1.19	2.38	3.17
Production (000 tons)	3225.00	-0.12	-0.28	-0.34

Clearly, the export tax policy reduces not only competitiveness of the Indonesian palm oil industry but also hurts producers of CPO (some of them small-holder farmers) due to the lower price of CPO relative to the world market price. On the other hand, refiners that process CPO into various products - such as cooking oil, margarine, shortening - gain from this policy since they get CPO at lower prices. Finally, consumers may or may not gain from this policy since there is no guarantee

that the processors will pass on the lower price of cooking oil. Considering that the concentration ratio (CR4) in this industry is large, which indicates a potential oligopolistic market structure, it is not likely that the consumers fully benefit from the lower price of cooking oil. The imposition of an export tax diverts CPO from the export market to the domestic market, lowering all cooking oil prices. This leads to competition with the domestic coconut oil industry, which otherwise would provide more of the raw material for domestic cooking oil. Considering that significant amount of copra is made from coconuts that come from small-holder farmers, the export tax policy on CPO could further lower price of coconuts and pressure farm incomes.

An Alternative Formulation of Export Tax Rate

From the analysis undertaken considering the effects of export tax government policy on Indonesian CPO industry, the results indicate that the implementation of the CPO export tax has significant advantages and disadvantages to the CPO industry. It has been realized that export tax policy has a redistribution impact to all stakeholders involved in the industry and government revenue. This policy has benefitted both consumers and the government making them better off. On the contrary, producers have become worse off, indicated by the decline in mature oil palm area, production, export, farm income and employment.

Considering the benefits and costs of the policy, the government is likely to maintain this policy in the future. This is because it would enable the government to redistribute income to the majority of the population who are consumers of CPO by products like cooking oil. The government also depends so much on the revenue earned from export through export tax policy. As this policy has substantial impacts on the industry, it needs to be reformulated in such a way that consumers are fairly protected from a sharp fluctuation of the international market, while producers still gain a normal profit or incentive to develop their plantations. Following this, the magnitude/rate of CPO tax should consider the following facts:

1. Investment in oil palm plantations is a long-term venture and therefore, price fluctuation cannot be avoided by the investors/ producers. Within a certain period of time, CPO price may well be above production cost and *vice versa*. Production cost in this case includes variable cost and capital accumulation for reinvestment or rehabilitation (sustainable development approach);

2. Using this approach, production cost (assuming that the exchange rate is Rp 9000/USD) is around USD 165.2/t or Rp 1 487/kg. therefore, the value to be taxed should be the profit between the market price and the production cost;

3. Profits/losses strongly depend on the world price (WDPOP) and exchange rate (INE). Therefore, these two factors should be explicitly considered to determine the rate of the tax. Thus, profit (P) = (WDPOP*INE - 1 487);

4. When the price of CPO is below the production cost, the producers/smallholders suffer from a loss. Using world CPO price in the last two decades, it was found that the number of times that CPO prices were below the production cost, or probability (P) to get profit is around 0.7 (P =0.7). This means that if the producers/smallholders have to transfer part of their profit to consumers and government, it is only around 0.7 of the time can that be transferred. This coefficient acts as the first weight in distributing welfare as represented by Equation 6;

5. On the basis of the secondary rights theory which states that profit gain of an industry is not merely enjoyed by the people involved in the industry, but also by people, who because of some obstacles cannot participate in the industry. In line with this argument, it is assumed

that 75 percent of the profit belongs to producers as primary right, while the rest of about 25 percent will belong to consumers as a secondary right (SR);

6. The magnitude of the tax should also consider the number of producers and consumers, as a proxy of political power/pressure group. The number of producers together with their family members is assumed to be 5 percent of the total population in Indonesia. In this study, the number of consumer (NC) and producers together with family members (NP) are 232 million and 11.6 million, respectively; and

7. The magnitude of the tax should also consider the income share of oil palm plantation to total farmers' income (IS), and share of cooking oil expenditure to total household expenditure (ES). Within this study, the former is estimated to be around 80 percent and the latter to be 4 percent (BPS, 2001).

Following all these arguments then, the formulation of an alternative export tax is as follows:

PE = Π* P * SR * (NC/NP) *(ES/IS)
= (WDPOP*INE-1 487)*0.7*0.25*(232/11.6)*(4/80)..... (6)
= (WDPOP*INE-1 487)*0.175
= (WDPOP*INE-1 487)*17.5 %.....(7)

Therefore, nominal tax is 17.5 percent

where:
PE = Export tax rate (Rp/kg)
WDPOP = Export price (USD/t)
INE = Exchange rate (Rp/USD)

Estimating effective tax for Indonesian CPO industry using the above formulated equation is as follows;
Therefore

$$EET = \frac{(WDPOP - INPQ)}{WDPOP} * Tax$$

$$EET = \frac{(454 - 165.2)}{454} * 17.5$$

= 11.13 percent

Where: WDPOP = USD 454/ton (average price for entire period studied)
INPQ = USD 165.2/ton (average cost of production)
Tax = Nominal export tax rate (percent)

Effect of Recommended Export Tax on CPO Industry

The Indonesian government should implement the CPO export nominal tax of 17.5 percent that translates to 11.13 percent effective export tax. With this export tax rate, the mature area will reduce at the rate of 1.228 percent. In other words, the mature area will reduce by about 42 300 tons per year due to tax implementation as reported in Table 5. According to the plan of the Ministry of Agriculture of Indonesia of reducing the area under palm oil so as to have a stable price, an increase in the export tax would be of importance as it will lead to voluntary reduction in production area under palm oil as it would result into reduction of export to other countries. In this scenario, with implementation of export tax policy recommended, the export volume will reduce by 7.331 percent

or about 170 000 tons for quarter year period hence increasing the quantity of CPO in Indonesian domestic market.

The domestic consumers of CPO and cooking oil will be the greatest beneficiaries in the new tax scheme. With tax implemented at 11.13 percent, the price of palm oil will reduce by 6.261 percent. This will make the consumers of palm oil in Indonesia to pay for palm oil at Rp 255.12/kg less than without an increment in tax. The cost of cooking oil will be expected to reduce as a result of the reduction in CPO price since it is the main source of raw materials for the cooking oil industry in Indonesia.

The main losers with the implementation of the proposed export tax rate will be consumers in the importing countries and the local producers of CPO. The production reduces by about 6 000 tons in that period (0.186 percent) translating to over 24 000 tons reduction per year. This effect of the export tax is great on the producers than on traders because the exporters always shift the tax bundle to the producers hence offering reduced prices for their products.

Table 5. Effect of the recommended export tax on the crude palm oil industry

Variable	Mean	Percent	Value
Mature area (000 ha)	871.16	-1.228	-10.562
CPO consumption (000 tons)	849.84	0.078	0.663
CPO Export (000 tons)	2360.00	-7.331	-169.994
CPO Domestic price (Rp/kg)	4089.00	-6.261	-255.120
Palm Oil Productivity (Ton/ha)	3.68	-0.030	-0.001
CPO Stock (000 Tons)	930.79	1.770	16.436
Production (000 tons)	3225.00	-0.186	-5.999

This export tax formulation has some sound justifications. Firstly, the tax will be effective if the producers gain profit, at least enough to rehabilitate their plantation. This represents sustainable development argument. Secondly, the benefits gained due to price increase or currency depreciation are distributed among producers, consumers and the government after considering secondary rights (equity argument), the number of producers and consumers that could be a proxy of political power or pressure group (political argument) and the importance of CPO in the producer and consumer perspective (economic or welfare argument).

CONCLUSIONS AND RECOMMENDATIONS

The study found out that the export tax policy has significant impact on the CPO industry in Indonesia. The export tax led to the reduction of the mature area of oil palm plantation. It can also be concluded that the export tax policy benefitted the domestic consumers of both CPO and cooking oil as it was effective in controlling domestic cooking oil price as it reduced the domestic prices of these products. With this export tax policy, the government can successful to keep the cooking oil price down when the world CPO price increased or when rupiah was substantially depreciated.

The impact of export tax led to depression of production resulting to reduced quantity produced. Producers, mainly smallholders, have suffered a great deal due to the policy. As the domestic price of CPO is depressed by this policy, the farm gate price of the farmers' product (fresh fruit bunch or FFB), declines substantially.

The following recommendations should be considered to improve the competitiveness of Indonesian CPO in the world market.

1. There should be an increase in investment in research and development in the palm oil sector. This would result in improved human resources technology that would result in improved production by the farmers hence would result in high productivity.

2. The government policy on imports should promote investment in the agricultural sector by guaranteeing security, permit ownership of plantations by individuals, reducing import cost on farm machines and implements used in palm oil industry, provide incentives on imports of agricultural machines.

3. The Indonesian government in conjunction with investors in the CPO sector must invest in infrastructure to make them competitive. This investment should be in the fields of transport network, production firms and marketing systems. There should be the provision of credit to the palm oil producers. The banking system can enable the palm oil investors to access loans that would increase their production and the pay back at an appropriate interest rate after an appropriate time.

4. The export tax formulation with well considered and much sounder justifications is needed so that benefits gained from price increases or currency depreciation are distributed among producers, consumers and the government after considering secondary rights (equity argument). The results of this study show that the effective export tax rate should be around 11.13 percent.

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J. ISSAAS Vol. 15, No. 2:120 -135 (2009)

FACTORS AFFECTING THE CHOICE OF CONTRACT ARRANGEMENTS IN SWINE PRODUCTION IN HUNG YEN PROVINCE, VIETNAM

Do Truong Lam[1] and Corazon T. Aragon[2]

[1]Department of Quantitative Analysis, Faculty of Economics and Rural Development, Hanoi University of Agriculture
[2]Professor, Department of Agricultural Economics, College of Economics and Management, University of the Philippines Los Banos

(Received: October 1, 2009; Accepted: November 25, 2009)

ABSTRACT

This paper determined the factors that influenced the swine farmers' decision to enter into a contract arrangement with buyers and/or input suppliers using multinomial logit analysis in Hung Yen Province, Vietnam. The study employed the multi-stage sampling method in the selection of the sample districts and communes. Primary data were gathered from 200 sample swine farmers using a pre-tested interview schedule.

The results revealed that the significant factors that affected the farmers' decision to enter into contract arrangements in swine production were the farmer's age and educational attainment, the proportion of time spent in swine raising, the number of swine head raised, the distance of the farm to the Vietnam Bank for Agriculture and Rural Development, the distance of the farm to commercial input suppliers, and the distance of the farm to veterinary shops. Policy recommendations that will encourage smallholder participation in contract farming include provision of credit assistance to independent smallholders, conduct of training courses on improved swine production practices, and assistance in the preparation of production-marketing contracts that will benefit the swine farmers.

Key words: Multinomial logit analysis

INTRODUCTION

The demand for and the production of livestock products in Vietnam have been increasing rapidly over the past 15 years and are expected to continue growing with the rise in income due to Vietnam's strong economic performance, increasing human population, and the trend towards urbanization in the country. The most significant source of growth comes from pork or swine meat. In 2005, pork accounted for about 80 percent of total meat production in Vietnam compared to only 13 percent for poultry meat (Huong, 2006). Beef, buffalo meat, and goat meat accounted for the remaining seven percent.

Contract farming is a relatively new development in Vietnam's swine sector. The concept of contract farming is strongly supported by the Vietnam government. This is evident through Law No. 80/2002/TTg on contract farming which promotes cooperation between the state, the farmers, researchers, and enterprises in facilitating signed contracts between enterprises and farmers. The government has also extended its assistance to smallholders by organizing them to form cooperatives for the purpose of encouraging them to engage in contract farming.

In recent years, both formal and informal forms of contract arrangements in swine production have emerged in Vietnam. Formal contract arrangement is employed between swine farmers and

integrators. In formal contracts, there is a written proof or document of the arrangement between the swine farmers and integrators. On the other hand, informal contractual arrangements exist between the swine farmers and cooperatives, and between the swine farmers and input suppliers. Informal contracts are merely verbal, informal, and unwritten arrangements between the swine raisers and the cooperatives or input suppliers.

An example of a formal contract arrangement is between the CP-Vietnam Company and Jappa Comfeed of Indonesia and swine raisers in Hung Yen province. These companies have a breeding component to control the genetic quality of stock, a feed milling/mixing section to control the quality of livestock nutrition, and a veterinary and animal health program to control the incidence of diseases. The swine farms with supervision from integrators choose the optimal timing of their output sale and receive updated information on daily market prices for live hogs. The integrator is the provider of inputs and at the same time the buyer of outputs. There is a slight variation to this formal contract arrangement wherein some contract growers, usually referred to as satellite farms of the integrators, are also contracting some small-scale swine producers within their neighborhood to produce the same output that they are contracted to deliver to the integrator.

The cooperative is also sometimes linked to either an integrator for the supply of feeds and stocks (weanlings for fattening and/or female growers for breeding sows), or various input suppliers (feeds and stock). Upon establishing links with an integrator, the cooperative serves as the contract grower for the integrator while the cooperative members undertake the contract growing activities for the cooperative. In this case, the relationship between the cooperative and the farmer-members is similar to that between the integrator and the swine farmers since the cooperative takes the role of the contractor and the farmer-members take the role of the contract grower. Hence, swine farmers who would usually not qualify to be swine contract growers under a formal contract arrangement are given the opportunity to be able to serve as contract growers in this informal type of contract arrangement with a cooperative and without obligating them to invest substantial amounts of money for the construction of swine pens and the purchase of feeding equipment.

In some cases, the linkage between a cooperative and the integrator is mainly for the provision of a regular feed and/or stock supply to the cooperative. The cooperative members raise swine without an agreement with the integrator to purchase their live hogs. In other cases, the cooperative is linked to several suppliers of inputs (e.g., feeds and stocks). A feed manufacturer would provide the feed supply and stocks obtained from numerous public (e.g., state breeding farms) and private sources (e.g., integrators, collectors, and farmers in the neighborhood). Farmer-members can either sell their swine to the cooperative or directly to their preferred market outlet such as collectors/traders, slaughterhouses, or other farmers in their locality.

In an informal contract arrangement between the swine farmers and a cooperative, the latter also acts as the guarantor of the quality of swine raised by its farmer members owing to its own interest to be known as a source of good quality swine in order to establish its credibility and increase its market share. To ensure the production of good quality swine produced by its farmer-members, the cooperative provides technical support services to its members to improve their technical skills in swine raising, ensures that the inputs used by the members are of good quality and provides access to veterinary services to control diseases and reduce mortality. The cooperative makes sure that its members use good quality inputs by urging them to buy only from reputable sources of feeds and animal stocks. Also, access to veterinary services provided by cooperative can be either in-house or contracted to outside providers. Farmer-members are also assisted in looking for buyers especially if the cooperative has a supply contract with output buyers such as slaughterhouses, processing firms, and wholesalers. Farmers are then assured of a regular market for their swine and incur minimum transaction costs. The cooperative also assists its members in negotiating with prospective buyers for

a higher price for their swine product in case the farmer-members would like to tap other market outlets.

Another informal contract is between the swine producer and an input supplier, usually a feed distributor. The feed distributor is linked to an integrator to supply feeds to farmers. The main motivation for the feed distributor's linkage with a regular clientele of swine farmers is to have an assured market for the feeds that it sells. In order to attract farmer-customers, the feed distributor sells the feeds on credit basis without charging an interest rate. The feed distributor can also facilitate the sale of the swine farmers' slaughter hogs or weanlings by linking them with output buyers and providing an informal form of certification on the quality of feeds used by the swine producers. The swine farmers benefit from this arrangement with the feed distributor in a number of ways such as: (1) having a regular supplier of feeds with known quality; (2) being able to buy feeds on credit basis; (3) being linked to an output buyer, and more importantly; (4) having a third party entity (the feed distributor) to certify the quality of their swine indirectly through the use of feeds with known quality (i.e., from the reputation of the feeds distributed by the feed distributor). The certification from the feed distributor on the good quality of their swine will enable the swine farmers to negotiate for a better price and easily look for prospective swine buyers thereby reducing their transaction cost in search of prospective swine buyers.

Contract arrangements are more prevalent among large and commercial swine farmers. Government policies were instituted to promote large and commercial swine production and processing operations.

This paper sought to determine the factors affecting the swine farmers' decision to enter into contract arrangements with buyers/input suppliers in Hung Yen Province, Vietnam.

METHODOLOGY

Method of Data Collection and Sampling Procedure

The study employed the multi-stage sampling method in the selection of the study areas. In the first stage, two representative districts were selected. Hung Yen Province is divided into two districts. The first district, which has a developed swine industry, includes Van Giang, Yen My, Van Lam, Tien Lu, and Khoai Chau. The second district with a slowly developing swine industry is composed of Phu Cu, My Hao, Kim Dong, An Thi, and Hung Yen City. Van Giang and Phu Cu were chosen as the sample districts.

In the second stage, two communes in each sample district were selected as the study areas. The communes selected in Van Giang were Phung Cong and Nghia Tru while in Phu Cu, the communes that were chosen were Minh Tan and Tam Da.

Using stratified random sampling technique, 50 farm household heads in each commune were chosen as sample respondents. The household heads were stratified according to the type of contract arrangement. The total sample size was 200 consisting of 69 independent swine farmers, 50 farmers with an informal contract with input suppliers, 36 farmers with an informal contract with a cooperative and 45 farmers with formal contract with an integrator.

The sample respondents were personally interviewed using a pre-tested interview schedule to gather information on the following: farm household characteristics such as age, gender, education, experience, and training received; various asset-related variables; credit access and amount of loan borrowed; inputs used in swine production by type; volume and prices of inputs and outputs; location characteristics such as distance to nearest output market and input suppliers or veterinary shops;

marketing costs incurred; and the benefits from entering into contract arrangements with input suppliers or product buyers.

Analytical Procedure

The multinomial logit analysis was used to analyze the factors affecting the choice of contract arrangements in swine production. The multinomial logit model allows multiple responses with the underlying assumption that each choice is independent of the other choices. The qualitative response and limited response models that deal with dependent variables are usually qualitative, and categorical in outcome. One example is the outcome of a decision. The farmer can decide to enter or not in a contract arrangement with buyers/input suppliers.

In case all the sample respondents selected the same type of contract arrangement, the decision of choosing the contract arrangement is discrete. Consequently, the model chosen for explaining the choice is a discrete one, so the estimation is made using econometrics of discrete regression and qualitative choice models. The model is multinomial because the qualitative dependent variable *y* has more than two values, $y_i = j$, $j = 0, 1, ..., m$, respectively. In this paper, the values of y represent the four types of contract arrangement.

Initially, the factors affecting the choice of contract arrangements in swine production were classified into four categories, namely: physical, economic, institutional, and social (Figure 1). The physical factors that were hypothesized to have an influence on the swine farmer's decision to engage in contract farming include distance between the swine farm and the Vietnam Bank for Agricultural and Rural Development (VBARD), a commercial bank, the distance between the swine farm and commercial input suppliers; and the distance between the swine farm and veterinary clinics. The greater distance between the swine farm and the source of technical services, the more likely that a swine farmer will enter into a contract arrangement with integrators. Labor productivity is reduced in distant farms despite the increase in workload caused by the additional time needed to transport inputs or output from the market to the farm and vice versa.

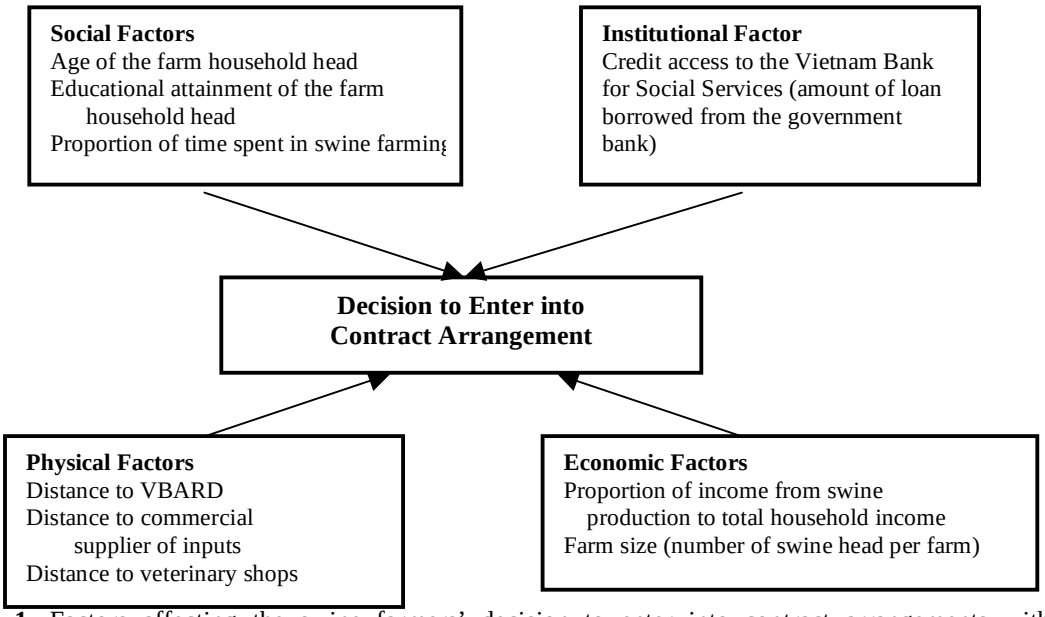

Fig. 1. Factors affecting the swine farmers' decision to enter into contract arrangements with buyers/input suppliers.

Social factors refer to the time spent in swine farming and the characteristics of the farm household head such as age and educational attainment. The institutional factor was measured in terms of the amount of loan received from the government bank (the Vietnam Bank for Social Services). The two major economic factors that may directly affect a farmer's decision to enter into contract arrangements are the proportion of income from swine farming to total farm income (i.e., as a proxy variable for swine raising as a major occupation) and farm size measured by the number of head of swine per farm. It is expected that swine farmers with a greater proportion of their farm income derived from swine raising and those who have a larger number of heads of swine per farm will have a higher probability of entering into a contract arrangement with buyers/input suppliers.

The multinomial logit model was used to measure the effects of economic and non-economic variables with regard to the farmers' decision, meaning, estimating the marginal effects and estimated elasticities of the probability of choice of the swine farmers. The preferred contract arrangement is a dichotomous variable with the following value: choice = 0,1,…m if a farmer selects a given type of contract arrangement in swine production.

The STATA 8 software program was used to estimate the empirical models of the choice of contract arrangements in swine production. Empirical models were estimated using the multinomial logit regression models. The empirical model of the multinomial logit function form is shown below:

$$Z_i = Ln\left(\frac{p_i}{1-p_i}\right) = \square_0 + \square_1.age + \square_2.education + \square_3.time + \square_4.main\_occupation + \square_5.number\_swine + \square_6.received\_loan + \square_7.distance\_1 + \square_8.distance\_2 + \square_9.distance\_3 + u_i$$

where:

p_i	= the probability of choice of farmer i. A farmer chooses the form of contract arrangement in swine production
$\square_0$	= intercept
age	= age of the swine farmer in years
education	= level of education of the swine farmer in years
time	= number of hours the farmer spent in raising swine
main_occupation	= the proportion of income from swine raising to the total farm income in percent
number_swine	= the number of head of swine raised per farm
received_loan	= the amount of loan the farmer received from the government bank in VND thousands
distance_1	= distance of the farm to the nearest VBARD in kilometers (km)
distance_2	= distance of the farm to the nearest input suppliers in km
distance_3	= distance of the farm to the nearest veterinary shop in km

$\square_i$ (i = 1 to 9) = coefficients of independent variables in the multinomial logit function

e = the base of natural logarithms and approximately equal to 2.718

u_i = error term

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Sample Swine Farmers

Table 1 presents the selected socio-economic characteristics of 200 sample swine farmers in two districts of Hung Yen Province. The sample swine farmers were classified according to the contract arrangement they engaged in, namely: (1) independent farmers, (2) farmers with informal contract with input suppliers, (3) farmers with informal contract with a cooperative, and (4) those with formal contract.

The oldest household head was 49 years old (in the independent farmer group) while the youngest was 44 years old (in the informal contract with input suppliers group). The average age of the household heads was 47 years.

Table 1. Selected socio-economic characteristics of 200 sample swine producers by type of contract farming, Hung Yen Province, Vietnam, 2008.

Socio-Economic Characteristics	Type of Contract Farming				F-value
	Independent	Informal Contract		Formal Contract	
		With Input Supplier	With Cooperative		
Mean age of the household head (years)	48.71	44.24	47.97	45.51	2.48*
Mean educational level of the household head (years)	5.45	7.90	8.06	9.71	36.53***
Mean family size (no. of family members)	4.26	4.42	4.14	4.51	0.79NS
Mean no. of farm laborers (no. of persons)	2.25	2.32	2.44	2.11	1.11NS
Ave. number of head per farm	21	37	43	152	25.08***
Ave. number of head per litter per farm	5	10	11	39	45.14***
Ave. number of litters per year	4.19	3.85	4.02	4.78	1.13NS
Ave. live weight when sold (kg)	67.94	72.12	76.14	73.6	3.21**

Note: *** , ** and * mean significant at 1%, 5% and 10% probability level, respectively.
NS means not significant at 10% probability level.
VND - Vietnam dong.

Swine farmers with formal contract had the highest mean educational attainment (approximately 10 years), followed by those with informal contracts (approximately 8 years). The independent farmers were the least educated with an average schooling of 5.45 years.

Household size and the number of family members involved in raising swine were not significantly different among the sample swine respondents belonging to different contract groups. The average sample size was four while the number of family members who participated in swine production was two.

Analysis of Variance (ANOVA) results reveal that the mean number of heads of swine raised per farm was significantly different among the farm groups at one percent probability level. Farmers belonging to the formal contract group had the largest average number of swine raised (approximately 152 heads per farmer). Swine farmers with informal contracts with cooperatives and input suppliers raised an average of 43 and 37 heads of swine per farm, respectively. In contrast, the independent farmers had the lowest average number of swine raised (about 21 heads per farmer). The small number of animals raised by independent swine producers served as a constraint to their entering into a contractual arrangement with buyers considering that the latter prefer to buy from swine producers with a large number of swine for sale.

Table 1 also shows that the average number of heads per litter per farm was significantly different at one percent probability level among the four farm groups. On the average, swine farmers with formal contract recorded the highest number of heads of swine per litter (39 heads per litter) per farm while the independent farmers had the least with only five heads of swine per litter. On a per farm basis, the average number of heads of swine per litter of the farmers who had informal contract arrangements with cooperatives and input suppliers was 10 and 11, respectively. The average number of litters per year, however, was not significantly different among the four farm groups. The swine farmer-respondents reported that their swine herd gave birth three to four times per year. The production period per cycle was three to four months. Although there was no difference in the age of the swine sold among farm groups, the live weight of the animals when sold significantly differed among farm groups at one percent level of significance. The average live weight per head of swine when sold was highest in the farm group with informal contract with a cooperative (76.14 kg) and was lowest in the independent farmer group (67.94 kg). Farmers belonging to the formal contract group recorded an average live weight of 73.60 kg per head while those under the informal contract with input suppliers group registered 72.12 kg per head of swine.

Results of Multinomial Logit Analysis

Results of the multinomial logit analysis for three general types of contract arrangements (e.g., formal contract with an integrator, informal contract with input suppliers and informal contract with a cooperative) in Hung Yen Province are presented in this section.

Informal and formal contracts relative to no contract. Table 2 shows the estimated coefficients of the multinomial logit model, where the base category is “no contract” (i.e., independent farmers).

The results from the multinomial logit model estimation indicate that the educational level of the farmer and the amount of time spent in swine farming significantly affect the farmer’s decision to enter into formal and informal contracts relative to being an independent farmer at one percent probability level. This means that farmers who have higher educational attainment have more knowledge of the benefits from contract arrangement compared with other farmers. Therefore, farmers who have higher educational attainment are more likely to engage in formal or informal contracts rather than remaining as independent farmers. On the other hand, the farmers who spend more time in swine production want to have a stable job. They usually invest a larger amount of capital in swine production. They consider swine production as their main occupation. In this case, farmers who spend more time in swine farming are more likely to engage in formal and informal contracts with feed distributors or swine traders rather than becoming independent farmers.

Table 2. Effects of selected socio-economic factors on the choice of contract arrangements in swine raising with the independent farmer category as the reference group in Hung Yen Province, Vietnam, 2008.

Variables	Type of Contract Farming		
	Informal Contract		Formal Contract
	With Input Suppliers	With Cooperative	
Intercept	-23.470***	-34.457***	-62.942***
	(-8.059)	(-8.809)	(-13.216)
Age	-0.018NS	0.044NS	0.022NS
	(-0.034)	(0.039)	(0.060)
Education	0.572***	0.620***	1.035***
	(0.189)	(0.208)	(0.273)
Time spent in swine raising	0.007**	0.006**	0.016***
	(0.003)	(0.003)	(0.005)
Swine raising as main occupation	0.005NS	0.021NS	0.020NS
	(0.026)	(0.029)	(0.042)
Number of swine head	0.319***	0.340***	0.446***
	(0.082)	(0.084)	(0.089)
Received government loans	-0.338e-4NS	-0.789e-4NS	-0.105e-3NS
	(-0.654e-4)	(-0.841e-4)	(0.104e-3)
Distance of the farm to VBARD	1.889*	1.888 NS	1.282 NS
	(1.085)	(1.223)	(1.415)
Distance of the farm to commercial input suppliers	3.135 NS	16.199**	21.871**
	(7.431)	(8.161)	(10.217)
Distance of the farm to veterinary shops	2.186 NS	2.988 NS	8.066**
	(1.811)	(2.063)	(3.190)
LR chi^2 (27)		347.55	
Probability > chi^2		0.0000	
Log likelihood		-97.8275	
Pseudo R^2		0.6398	

***, **, and * mean significant at 1%, 5%, and 10% probability level, respectively.
NS means not significant at 10% probability level. Figures in parenthesis are standard errors of estimate.

The number of swine heads per farm was a significant factor in the farmer's choice of entering into formal and informal contract arrangements relative to having no contract at all at one percent probability level. Farmers with more swine heads are more likely to engage in contract arrangement than those operating independently. This is consistent with observations from the descriptive statistics wherein farmers with informal and formal contracts generally had more swine heads compared to independent farmers or those with no contract. One possible reason for this

behavior is that farmers who are raising a large number of pigs want to reduce production and/or marketing risks by having an assured market for their animals and/or assured supply of good quality feeds through the establishment of production-marketing contract agreements with buyers and/or input suppliers/feed distributors. The age of the household head did not affect the farmer's decision of entering into informal and formal contracts relative to being an independent producer at 10 percent probability level. Both young and old farmers want to enter into informal and formal contracts instead of remaining as an independent producer.

The government, through the Vietnam Bank for Social Policies, provides a maximum loan amount of five million VND per poor household and charges the lowest interest rate compared with commercial banks which extend agricultural loans. This bank does not also require collateral from borrowers. Since the loan amounts availed of from the government-owned bank did not differ significantly among the sample swine farmers, the government loan variable was found to have an insignificant effect on the farmers' decision to enter into informal and formal contracts relative to becoming an independent producer at 10 percent probability level. Due to the limited loan amount extended by the government bank, swine farmers wanted to avail of additional loans for swine production from VBARD, a commercial bank that does not set a maximum loan ceiling, but requires the submission of collateral from loan borrowers. The distance of the swine farm to VBARD, a proxy for physical access to formal credit from a commercial bank, was also found to significantly affect the swine farmer's decision to enter into an informal contract with input suppliers at 10 percent probability level. This result suggests that farmers whose swine farms are located farther from VBARD are more likely to engage in informal contracts with input suppliers rather than remaining independent. However, this variable was not a significant factor influencing the swine farmer's decision to enter into an informal contract arrangement with a cooperative and a formal contract with buyers relative to having no contract at 10 percent probability level.

The distance of the farm to commercial input suppliers significantly affected the decisions of the farmer to enter into an informal contract with a cooperative and a formal contract relative to having no contract at 5 percent probability level. Specifically, this finding suggests that swine farmers whose farms are located farther from commercial input suppliers are more likely to enter into informal contracts with cooperatives and formal contracts as well rather than being an independent farmer. Having a contract arrangement with a cooperative or an integrator would be more beneficial to those residing far from input suppliers since they will have better access to production inputs such as feeds and feed supplements. As mentioned earlier, the integrator and the cooperative provide feeds to swine growers with whom they have an established contract arrangement. It would be more risky and costly for the swine farmers who live in remote areas to purchase from commercial input suppliers due to lack of updated information on feed prices and the high transportation cost incurred in procuring the feeds and feed supplements from these input sources.

Moreover, the distance of the farm to veterinary shops significantly influenced the farmer's decision to enter into a formal contract arrangement at 5 percent probability level. This means that farmers who are located farther away from veterinary shops are more likely to enter into formal contract arrangements relative to remaining an independent farmer. Obviously, engaging in formal contracts will facilitate access to veterinary services that independent farmers would not have easy access given the distant location of veterinary shops. However, the distance of the farm to veterinary shops had no significant effect on the farmer's decision to enter into an informal contract arrangement with input suppliers and a cooperative relative to having no contract at 10 percent probability level.

Informal contract with a cooperative relative to informal contract with input suppliers.

Table 3 shows the estimated coefficients of the multinomial logit model with the group of farmers with informal contract with input suppliers as the reference or base category.

Table 3. Effects of selected socio-economic factors on the choice of contract arrangements in swine raising with informal contract with input suppliers category as the reference group in Hung Yen Province, Vietnam, 2008.

Variables	**Independent (No Contract)**	**Informal Contract With Cooperative**	**Formal Contract**
Intercept	23.470***	-10.987**	-39.473***
	(8.059)	(-4.998)	(-10.855)
Age	0.018^{NS}	0.062*	0.040^{NS}
	(0.034)	(0.032)	(0.053)
Education	-0.572***	0.048^{NS}	0.463**
	(-0.189)	(0.139)	(0.213)
Time spent in swine raising	-0.007**	-0.395e-3^{NS}	0.010**
	(0.003)	(-0.002)	(0.004)
Swine raising as main occupation	-0.005^{NS}	0.016^{NS}	0.015^{NS}
	(-0.026)	(0.019)	(0.034)
Number of swine head	-0.319***	0.021^{NS}	0.127***
	(-0.082)	(0.025)	(0.038)
Received government loan	0.338e-4^{NS}	-0.451e-4^{NS}	0.708e-4^{NS}
	(0.654e-4)	(-0.57e-4)	(0.822e-4)
Distance of the farm to VBARD	-1.889*	-0.334e-3^{NS}	-0.607^{NS}
	(-1.085)	(-0.767)	(-1.019)
Distance of the farm to commercial input suppliers	-3.135 ^{NS}	13.064***	18.736**
	(-7.431)	(4.912)	(7.555)
Distance of the farm to veterinary shops	-2.186 ^{NS}	0.802^{NS}	5.880**
	(-1.811)	(1.471)	(2.772)
LR chi^2 (27)		347.55	
Probability > chi^2		0.0000	
Log likelihood		-97.8275	
Pseudo R^2		0.6398	

***, **, and * mean significant at 1%, 5%, and 10% probability level, respectively.
NS means not significant at 10% probability level.
Figures in parenthesis are standard errors of estimate.

Age of the swine farmer exerted a significant influence on the decision of the farmer to enter into an informal contract arrangement with a cooperative relative to having an informal contract with input suppliers at 10 percent probability level. This result suggests that farmers who are older are likely to engage in informal contract with cooperatives rather than having an informal contract with input suppliers. This may be attributed to the fact that because of their old age, it is more convenient for them to purchase inputs from a cooperative rather than look for commercial suppliers of inputs.

Moreover, the distance of the farm to commercial input suppliers had a significant effect on the farmer's decision to enter into an informal contract with a cooperative rather than having an informal contract with input suppliers at one percent probability level. This means that farmers who are located farther away from commercial input suppliers are more likely to enter into an informal contract arrangement with a cooperative relative to having an informal contract arrangement with input suppliers. This implies that having informal contracts with a cooperative facilitates easier access to input services than with input suppliers given the far location of commercial input suppliers. This arrangement with a cooperative will also reduce their transaction or procurement cost.

On the other hand, the educational attainment of the swine farmer, the proportion of time spent in swine raising, swine raising as the main occupation of the farmer, the number of swine head, the amount of loan received from the government, the distance of the farm to VBARD, and the distance of the farm to veterinary shops did not exert a significant effect on the farmers' decision to enter into informal contract arrangements with a cooperative relative to an informal contract with input suppliers.

Formal contract relative to informal contract with input suppliers. As shown in Table 3, the educational attainment of the farmer, the amount of time spent in swine farming, the distance of the farm to commercial input suppliers and the distance of the farm to veterinary shops significantly influenced the farmer's decision to enter into a formal contract arrangement relative to having an informal contract with input suppliers at 5 percent probability level. Farmers who are more educated and who spend more time in swine farming as well as those whose farms are located far from commercial input suppliers and veterinary shops are more likely to enter into a formal contract arrangement rather than having an informal contract with input suppliers.

The number of swine heads was also a significant factor in the farmers' decision to enter into a formal contract arrangement relative to having an informal contract with input suppliers at one percent probability level. The study found that farmers with a bigger number of swine heads are more likely to enter into a formal contract arrangement relative to having an informal contract with input suppliers.

Formal contract relative to informal contract with a cooperative. Table 4 shows the estimated coefficients of the multinomial logit model with the group of farmers with an informal contract with a cooperative as the base or reference category. The results of the multinomial logit analysis indicate that the education attainment of the farmers and time spent in swine farming significantly affected the farmers' decision to enter into a formal contract arrangement than having an informal contract with a cooperative at 5 percent probability level. Farmers who are more educated are aware of the benefits from entering into formal contract arrangements. Therefore, they are more likely to enter into formal contract arrangements rather than an informal contract with a cooperative. Farmers who spend more time in swine farming are more likely to enter into formal contract arrangements rather than forging an informal contract with a cooperative.

The number of swine heads was significant in influencing the farmers' decision to enter into a formal contract arrangement relative to having an informal contract with a cooperative at one percent probability level. Farmers with bigger number of swine heads are more likely to enter into a formal contract arrangement rather than an informal contract with a cooperative.

The distance of the farm to veterinary shops also significantly affected the decisions of the farmers to enter into a formal contract arrangement than having an informal contract with a cooperative at 10 percent probability level. Those whose farms are situated far from veterinary shops are more likely to enter into a formal contract arrangement rather than choosing an informal contract with a cooperative.

Table 4. Effects of selected socio-economic factors on the choice of contract arrangements in swine raising with informal contract with a cooperative category as the reference group in Hung Yen Province, Vietnam, 2008.

Variables	**Independent Farmer**	**Informal Contract With Input Suppliers**	**Formal Contract**
Intercept	34.457***	10.987**	-28.485***
	(8.809)	(4.998)	(-10.435)
Age	-0.044^{NS}	-0.062*	-0.021^{NS}
	(-0.039)	(-0.032)	(-0.049)
Education	-0.620***	-0.048^{NS}	0.415**
	(-0.208)	(-0.139)	(0.207)
Time spent in swine raising	-0.006**	0.395e-3^{NS}	0.010**
	(-0.003)	(0.002)	(0.004)
Swine raising as main occupation	-0.021^{NS}	-0.016^{NS}	-0.001^{NS}
	(-0.029)	(-0.019)	(-0.035)
Number of swine head	-0.340***	-0.021^{NS}	0.106***
	(-0.084)	(0.025)	(0.038)
Received government loan	0.789e-4^{NS}	0.451e-4^{NS}	-0.257e-4^{NS}
	(0.841e-4)	(0.57e-4)	(-0.743e-4)
Distance of the farm to VBARD	-1.888 ^{NS}	0.334e-3^{NS}	-0.606^{NS}
	(-1.223)	(0.767)	(0.847)
Distance of the farm to commercial input suppliers	-16.199**	-13.064***	5.672^{NS}
	(-8.161)	(-4.912)	(7.014)
Distance of the farm to veterinary shops	-2.988 ^{NS}	-0.802^{NS}	5.078*
	(-2.063)	(-1.471)	(2.642)
LR chi^2 (27)		347.55	
Probability > chi^2		0.0000	
Log likelihood		-97.8275	
Pseudo R^2		0.6398	

***, **, and * mean significant at 1%, 5%, and 10% probability level, respectively.
NS means not significant at 10% probability level.
Figures in parenthesis are standard errors of estimate.

However, the distance of the swine farms to commercial input suppliers did not significantly affect the farmers' decisions to shift from an informal contract with a cooperative to a formal contract arrangement with an integrator at 10 percent probability level. This could be attributed to the fact that swine farmers with informal contract arrangement with a cooperative received feeds and weanlings from the cooperative. Similarly, farmers with formal contract arrangements received feeds, weanlings and veterinary services from the integrator. Hence, the distance of the swine farms to commercial input suppliers did not matter to those with an informal contract with a cooperative or a formal contract with an integrator.

Marginal Effects Analysis

Marginal effects refer to the changes in probability given a unit change in the independent variable and are a more useful basis for interpreting the results of the multinomial logit model. The estimated marginal effects as shown in Table 5 suggest that the impact of the independent variables on the farmer's decision to be an independent operator is not statistically significant. This implies that farmers are more likely to enter into informal and formal contract arrangements rather than remaining as independent farmers.

Table 5. Estimated marginal effects under each type of contract arrangement in Hung Yen Province, Vietnam, 2008.

Variables	Type of Contract Farming			
	Independent/ (No Contract)	Informal Contract		Formal Contract
		With Input Suppliers	With Cooperative	
Age	-3.57E-08^{NS}	-0.013^{NS}	0.010^{NS}	0.002^{NS}
Education	-1.87E-06^{NS}	-0.055^{NS}	-0.030^{NS}	0.085**
Time spent in swine raising	-2.36E-08^{NS}	-0.001^{NS}	-0.001*	0.002**
Swine raising as main occupation	-3.68E-08^{NS}	-0.004^{NS}	0.002^{NS}	0.002^{NS}
Number of swine head	-9.46E-07^{NS}	-0.016***	-0.006^{NS}	0.022**
Received government loan	1.78E-10^{NS}	0.135e-7^{NS}	-0.388e-8^{NS}	-0.962e-8^{NS}
Distance to VBARD	-4.56E-06^{NS}	0.063^{NS}	0.053^{NS}	-0.116^{NS}
Distance to commercial input suppliers	-3.27E-05^{NS}	-3.728***	1.282^{NS}	2.447*
Distance to veterinary shops	-1.05E-05^{NS}	-0.721*	-0.338^{NS}	1.058**

***, **, and * mean significant at 1%, 5%, and 10% probability level, respectively.
NS means not significant at 10% probability level.

In particular, education appeared to have a higher impact on the probability of entering into formal contract arrangements. For example, a one year increase in educational level will increase the probability of entering into this type of contract by 0.085 percent. Moreover, the probability that the farmer will enter into informal contract arrangements with a cooperative will decrease by 0.001 percent and the probability that farmer will enter into a formal contract arrangement will increase by 0.002 percent as their time spent in swine farming increases by one hour.

The estimated marginal effects of the farmers' main occupation (i.e., swine farming), the amount of government loan, and the distance of the farm to VBARD were not statistically significant at 10 percent probability level.

From the points of view of informal contract with input suppliers and formal contract, the estimated marginal effects of the number of swine heads suggest that if a farmer raises one additional head of swine, this will reduce the probability that a farmer will engage into informal contract with input suppliers by 0.016 percent. It will also increase the probability that a farmer will enter into a formal contract arrangement by 0.022 percent.

As regards the distance variables, a one-kilometer increase in the distance between the farmer's farm and the location of commercial input suppliers will increase the probability that a farmer will enter into a formal contract by 2.45 percent. Moreover, a one-kilometer increase in the distance between the farmer's farm and the location of veterinary shops will increase the probability that a farmer will enter into a formal contract arrangement by 1.06 percent. As mentioned previously, an advantage of having a formal contract arrangement with an integrator is that the latter provides the swine farmers with feeds, weanlings and veterinary services. Hence, entering into a formal contract arrangement with an integrator will minimize the transportation costs incurred by farmers whose farms are less accessible to commercial input suppliers and veterinary shops.

CONCLUSION AND RECOMMENDATIONS

The swine farmers' decision to enter into contract arrangement is affected by economic and non-economic factors. The important factors include the educational level of the farmer, the amount of time spent in swine farming, the number of swine heads per farm, the age of the swine farmer, the distance of the swine farm to VBARD, the distance of the farm to commercial input suppliers, and the distance of the farm to veterinary shops.

To encourage independent swine producers in Hung Yen Province to enter into a formal contract arrangement with buyers or an informal contract arrangement either with a cooperative or feed distributor, the following policy recommendations are suggested:

1. Expand government credit assistance to smallholders to enable them to purchase improved breeds of weanlings, commercial feeds, and veterinary medicines; increase their swine stock; and modernize their pig pen facilities;

2. Provide assistance to independent farmers who would like to enter into contract arrangements with buyers especially in the preparation of market contract arrangements to protect the farmers from being exploited by their prospective buyers;

3. Widely disseminate information on the benefits from joining a cooperative (e.g., provision of feeds and training on improved swine production practices by cooperatives to its members) to independent swine producers to encourage them to join cooperatives; and

4. Conduct more training courses on improved swine production practices for independent swine producers in order to enable them to adopt improved swine production methods. With the improvement in the quality and breed of swine raised, prospective buyers will be attracted to enter into a marketing contract arrangement with them. The subject matters to be covered in the training courses should focus on pig pen sanitation measures, swine vaccination, proper feeding, methods of treating different swine diseases, and accounting. All these information is deemed important for the independent farmers who want to enter into formal contract arrangement with potential buyers or an informal contract arrangement with a cooperative or feed distributor to enable them to succeed in their swine business.

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J. ISSAAS Vol. 15, No. 2:136 -146 (2009)

EFFECTS OF PELLETING PROCESS ON FERTILIZING VALUES OF BROILER LITTER

Tawadchai Suppadit

The Graduate School of Social and Environmental Development,
National Institute of Development Administration, Bangkapi, Bangkok 10240, Thailand,
E-mail: stawadchai@hotmail.com; tawatc.s@nida.ac.th;

(Received: June 22, 2009; Accepted: November 28, 2009)

ABSTRACT

The effects of a pelleting process on broiler litter properties were investigated at the Siriwan Co. Ltd.'s network farms, Saraburi Province, Thailand. The pelleting process decreased among-set variability in dry matter, electrical conductivity, urea N, K, Na, S, Fe, Cu and Cd contents. On the othr hand, this process increased among-set variability in pH, total N, ammonium N, nitrate N and total P. N form contents including total N, ammonium N, nitrate N, organic N and urea N in the pelleted broiler litter that could be estimated accurately through the basis of dry matter content. Additionally, heavy metal (Cd, Ni, Pb and Cr) content was significantly higher in the pelleted form than in the fresh form which was consistent with a reduction in moisture content. The pelleted broiler litter was clearly preferable to the fresh broiler litter in terms of storage, handling, transport and field application. The results highlight a need to optimize the pelleting process with the objective of minimizing variability in pH, total N, ammonium N, nitrate N and total P.

Key words: Animal waste, fertilizer, prediction, recycle

INTRODUCTION

Broiler production is a prominent livestock industry in Thailand, generating tremendous waste or litter which includes a mixture of manure, bedding material, waste feed and feathers removed from broiler houses (Suppadit, 2000) that has significant potential effects on environmental quality (McCasky *et al*., 1989). If improperly managed, broiler litter can pollute the environment, primarily by contaminating surface and ground waters (Suppadit, 2003). However, the broiler litter has a high nutritional value and is used as an organic fertilizer, thus recycling nutrients such as nitrogen, phosphorus and potassium. These components (broiler litter) have traditionally been used as an amendment (Suppadit, 2005). But, utilizing fresh broiler litter directly in food crop production can lead to unacceptable residues associated with pathogens, parasites, fungi, heavy metals and noxious odor (Suppadit *et al*., 2002a). This has an adverse impact on the health of growers and consumers and on crop quality.

To overcome these problems, pelleting the broiler litter is proposed. Pelleting is a process that eliminates microorganisms and odor in broiler litter (Suppadit, 2004). Furthermore, pelleting can facilitate usage, storage, handling and transportation management (Suppadit *et al*., 2002b). To the best of our knowledge, there has been no study of the effects of pelleting on fertilizer in Thailand. The study sought to investigate the effects in pelleting method on the fertilizing values of broiler litter in terms of the basic physicochemical properties, nutrient contents and heavy metal contents.

MATERIALS AND METHODS

Preparation of Experimental Broiler Litter

Broiler litter was obtained from the Siriwan Co. Ltd.'s network broiler chicken (*Gallus gallus domesticus*) farms, Saraburi Province, Thailand, consisting of five 1,000 m^2 concrete-floored and closed houses with evaporative cooling system that measured 20.0 m wide x 50.0 m long with a stocking density of 17.5 birds/m^2. At the beginning stage of each 50-day production cycle, the floor was covered with 5.50 kg/m^2 of rice hull, the by-product of rice-growing that is widely used in chicken farms in Thailand. In fact, rice hull is high in silica, and as an important source of carbon in chicken litter used as fertilizer (Pongpiachan, 1999). It is a material with near-neutral pH, high C:N ratio, and relatively high Fe, Mn, Zn and Cr contents (Table 1). At the end of each production cycle, after removal of the birds, the broiler litter was removed with a loading shovel and piled under plastic cover, and the floor was washed, cleaned and disinfected. Then, fresh rice hull was introduced for the next cycle.

In this study, the sampling time of broiler litter was February 2008 to February 2009. After removal with the loading shovel, samples were immediately collected at the end of four production cycles, from all five houses. A composite sample was prepared , 200 g of each 20 samples were taken from each pile, at 75.0-100 cm deep. Twenty working samples (4.00 kg) were collected from 4 cycles of the 5 houses.

The broiler litter taken at the end of each production cycle was processed based on Suppadit's method (2000). The Siriwan Model Machine located at Siriwan Co. Ltd., Thatoom Sub-district, Kaeng Khoi District, Saraburi Province, Thailand was used for pelleting process. Fresh litter was sent into a screw conveyer, moved into a receiving elevator, and sent into the pelleting chamber. The litter was fed between the die and rollers, and as the rollers turned, it was then forced into the holes to produce pellets. The movement of the rollers and die during the compression process generated heat over 90°C. The pelleting technology is to mold broiler litter into a pellet form that produced cylindrical pellets 6.00 mm in diameter and 1.50-2.00 cm in length. Twenty samples of pelleted form were taken from each house every ten minutes during the pelleting process. These samples were then pooled. Samples of fresh and pelleted form of broiler litter were analyzed in the laboratories of the Chiang Mai Field Crops Research Center.

Fertilizing Value Analyses

Subsamples of fresh and pelleted broiler litter were oven dried at 65-70°C for 24 hours, for moisture and dry matter determination. The remaining fresh broiler litter was air dried and passed through a 2.00-mm-mesh sieve to remove feather fragments. The remaining pelleted broiler litter was ground to a particle diameter of about 2.00 mm.

Physicochemical properties, nutrient contents and heavy metal contents of fresh and pelleted broiler litter were analyzed according to the procedures in The Land Development Department manual (2005). Electrical conductivity and pH were determined in a 1 (solid) : 10 (water extracts) using conductivity meter and pH meter, respectively (Peverill *et al*., 1999). Ash was determined by combustion in porcelain dish (Greweling and Peech, 1960); organic C by Walkley and Black method (Walkley and Black, 1947); total N and S by Dumas method (Jackson, 1967); ammonium (NH_4-N), nitrate (NO_3-N), organic N and urea N by AOAC standard methods (AOAC, 1970; 1980); total P by the molybdenum blue method (Chapman and Pratt, 1961); K, Ca, Mg, Na, Fe and Mn contents by atomic emission/absorption spectrophotometry method (Thomas *et al*., 1967); B by the azomethine-H method (Wolf, 1974); Cu, Zn, Cd, Ni, Pb and Cr by atomic absorption spectrophometry method (Tessier *et al*., 1979).

Statistical Analysis

The data were subjected to analysis of variance (normal data) or Kruskal-Wallis analysis and Mann-Whitney *U* tests (non-normal data) (Key, 2009). Linear regression analysis (Key, 2009) was used to investigate the possible utility of dry matter content as a predictor of nutrient contents. All analyses were performed with the statistics package SPSS 15.0 (Leech *et al*., 2007).

RESULTS AND DISCUSSION

Characteristics of the Fresh and Pelleted Broiler Litter

For the fresh broiler litter, total N content was high (6.00 % dry weight), and N:P:K ratio was 3.35:1.00:1.79 (Table 1). N levels in broiler litter were more likely to reflect feed characteristics (Lopez-Mosquera *et al*., 2008). During the processing in the Siriwan Co. Ltd.'s network farms, protein content in feed ranged 22.0% at the first stage (0-21 days), 20.0% at the second stage (22-42 days) and 18.0% at the end stage (> 42 days) of production cycle. Organic N was high (83.5%) that agreed with the earlier study of Suppadit (2005) who investigated fresh broiler litter from different 20 farms (80.0-85.0%) in Saraburi Province, Thailand. As a result of low C:N ratio (6.43), this organic N can be considered as readily mineralized (Alexander, 1991). Most of inorganic N was ammonium N (0.500 %), that agreed with Carballas (1996) research (0.300-1.00%). Although there were different in physiological, seasonal, environmental and management aspect factors that may affect broiler litter component. The results were similar to those obtained from the other previous studies of Ekinci *et al*. (2000) (dry matter, 69.4-80.5%), Gordillo and Cabrera (1997a) (electrical conductivity, 6.30-12.6 dS m^{-1}), Gordillo and Cabrera (1997b) (pH, 6.30-8.40), Stephenson *et al*. (1990) (ash, 8.80-54.4%), Wood and Hall (1991) (organic C, 29.3-38.8%), Nicholson *et al*. (1996) (C:N ratio, 6.40-11.8), Gordillo and Cabrera (1997b) (urea N, 0.200-1.10%), Brown *et al*. (1993) (total P, 0.600-3.90%), Brown *et al*. (1994) (K, 0.700-5.20%), Henry and White (1993) (Ca, 0.800-6.10%), Cummis *et al*. (1993) (Mg, 0.200-0.900%), Edwards *et al*. (1995) (Na, 0.700-1.50%), Nicholson *et al*. (1996) (S, 0.200-0.800%), Stephenson *et al*. (1990) (Fe, 529-2,982 mg/kg), Smith and Chambers (1993) (Mn, 125-667 mg/kg), Malone (1992) (Zn, 54.0-680 mg/kg), and Edwards *et al*. (1995) (Cd, 2.40-3.00 mg/kg).

However, total N (6.00%), nitrate N (0.290%), organic N (5.01%) and Cr (13.0 mg/kg) contents were relatively higher than the earlier studies of Beegle (1997) (total N, 2.60-5.30%), Gordillo and Cabrera (1997a) (nitrate N, 0.00500-0.100%), Fulhage and Pfost (1993) (organic N, 0.300-3.30), Edwards *et al*. (1995) (Cr, 8.50-9.00 mg/kg), while the content of B (20.2 mg/kg), Pb 0.450 (mg/kg) and especially Cu (70.8 mg/kg) and Ni (0.400 mg/kg) were relatively lower than those from the earlier studies of Cummis *et al*. (1993) (B, 23.0-125 mg/kg), Henry and White (1993) (Pb, 14.6-55.0 mg/kg), Brown *et al*. (1994) (Cu, 100-1,003 mg/kg), Edwards *et al*. (1995) (Ni, 7.60-181 mg/kg). The Cr content was a result of the Cr content in rice hull bedding. The higher the Cr content in rice hull bedding, the higher the Cr content in fresh broiler litter. Whereas, the content of B, Pb, Cu and Ni was low as a result of feed composition, particularly as regards Cu salts, antibiotics and coccidiostatics (Sims and Wolf, 1994; Lopez-Mosquera *et al*., 2008).

The pelleted broiler litter showed the primary characteristics of organic fertilizer under specification of the Land Development Department manual (2005) (dry matter, > 65%; organic C, > 17.4%; C:N ratio, 3.00-15.0; organic N, > 2.00%; total P, > 0.440%; K, > 0.830%; Cu, < 450 mg/kg; Zn, < 1,100 mg/kg) (Table 1). The pelleted broiler litter had high content of N (5.20% dry weight, 80.8% as organic N), P (1.70%) and K (3.08%) contents as well as N:P:K ratio that was 3.06:1.00:1.81. As in the fresh broiler litter, most of inorganic N was ammonium N (0.500%). A low C:N ratio (7.04) was harmonious to the high N content, and again the organic N (4.20%) can thus be considered readily mineralizable. All of these components showed that the pelleted broiler litter had

high value as fertilizer that it met all requirements as an organic fertilizer even if some components were denatured by the heat during the pelleting process (90°C). Heat and pressure from the pelleting process occurred only for a short period (~5-10 second) (Suppadit and Panomsri, 2009). Meanwhile, the low moisture content (85.8% dry matter) of pelleted broiler litter greatly reduced noxious odor. Heavy metal content (Cd, 3.30 mg/kg; Ni, 0.500 mg/kg; Pb, 0.500 mg/kg; Cr, 13.8 mg/kg) in all cases of pelleted broiler litter were much lower than the allowable maximum values for organic fertilizer (Cd, < 3.50 mg/kg; Ni, < 120 mg/kg; Pb, < 150 mg/kg; Cr, < 270 mg/kg) (The Land Development Department, 2005). These results showed that pelleted broiler litter was acceptable for fertilizer use.

Variability among the Production Cycles

As far as the factors are concerned, there were a rise in variability and stock-related factors (age, variety, stocking density) as well as factors relating to feeding, litter and losses of nutrients, especially N (Lopez-Mosquera *et al*., 2008). According to the utilization of pelleted broiler litter as a fertilizer, variability among the four consecutive production cycles of properties in fresh and pelleted form of broiler litter were investigated (Table 2). The results of this analysis indicated that indicators did not show significant among-cycle variability in either fresh or pelleted form that were ash content, organic C, total N, Ca, Mg, Mn, B, Zn, Ni, Pb and Cr. One indicator, C:N ratio, showed significant variability in both products. Indicators that showed significant variability in fresh form but not in pelleted form were dry matter, electrical conductivity, urea N, K, Na, S, Fe, Cu and Cd. Whilst, indicators that showed significant variability only pelleted broiler litter were pH, total N, ammonium N, nitrate N and total P. As noted, the pelleting process decreased variability in nine indicators, however, it increased variability in five indicators (pH, total N, ammonium N, nitrate N and total P). The reasons perhaps caused from variability in the temperature reached during the pelleting process, that may be important to control this factor carefully. Pressing and pelleting temperature could probably be important for nitrogen, since NH_3 volatilization increases exponentially with temperature (Wood and Hall, 1991; Lopez-Mosquera *et al*., 2008; Suppadit *et al*., 2008).

Effects of pelleting process

There was a difference in mean components between fresh and pelleted broiler litter (Table 3). The pelleting process decreased moisture content by over 44.1%, from an average of 25.4% (74.6% dry matter) in fresh broiler litter to an average of 14.2% (85.8% dry matter) in pelleted broiler litter. The moisture content was associated with volume reduction. The pelleting method was convenient for storing, handling, transporting and field application. However, fresh broiler litter typically offers risk to the environment, including N emission to the atmosphere and leaching to groundwater (Sims and Wolf, 1994; Lopez-Mosquera *et al*., 2008; Suppadit, 2009). The pelleting process likewise led to a significant reduction in organic C and especially total N content, although C:N ratio was not significantly affected. On the average, pelleted broiler litter showed less in organic C (5.18 %) and total N (13.3 %) than those in fresh broiler litter. These reductions probably reflect the high temperature (90°C) in which the fresh broiler litter was subjected. Lopez-Mosquera *et al*. (2008) also detected a significant reduction of fresh broiler litter in organic C after heating to 60-80°C, which was lower than that used in this study. As far as total N is concerned, it is well known that losses increase with increasing pelleting temperature, largely as a result of NH_3 volatilization (Gale *et al*., 1991; Wood and Hall, 1991; Lopez-Mosquera *et al*., 2008; Suppadit *et al*., 2008). However, differences between the fresh and pelleted form of broiler litter were not detected for ammonium N, nitrate N, or urea N. The pH level remained basic but was less significant in pelleted broiler litter (pH, 7.60) than fresh broiler litter (pH, 8.20). It is known that the oxidation of the organic matter is an acidifying method (McBride, 1994). The decrease in pH was possibly due to the release of H^+ that are associated with organic anions during pelleting process (Lopez-Mosquera *et al*., 2008). The alkalinity of the pelleted broiler litter made it suitable especially for neutral or acid soil areas (Suppadit, 2009).

Table 1. Fertilizing values of fresh and pelleted broiler litter.

Indicators	Fresh broiler litter			Pelleted broiler litter
	Previous studies	**References**	**In this study (Mean ± S.D.; *n* = 20)**	**(Mean ± S.D.; *n* = 20)**
Dry matter (% d.w.)	69.4-80.5	Ekinci *et al*. (2000)	74.6 ± 4.90	85.8 ± 4.20
Electrical conductivity (dS m^{-1})	6.30-12.6	Gordillo and Cabrera (1997a)	10.0 ± 2.50	11.0 ± 2.00
pH (H_2O)	6.30-8.40	Gordillo and Cabrera (1997b)	8.20 ± 0.500	7.60 ± 0.600
Ash (% d.w.)	8.80-54.4	Stephenson *et al*. (1990)	20.2 ± 0.200	21.1 ± 0.500
Organic C (% d.w.)	29.3-38.8	Wood and Hall (1991)	38.6 ± 1.20	36.6 ± 1.60
Total N (% d.w.)	2.60-5.30	Beegle (1997)	6.00 ± 0.500	5.20 ± 0.800
C:N ratio	6.40-11.8	Nicholson *et al*. (1996)	6.43 ± 0.600	7.04 ± 0.600
Ammonium N (% d.w.)	0.300-1.00	Carballas (1996)	0.500 ± 0.0600	0.500 ± 0.0800
Nitrate N (% d.w.)	0.00500-0.100	Gordillo and Cabrera (1997a)	0.290 ± 0.0300	0.300 ± 0.0500
Organic N (% d.w.)	0.300-3.30	Fulhage and Pfost (1993)	5.01 ± 0.400	4.20 ± 0.900
Urea N (% d.w.)	0.200-1.10	Gordillo and Cabrera (1997b)	0.200 ± 0.0300	0.200 ± 0.0200
Total P (% d.w.)	0.600-3.90	Brown *et al*. (1993)	1.79 ± 0.400	1.70 ± 0.300
K (% d.w.)	0.700-5.20	Brown *et al*. (1994)	3.20 ± 0.600	3.08 ± 0.400
Ca (% d.w.)	0.800-6.10	Henry and White (1993)	3.76 ± 0.700	3.50 ± 0.500
Mg (% d.w.)	0.200-0.900	Cummis *et al*. (1993)	0.660 ± 0.100	0.600 ± 0.100
Na (% d.w.)	0.700-1.50	Edwards *et al*. (1995)	1.50 ± 0.500	1.10 ± 0.200
S (% d.w.)	0.200-0.800	Nicholson *et al*. (1996)	0.600 ± 0.0500	0.700 ± 0.0300
Fe (mg/kg)	529-2,982	Stephenson *et al*. (1990)	740 ± 185	794 ± 148
Mn (mg/kg)	125-667	Smith and Chambers (1993)	348 ± 40.0	185 ± 20.2
B (mg/kg)	23.0-125	Cummis *et al*. (1993)	20.2 ± 2.28	13.8 ± 2.30
Cu (mg/kg)	100-1,003	Brown *et al*. (1994)	70.8 ± 10.5	64.2 ± 5.50
Zn (mg/kg)	54.0-680	Malone (1992)	263 ± 20.0	261 ± 18.8
Cd (mg/kg)	2.40-3.00	Edwards *et al*. (1995)	2.90 ± 0.400	3.30 ± 0.300
Ni (mg/kg)	7.60-181	Edwards *et al*. (1995)	0.400 ± 0.0200	0.500 ± 0.0400
Pb (mg/kg)	14.6-55.0	Henry and White (1993)	0.450 ± 0.0300	0.500 ± 0.0300
Cr (mg/kg)	8.50-9.00	Edwards *et al*. (1995)	13.0 ± 2.60	13.8 ± 2.20

Characteristics of the rice hull used as bedding material on the Siriwan Co. Ltd.'s network farm: Dry matter, 92.1 %; pH, 6.58; Total C, 36.5% d.w.; Total N, 0.510% d.w.; C:N ratio, 71.2; P, 0.00180% d.w.; K, 0.285% d.w.; Ca, 0.158% d.w.; Mg, 0.100% d.w.; Na, 0.256% d.w.; S, 0.0680% d.w.; Fe, 105 mg/kg; Mn, 422 mg/kg; Co, 2.79 mg/kg; Cu, 2.58 mg/kg; Zn, 22.7 mg/kg; Cd, <0.190 mg/kg; Ni, <0.100 mg/kg; Pb, <0.100 mg/kg; Cr, 10.6 mg/kg.

In this study, heating at 90°C led to significant reductions in Fe, Mn, B and Cu contents of fresh broiler litter, that agreed with the study of Lopez-Mosquera *et al*. (2008), which showed that B, Mn, Cu, Cr and Cd contents of broiler litter were affected by pelleting temperatures of up to 90°C. Heavy metals (Cd, Ni, Pb, Cr) in this study increased which is related to a decrease in moisture content in broiler litter that agreed with the previous study of Suppadit *et al*. (2008). This could be result of the contamination of the apparatus used in the pelleting process according to the previous study of Lopez-Mosquera *et al*. (2008).

Table 2. Temporal variability among the four production cycles in the fresh and the pelleted broiler litter.

Varieties	**Indicators**	***F* or X^2 value, fresh broiler litter**	***F* or X^2 value, pelleted broiler litter**
No significant variability in either product	Ash	$F = 0.200^{n.s.}$	$X^2 = 7.90^{n.s.}$
	Organic C	$X^2 = 7.10^{n.s.}$	$X^2 = 9.00^{n.s.}$
	Total N	$F = 3.80^{n.s.}$	$F = 5.50^{n.s.}$
	Ca	$F = 5.20^{n.s.}$	$F = 2.10^{n.s.}$
	Mg	$F = 5.40^{n.s.}$	$F = 5.10^{n.s.}$
	Mn	$F = 4.40^{n.s.}$	$F = 3.90^{n.s.}$
	B	$F = 0.900^{n.s.}$	$F = 2.80^{n.s.}$
	Zn	$F = 4.80^{n.s.}$	$F = 3.20^{n.s.}$
	Ni	$F = 6.20^{n.s.}$	$F = 4.70^{n.s.}$
	Pb	$F = 1.20^{n.s.}$	$F = 1.40^{n.s.}$
	Cr	$F = 6.30^{n.s.}$	$F = 8.90^{n.s.}$
Significant variability in both products	C:N ratio	$F = 6.80$*	$F = 10.2$*
Significant variability in the fresh but not the pelleted broiler litter	Dry matter	$F = 198$*	$F = 10.0^{n.s.}$
	Electrical conductivity	$F = 121$*	$F = 4.10^{n.s.}$
	Urea N	$F = 92.1$*	$F = 7.80^{n.s.}$
	K	$F = 6.90$*	$F = 3.60^{n.s.}$
	Na	$F = 28.9$*	$F = 1.10^{n.s.}$
	S	$F = 80.9$*	$F = 5.70^{n.s.}$
	Fe	$F = 7.80$*	$F = 0.800^{n.s.}$
	Cu	$F = 8.50$*	$F = 2.10^{n.s.}$
	Cd	$F = 8.90$*	$F = 2.30^{n.s.}$
Significant variability in the pelleted but not the fresh broiler litter	pH	$X^2 = 10.1^{n.s.}$	$F = 804$*
	Total N	$F = 5.20^{n.s.}$	$F = 7.70$*
	Ammonium N	$X^2 = 6.50^{n.s.}$	$F = 20.3$*
	Nitrate N	$X^2 = 9.00^{n.s.}$	$F = 25.4$*
	Total P	$X^2 = 4.40^{n.s.}$	$F = 7.40$*

* = Significant variability ($P<0.05$)
$^{n.s.}$ = Non significant difference ($P>0.05$)

Table 3. Differences in properties between the fresh and the pelleted broiler litter.

Varieties	Indicators	*F* or *U* value (difference between broiler litter comparisons)	Pelleted vs. fresh (difference between means)
No temporal variability	Ash (% d.w.)	$F = 1.70^{n.s.}$	+ 0.900
	Organic C (% d.w.)	$U = 26.5$*	- 2.00
	Total N (% d.w.)	$F = 14.0$*	- 0.800
	Ca (% d.w.)	$F = 0.300^{n.s.}$	- 0.260
	Mg (% d.w.)	$F = 2.20^{n.s.}$	- 0.0600
	Fe (mg/kg)	$F = 20.8$*	- 54.0
	Mn (mg/kg)	$U = 6.20$*	- 163
	B (mg/kg)	$F = 30.0$*	- 6.40
	Zn (mg/kg)	$F = 0.300^{n.s.}$	- 2.00
Temporal variability	Dry matter (% d.w.)	$F_{min} = 780$* (3 cycles)	+ 11.2
	Electrical conductivity (dS m^{-1})	$F_{max} = 12.2^{n.s.}$	+ 1.00
	pH	$F_{min} = 998$* (3 cycles)	- 0.600
	C:N ratio	$F_{max} = 15.1^{n.s.}$	+ 0.610
	Ammonium N (% d.w.)	$F_{max} = 4.20^{n.s.}$	0
	Nitrate N (% d.w.)	$F_{max} = 5.30^{n.s.}$	+ 0.0100
	Organic N (% d.w.)	$F_{max} = 12.9^{n.s.}$	- 0.810
	Urea N (% d.w.)	$F_{max} = 6.00^{n.s.}$	0
	Total P (% d.w.)	$F_{max} = 1.60^{n.s.}$	- 0.0900
	K (% d.w.)	$F_{max} = 15.8^{n.s.}$	- 0.120
	Na (% d.w.)	$F_{max} = 7.00^{n.s.}$	- 0.400
	S (% d.w.)	$F_{min} = 65.8$* (4 cycles)	+ 0.100
	Cu (mg/kg)	$F_{min} = 18.8$* (3 cycles)	- 6.60
	Cd (mg/kg)	$F_{min} = 156$* (3 cycles)	+ 0.400
	Ni (mg/kg)	$F_{min} = 16.5$* (2 cycles)	+ 0.100
	Pb (mg/kg)	$F_{min} = 12.8$* (2 cycles)	+ 0.0500
	Cr (mg/kg)	$F_{min} = 30.0$* (2 cycles)	+ 0.800

For indicators not showing temporal variability (see Table 2), the two broiler litters products were compared by considering the samples obtained from the four different cycles simply as replicates (n = 20); for indicators showing temporal variability, comparisons were performed cycle by cycle (n = 5 in each case), and an overall significant difference between the fresh and pelleted broiler litter was defined to be present when significant differences were detected in two or more of the four cycles; for these latter indicators, the value shown is the maximum F value for non significant comparisons, or the minimum F value for significant comparisons, with the number of individual significant values in bracket.

* = Significant variability ($P<0.05$);

$^{n.s.}$ = Non significant difference ($P>0.05$)

Fertilizing Value Prediction

The results of linear regression on fertilizing values, in both fresh and pelleted broiler litter are shown in Table 4. To be harmonious to the previous study of Nicholson *et al*. (1996) which suggested that dry matter content of broiler litter is a good predictor of total N, P, K, Mg and S contents expressed through fresh broiler litter weight. The content of dry matter in pelleted broiler litter in this study was only a good predictor for various nitrogen contents, but not for other indicators. This suggests that simple determination of dry matter content could be effective for estimating total N content (ammonium N, nitrate N, organic N, urea N) in pelleted broiler litter. This may be particular value as a basis for rapid quality-control tests during the pelleting process.

Table 4. The results of linear regressions with dry matter as candidate predictor variable and chemical properties as dependent variables.

Broiler litter	**Regression equation [*n* = 20 (5 houses x 4 cycles)]**	r^2	***F* value**	***p* value**
Fresh	Total N = -6.70×10^{-3} DM + 6.50	0	0.0200	0.850
Pelleted	Total N = -0.219 x DM + 23.9	0.710	17.8	0.00100
Fresh	Organic N = -3.14×10^{-2} DM + 7.35	0.0300	0.250	0.540
Pelleted	Organic N = -0.188 x DM + 20.3	0.700	14.6	0.00200
Fresh	Ammonium N = 1.14×10^{-2} DM - 0.350	0.220	2.80	0.130
Pelleted	Ammonium N = -1.38×10^{-2} DM + 1.68	0.790	16.4	0.00200
Fresh	Urea N = 5.36×10^{-3} DM - 0.200	0.450	8.10	0.0560
Pelleted	Urea N = -9.32×10^{-3} DM + 1.00	0.760	20.3	0.00100
Fresh	Nitrate N = 3.62×10^{-3} DM + 0.0200	0.210	2.77	0.110
Pelleted	Nitrate N = -10.5×10^{-3} DM + 1.20	0.730	21.8	0.00300
Fresh	Total P = -3.23×10^{-2} DM + 4.20	0.165	2.23	0.125
Pelleted	Total P = -1.30×10^{-2} DM + 2.82	0.0500	0.430	0.620
Fresh	K = 6.30×10^{-2} DM - 1.50	0.230	3.67	0.100
Pelleted	K = -8.06×10^{-2} DM + 10.0	0.310	4.11	0.0700
Fresh	Mg = 1.29×10^{-2} DM - 0.300	0.300	5.30	0.0540
Pelleted	Mg = -9.32×10^{-3} DM + 1.40	0.120	1.30	0.344
Fresh	S = -3.75×10^{-3} DM + 0.88	0.220	3.33	0.0860
Pelleted	S = 3.50×10^{-3} DM + 0.40	0.210	2.65	0.150

CONCLUSIONS

The pelleted broiler litter meets all qualifications as an organic fertilizer on account of high fertilizer value. Some components may be slightly denatured due to the heat and pressure from the pelleting process that occurred only for a short period (~5-10 second). Pelleted broiler litter has more appropriate characteristic in fertilizing values than fresh broiler litter. Total N, ammonium N, nitrate N, organic N and urea N can be estimated from dry matter content. From a practical point of view, the pelleting process is convenient for storing, handling, transporting and field application of the broiler litter.

ACKNOWLEDGEMENTS

The authors would like to thank the Siriwan Company Limited for financial support and pelleting machine and highly appreciates the Chiang Mai Field Crops Research Center, Thailand for their permission in using some of part of the laboratory.

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J. ISSAAS Vol. 15, No. 2:147 -158 (2009)

ENHANCING THE VIABILITY OF CASSAVA FEEDSTOCK FOR BIOETHANOL IN THE PHILIPPINES

Roberto F. Rañola, Jr.[1], Rex B. Demafelis[2], Edwin Del Rosario[3] and Butch G. Bataller[2]

[1]Department of Agricultural Economics, College of Economics and Management (CEM), University of the Philippines (UPLB), College, Laguna 4031, Philippines;
[2]Department of Chemical Engineering, College of Engineering and Agro-Industrial Technology (CEAT), University of the Philippines Los Baños (UPLB), College, Laguna 4031 Philippines;
[3]Institute of Plant Breeding (IPB), College of Agriculture, College, Laguna 4031, Philippines

(Received: September 19, 2009; Accepted: December 1, 2009)

ABSTRACT

This paper discusses the potential of cassava as a source of feedstock for bioethanol and the major policy considerations for developing the industry. The paper provides some recommendations on enhancing the viability of cassava as source of bioethanol in the Philippines. Cassava has been identified in the Biofuels Act of 2006 as one of the possible sources of feedstock for bioethanol in the Philippines. However, as the paper explains, there are certain important concerns that need to be addressed for the project to be viable. These include the market, productivity of cassava production, cost of cassava feedstock in comparison with other feedstock sources, potential production areas, production technologies, feedstock supply arrangements between feedstock producers and processing plants, incentives for industry players, and impact on the environment.

Key words: Biofuel, market, policy

INTRODUCTION

The Biofuels Act of 2006 (RA9367) which was signed on January 12, 2007 mandates 5% and 10% bioethanol blending on February 6, 2009 and 2011, respectively. This corresponds to 269 ML and 594 ML ethanol for 2009 and 2011, respectively. The main intention of the law is to reduce the dependence of the country on imported fossil fuel and cushion it from the erratic price fluctuations as well as ensure the availability of clean energy which can lead to reductions in Greenhouse Gas (GHG) emissions. Ethanol (CH_3CH_2OH) is a flammable, colorless, slightly toxic chemical compound commonly found in alcoholic beverages. This can be produced from plant material or petroleum. Ethanol derived from crops is called bioethanol in order to distinguish it from that which is produced synthetically from petroleum. The provisions of said Biofuel law of the Philippines include incentives to investors in enterprises that will be involved with production, distribution and use of locally produced biofuel. The specific tax on local or imported biofuels component of the blend per liter of volume is zero given that the local or imported bioethanol is denatured into bioethanol fuel. The value added tax on the sale of raw material used in the production of biofuels is also zero up to 5 years Income Tax Holidays. Another incentive provided by the law is that the water effluents from the production of biofuels which was used for the purpose of reuse, e.g. distillery slops used as liquid fertilizer and other agricultural purposes, will be exempted from wastewater charges (Biofuels Act of 2006).

Among others, one of the crops mentioned in the Biofuel Act as a possible source of biofuel is cassava. Would it be feasible to tap this crop for biofuel given all these incentives? This paper discusses the potential and current constraints of utilizing cassava as a possible source of feedstock for bioethanol production and the possible approaches to relaxing these constraints. Specifically, it

discusses issues related to the supply of cassava, market arrangements, energy requirement for processing, financial viability and environmental considerations.

METHODOLOGY

This paper is based on the results of a study on the feasibility of using cassava as feedstock for bioethanol in the Philippines. The first part of the study involved the determination of the best practices for the production of cassava for ethanol production followed by the determination of best processing performances adaptable in the Philippines, specifically in the identified areas of the prospective investors. Technical, manpower and cost requirements for setting up the processing plant and the cassava plantation were also determined. Finally, the financial and sensitivity analyses were undertaken to determine the economic viability of producing ethanol from cassava. The study considered three cases for the economic viability study: a) the viability of cassava tuber production both for corporate farming and joint venture business arrangements (Case 1); b) the viability of the processing cassava tubers into bioethanol (Case 2), and; c) the viability of an integrated feedstock production and bioethanol processing plant (Case 3). The potential of the project for energy recovery and utilization, and for earning carbon credits within the Clean Development Mechanism under the Kyoto protocol were also considered in the study.

The study team visited Eastern Petroleum cassava plantation in General Santos City and Bago Distillery, Incorporated in Negros Occidental for the purpose of collecting the required information and verifying data. The analysis of the data was the basis for identifying the constraints in production, processing and marketing and opportunities as well as the approaches to addressing these constraints and exploiting the opportunities.

RESULTS AND DISCUSSION

Cassava as Potential Feedstock

In the Philippines, cassava has for a long time primarily been cultivated for food and in smaller but increasing quantities, for animal feed and other industrial products. The crop is relatively typhoon and drought-resistant, and requires minimum crop maintenance. Cassava tubers can also be chipped, dried and stored for utilization during periods of lean supply. In areas with evenly distributed rainfall, cassava can be harvested all year-round. More recently, it has gained importance as a possible fuel commodity not only in the Philippines but also in China, Thailand, Indonesia, and other countries which have more advanced national biofuel programs.

Cassava can survive in a wide range of soil types but grows best in deep, fertile and well-aerated soils although it can give fairly good yields in poor soils provided it is not water-logged. Well-drained soil is very important when engaging in cassava production. Sandy loam or clay loam soil is ideal for cassava since this will enable better root development and ensure quality tubers. Hard soils on the other hand frequently cause tuber deformation and difficulty in harvesting. The crop may be grown in plain to rolling terrain. However, growing cassava in sandy soils of hilly topography must be provided with practices that will minimize soil erosion to maintain the soil productivity. Soil pH range of 5.5-6.5 is needed by the crop but it can tolerate acidity rather than salinity. Cassava can grow in areas with ambient temperature of 25-30 °C and in places with as high as 5000 m. The optimum annual rainfall requirement is 760 to 1,015 mm and grows very well in areas with more or less evenly distributed rainfall throughout the year. However, it can grow with as low as 500 mm annual rainfall. In areas with distinct wet and dry seasons, planting is best done at the start of the rainy season. Cassava can tolerate prolonged drought except at the early stage of development. Drought stress can cause shedding of older leaves and arrested growth. Sufficient moisture however must be available

during the establishment period. Although yield may be affected, the crop can adapt in places where rainfall is low since it has the ability to utilize nutrients from the stalk and storage roots once moisture is restored.

Table 1 shows the estimates of the cost of ethanol derived from different types of feedstock (DA-BAR, 2007). Average costs of feedstock per liter of ethanol from molasses and corn are quite high, while those using sweet sorghum is comparable to that of sugarcane. In comparison, feedstock from cassava can be the most expensive among the major feedstock depending on prevailing prices of tubers or derived products, as well as in the form the cassava products are used. Cassava used for food and other related preparations are generally purchased at a higher price than those used for industrial purposes. Potentially however, cassava can be inexpensive and be the cheapest source of starch-based feedstock for bioethanol production given its very high starch-to-sugar conversion ratio.

Table 1. Feedstock cost comparison, cost/liter, Philippines, 2004-2005.

Feedstock	Price (PhP/MT)		Liter/ha /year	Feedstock Cost (PhP/L)	
	Min	Max		Min	Max
Sugarcane	1,000	1,100	6,120	13.89	15.28
Molasses	4,500	5,400	806	19.06	22.62
Corn	8,500	10,000	5,282	20.92	24.61
Sweet Sorghum				13.98	15.67
Stalk	550	600	5,625	12.22	13.33
Grain	6,000	7,000	2,513	17.91	20.9
Cassava	1,500	5,800	5,549	8.38	32.4

In 2006, the total cassava production area in the Philippines was estimated at 204,678 hectares with a production volume of 1,756,854 metric tons (BAS, 2007). The national average yield was only 8.6 mt/ha/yr. This may be attributed to the fact that the crop is traditionally grown with minimal farm inputs. Potentially, the yield can be increased since cassava is very responsive to fertilization and irrigation. Data from multi-location or regional tests of the National Seed Industry Council show for example that average yield of cassava, particularly those of improved varieties, can reach up to 20 to 40 tons/ha/yr. With such high feedstock yield levels, ethanol yield from cassava becomes comparably better than those from other feedstock such as sugarcane or sweet sorghum.

Cassava productivity can also be greatly enhanced through the adoption of appropriate cultural management practices, the utilization of high yielding, adapted crop varieties and improved harvesting and processing techniques. Improved production efficiency leads to reduced cost of production and consequently to lower feedstock cost.

Potential Areas for Growing Cassava

There are six provinces that have been identified in the study as best suited for growing cassava for feedstock production (Table 2). The topography of the target areas varies from predominantly plain to mountainous. The sites mostly fall under the Type IV climate classification with uniform rainfall distribution throughout the year. Soil types range from sandy to clay but are predominantly sandy loam.

Table 2. General topography, climatic and soil characteristics of cassava target sites, 2008**.**

Target Area	Topography	Soil Type	Climate
Saranggani	Plain to Rolling	Sandy Loam to Clay Loam	Type IV
South Cotabato	Mostly Rolling	Loam to Sandy Loam	Type IV
Sultan Kudarat	Mostly Rolling to Plain	Sandy Loam to Loam	Type IV
Misamis Oriental	Undulating to Hilly	Clay to Sandy Loam	Type II & III
General Santos	Mostly Plain	Sandy Loam to Silty Loam	Type IV
Zambales	Plain to Rolling	Mainly Sandy	Type I

The common characteristics of these areas that make them ideal for producing cassava include low propensity for typhoons, mostly plain to undulating topography, well drained soils, well distributed rainfall, the large enough area for growing cassava and high productivity. The yield per hectare of these target areas range from 11.8 to 22.2 MT/Ha, which is higher than the national average productivity of 8 MT/Ha. Zambales, however, has a low yield of 5.8 MT/Ha. Other potential production areas for cassava production include the provinces of Bukidnon, Negros, North Cotabato and Davao. Many of these provinces have comparable physical characteristics as the target sites described above and have been traditional growing areas for cassava. Production hectarage of cassava in Bukidnon is around 6,460 hectares with an annual production volume of 131,048 MT. Average yield is one of the highest at 20.3 MT/Ha. Negros Occidental and Negros Oriental are planted to 3,065 hectares and 2,750 hectares of cassava, producing 26,191 and 10,048 MT per year, respectively. Average yields however are quite low at 3.6 to 8.8 MT/Ha. North Cotabato is planted to around 910 hectares producing around 8,863MT annually; yield levels average 9.7 MT/Ha. Cassava plantations in the Davao Region provinces of Davao Oriental, Davao Sur and Davao Norte are around 356, 772 and 444 hectares, respectively, contributing 2,185 MT/yr, 884 MT/yr and 3,110 MT/yr, respectively. Average yields range from 6 to 7 MT/Ha.

A good number of the potential cassava growing areas mentioned above are also planted to large sugarcane fields making them all the more suitable for cassava growing. Moreover, most of these provinces have Agrarian Reform Communities (ARC's) covering numerous municipalities. Establishing plantations in ARC's particularly under the joint venture or contract growing agreements is advantageous due to the existence of beneficiary organizations supervised by the provincial offices of the Department of Agrarian Reform. In Region XII, there are around 72 ARC's covering 202 barangays in the main target production site for cassava feedstock production.

A key factor to consider in the selection of plantation areas is proximity to where the produce will be conveyed for processing. The production sites to be developed should as much as possible be contiguous and located near the processing plant. The location of primary processing centers should allow the chipping and drying of harvested tubers without delay. Primary processing and storage sites should also be located such that the cost of inbound transport to the distillery site is minimized. The road infrastructure connecting the plantation sites to the primary processing facilities and the distillery plant should be adequate enough to facilitate the delivery of the feedstock.

Production of Cassava

There are three major considerations in the production of cassava, namely, the production arrangements, plantation area requirements and establishment and cassava varieties and cultural management technologies.

Contract arrangements for producing cassava and cassava chips are very important to ensure the continued supply of feedstock for the processing plant. There are two possible contract arrangements between the distillery company and the farmer-landholder that may be considered, the corporate farming system and the joint venture agreement. These production agreements allow the distillery plant to manage the supply chain and minimize risks of their investments. These arrangements were determined through plantation visit to Eastern Petroleum in General Santos City.

Under a corporate farming setup, the company arranges for a long term lease of 10 to 25 years with the landholder. Increase in lease rates of 1 to 2% per year are reasonable standard provisions. In almost all cases, the corporation also provides priority employment to the farmer landholders and their immediate relatives. This corporate farming arrangement is advantageous to the company as it allows full control of the management and operation of the collective landholdings ensuring continued farm production. However under this arrangement, the wages are fixed and do not provide incentives for increase in productivity. In addition, appropriate measures to prevent or minimize incidences of pilferage can be a major consideration in large plantation areas.

In the Joint Venture scheme, farmer cooperatives or clusters provide land and labor for the production of cassava. The company operating the processing plant provides the technical support, planting materials, agro-chemicals and other production inputs. Upon harvest of the produce, farmers get 30 to 40% of the profit and the rest retained by the company. This scheme provides a less rigid corporate structure and might prove more acceptable to small farmer-landholders. Also, farmers are encouraged to improve productivity since their income is based on the partnership's profit. Disadvantages of such a business arrangement are the increased possibility of diverting harvest (pole-vaulting) and pilferage when the current market price of the produce is very high. There is also no assurance of continued supply of feedstock, as the company has no long-term control over landholding.

The ethanol processing plant may also explore other production arrangements other than the ones described above to augment its requirement for feedstock. These involve purchasing cassava under a Contract Growing or Direct Purchase agreement. With this arrangement, the company agrees to pay a fixed price per kg of fresh cassava roots produced by the farmers. Under these schemes, the grower rather than the company will have a direct hand in the production of feedstock. A major disadvantage of these agreements however is that there is no assurance of a continued supply of the feedstock for the operation of the processing plant.

An assortment of contract arrangements may be explored and modified to suit the interests of both the company and landholder. Any agreement made however should assure the distillery company of sufficient raw materials so its processing plant can maintain a certain minimum level of operation. It is also essential that concerned government agencies make certain that the terms and conditions of the agreements between the farmer-landholders and corporation are justly implemented.

The plantation establishment should be given utmost priority considering that they will be the source of planting materials for the cassava plantations and at the same time feedstock for the ethanol plant. Planting should start in areas nearest to the processing plant and progress towards the farthest area. Due to the scale of the production area, it would be practicable to divide the area into two or three sub-areas depending on the contiguity and number of production farms in each contiguous site.

The other consideration is the choice of cassava varieties to grow that determines to a large extent the potential yield of harvested produce. Presently, cassava varieties are generally classified according to their use namely: (1) for food, (2) for animal feed and (3) for starch production. Varieties for food and feed must be low in HCN while those used for starch or ethanol production must be high

in starch content. Recommended varieties of cassava approved by the National Seed Industry Council (NSIC) are ideal for various industrial uses because of their potentially high root yield and high root dry matter and starch contents. Factors usually considered when selecting varieties include: (1) high adaptability to the locality (2) high fresh yield (3) early maturity and (4) good storability.

The National Seed Industry Council (formerly Philippine Seed board) has recommended more than forty varieties of cassava for commercial production (DA-BPI 2003, 2004 and 2005). Majority of these varieties have high yield and produce roots with high dry matter and starch contents. However, the planting materials of most of these varieties are very limited in availability with only very few popular varieties multiplied for use in existing industries.

Established and proven technologies for cassava production for food and industrial uses have been developed by various government agencies, research institutions, private corporations and other industry stakeholders. Information and communication materials in various forms have been published to disseminate these technologies to target end-users (PCARRD 1983a and 1983b; PRCRTC, 2007; NOMIARC, 2007 and IPB-CSC, 2008). These technologies generally promote the use of good quality planting materials of high yielding varieties, optimum farm input and integrated pest management (IPM) under monoculture cropping and various intercropping systems. The production technology to be used in the feedstock production venture should take into account the above recommendations while also considering current production schemes specifically suited to the target sites.

Processing Schemes

There are two schemes considered for the primary processing of cassava into chips. The first scheme assumes a corporate farming system arrangement where the land is leased or owned by the company. This is characterized by the integration of all operations under a processing plant manager in close collaboration with the production manager. One main advantage of this scheme is the total control of the operation, and avoids dealing with individual farmers. The quality of the product is also expected to improve as all the operations are being handled in the plant. The major constraint of this scheme, however, is the selection and availability of the required 10,000 hectares for the project.

The second scheme, joint venture agreement, utilizes a middleman to undertake the washing, peeling, chipping and drying of cassava. The consolidator is in direct contact with the farmers. He may be required to support the farmers in terms of production inputs in exchange for the guarantee of selling their harvest to him. The consolidator sells the dried chips to the plant. The plant stores the dried chips and mills it into cassava flour as required by the secondary processing section. The main advantage of this scheme is the close collaboration between the consolidator and farmers. It is assumed that each consolidator will deal with about 50 farmers with about 5 hectares of land holdings each for a total of 250 hectares. The whole project will manage 40 consolidators for a total of 10,000 hectares. The consolidator will benefit from the business with the value addition from processing freshly harvested cassava into dried cassava chips. Financing the equipment capitalization might be shouldered by the project or by financing institutions such as DBP and/or Landbank of the Philippines.

Based on the results of the financial analyses of the alternative production and processing schemes, the corporate farming scheme seems to be a better business arrangement than the joint venture scheme. This is possibly so because of the efficiencies associated with larger scale production. (Table 3). The minimum viable price for the cassava chips processing by consolidators, bioethanol processing from cassava chips, and bioethanol processing from an integrated feedstock production and bioethanol processing from cassava are also presented in Table 4. The financial analysis of the different production arrangements were used as basis for determining the prices.

Table 3. Comparison of corporate farming and joint venture business arrangements.

Case 1. Cassava Plantation	Corporate Farming	Joint Venture
Area Requirement for full production (Ha)	10,000	10,000
Tubers Yield (kg/Ha)	20,000	20,000
Land Rental (Php)	4,000	-
Farmer's Share (%)	-	20
Tubers Minimum Viable Price (Php)	2.83609	2.85926
Percent Mark-up	55.25	75.76
Cost of Goods Sold per Unit (Php/kg tubers)		
Direct Material	0.31	0.31
Direct Labor	0.98	0.98
Overhead Cost	0.55	0.35
Total Cost of Sales	1.83	1.63
Selling and Administrative Expenses	0.03	0.03
Interest on Loan	0.20	0.32
Total Cost	2.07	1.98
Fixed Capital Investment (Php)	85,339,936	85,339,936
Working Capital (Php)	455,652,896	406,052,896
Total Project Cost (Php)	540,992,832	491,392,832
Financial Indicators		
Average Net Income (Php)	104,050,093	93,788,939
Return on Investment (%)	19.23	19.09
Internal Rate of Return (%)	12.00	12.00
Payback Period (yrs)	6.23	6.25
Net Present Value (Php)	5,290	1,844

Table 4. Minimum viable price of cassava chips and bioethanol from cassava, 2009.

	Price	Unit
Cassava chip processing by consolidators	12.9121	Php/kg
Bioethanol processing from cassava chips	50.9058	Php/L
Integrated bioethanol processing*	51.9471	Php/L

*Bioethanol Production from Corporate-run Cassava Feedstock Production and Bioethanol Processing
Source: DA-BAR, 2008.

The Market

The signing of Republic Act 9367 that mandates the phasing out of the use of harmful gasoline additives and/or oxygenates and that all liquid fuels for motors and engines sold in the Philippines must contain locally sourced biofuels components has provided a very good market opportunity for the Philippines. In addition, the rising prices as well as the uncertainty of supply of oil and the increasing greenhouse gas emissions has made timely the shift in the energy mix towards the use of cleaner indigenous renewable energy. The rising oil prices shall continue not only because of

depletion of reserves but also because of the continuing political instability in the Middle East. The domestic as well as foreign markets such as Japan, Taiwan, and South Korea are the possible markets for Philippine bioethanol. With the enactment of the Biofuels Law, there is already a captive domestic market for bioethanol as a transport fuel.

Given the Biofuel Law, the Department of Energy (DOE) projects that the country will need in 2009 about 223 million liters of bioethanol for the transport sector alone to comply with the 5% blending of bioethanol. By 2011, this ethanol requirement will increase to 482 million liters to 537 million liters by 2014 (Table 5).

The Philippines has a huge potential for producing different crops such as sugarcane, corn, sweet sorghum, and cassava that are suitable sources of feedstock for bioethanol production. Only sugarcane however can be a locally sustainable source of ethanol for motor fuel. Ethanol produced from sugarcane feedstock is the major competitor of the ethanol produced by the proposed project utilizing cassava feedstock. The bagasse from sugarcane can be utilized as renewable source of fuel for the distillery's boilers, thus minimizing the use of bunker oil. Ethanol coming from distilleries with excess capacities and cheaper ethanol coming from other countries are potential competitors to ethanol produced from cassava feedstock.

At present, at least four companies have signified their intention to use cassava as feedstock for bioethanol production. The target areas for cassava production include the provinces of: Saranggani, Zambales, South Cotabato, Sultan Kudarat and Misamis Oriental, and the City of General Santos.

Table 5. Bioethanol demand projections for the year 2006 –2014.

Year	Projected Gasoline Demand* (In Million Liters)	Mandated Blend	Bioethanol Requirement (In Million Liters)	Forex Savings** (Php Million)	Value of Ethanol Production (Millions of Pesos)***
A	B	C	D = B x C		
2006	3,892	0			
2007	4,091	0			
2008	4,274	0			
2009	4,457	5%	223	9,361	6,018
2010	4,639	5%	232	9,742	6,264
2011	4,823	10%	482	20,255	13,022
2012	5,006	10%	501	21,026	13,516
2013	5,188	10%	519	21,788	14,008
2014	5,371	10%	537	22,559	14,502

Source: Philippine DOE

Notes: * Based on 2006 Philippine Energy Plan (PEP) Update

** Based on current pump price for gasoline, Php 42/liter (September 2007

*** At a distillery price of Php 27.00 per liter of ethanol

A number of bioethanol companies are still in the process of planning and land acquisition and expected to start operations in 2011. New entrants in the market mean additional ethanol production capacities and represent new competitors in the industry. Competition is expected to become intense when the national ethanol requirement shall have been exceeded.

POLICY RECOMMENDATIONS FOR ENHANCING VIABILITY

There are three major factors affecting the viability of producing bioethanol from cassava feedstock in the Philippines. These include the size of the market for bioethanol, the productivity of cassava and impacts on the environment.

The size of the market for bioethanol and the competitiveness of cassava feedstock with other sources of feedstock are major consideration for tapping cassava as a possible source of bioethanol. The market is well defined and in fact with the passage of the biofuels law, this market can be considered as a captive market which eventually will be a protected market come February 7, 2011. This is expected to expand over time given the provisions of the law that mandates that the blending proportions should be increased over time from 5% in the first two years during the implementation of the law and 10% within the first four years. Subject to availability of bioethanol, production blends may be increased. The law also mandates that this should be sourced locally. In addition to the captive local markets, the foreign markets are quite sizable and it would take time before their requirements are met. It is expected that over time, the competition will be more intense as the supply increases and the local and foreign requirements for biofuel are met.

The second consideration is the potential of cassava as a source of biofuel feedstock. This refers specifically to the sufficiency and sustainability of the supply of feedstock for the processing plant. The factors influencing these are as follows: (1) the potential yield of the varieties used for different biophysical conditions; (2) production scheme which should consider vertical integration to ensure the sustainability of feedstock supply for the processing plants; (3) the presence and condition of the access roads which has a significant effect on the eventual cost of the feedstock; (4) the cost of power generation; and (5) processing.

The viability of the ethanol distillery plant is dependent on increased net income that may be realized by increasing productivity and at the same time reducing per-unit production costs.

One of the key determinants of viability is the sustainability of the feedstock supply. To ensure continued supply of the feedstock, production should provide satisfactory income and economic incentives for the feedstock producer. The incentives can come in the form of increasing cassava productivity, getting a good price for their farm produce and a share in other potential income streams. Income sharing arrangement on the potential income streams such as derived from CDM, liquid fertilizer, and the like, should for example be established with feedstock suppliers in a binding legal instrument. Considering that bioethanol fuel in the Philippines is a captured and eventually a protected market by Feb. 7, 2011, purchase price formula for cassava has to be formulated to protect and maximize profitability of the feedstock suppliers.

Another major determinant is the improvement in the cassava production system which would enhance efficiency and profitability for both landholder-farmers and the processing plant. Well-established technologies are currently available to improve the productivity of cassava for food and industrial uses. These technologies generally promote the use of superior varieties, optimum cultural management practices and integrated pest management. The production technologies to be used in the proposed feedstock production project should take into account the above strategies while also considering traditional production schemes specifically suited to the target sites. Development of protocol for rapid propagation of cassava should be supported for mass participation of small farmers in the production of cassava for bioethanol. An estimated 50 million pesos is needed to start this program.

Different growing regions and production sites however may face different problems and limitations in the production of feedstock. As more marginal areas are utilized in an effort to expand production, there may be a decline in fertility levels. This however may be addressed by the

application of higher levels of fertilization inputs and the use of suitable varieties adapted to the particular growing conditions. Bulk negotiated government purchase of fertilizer should be pursued as this will reduce fertilizer price to Php800.

The efficiency and profitability of cassava and feedstock production will be greatly enhanced by continuing research on cassava production and processing. Increased government funding for cassava R and D along with the support of private end-users should provide mutual benefits to growers and industry stakeholders. Government research investment on crop technology development should focus on interventions that would lower the high labor and input requirements of cassava production. Higher budget allocation for research on farm mechanization, cultural management and varietal development should be provided by government to increase yield, increase starch content and consequently increase ethanol productivity of cassava as feedstock. More directly, subsidies or tax exemptions for such high cost inputs as fertilizers and agro-chemicals as well as fuel for farm machineries would significantly help reduce farm production costs.

The expansion of areas for cassava production would be expected to result to certain positive and negative externalities arising from the effects on existing industries that may be affected by the newly introduced business enterprises. The generation of a large number of jobs is expected for populations along the target production sites and adjacent localities. However, this may also increase pressure on food demand and supply. Likewise, the increase in demand for utilities may increase the pressure on the use of common local resources such as water, labor and transportation facilities.

While there is a positive impact on labor employment, the availability of labor may be a foreseeable problem with more progressive growing regions. Much labor may be drawn from farm communities to the cities since more job opportunities and higher wages are available in areas near urban centers and industrial sites. To prevent acute shortages of labor, the feedstock producer or ethanol plant should provide enough incentives for agricultural workers to stay and work in the farm.

The increase in cassava production for bioethanol would lead to an increase in pressure on existing road and transport facilities, especially those far from urban areas which would most likely have less-developed road network. This would mean higher transport costs for feedstock from the farms to the processing centers, and in conveying field supplies to the production farms. Under such circumstances, additional investments should be allocated for land clearing and road development. Investors to the proposed project may also seek government assistance to support road development efforts in the proposed growing areas, Corporate action may also be needed in order to construct vital roads and bridges in selected ethanol production areas, assuming there is no government assistance in these areas.

In most of the target or potential production sites in the country, there is enough area for growing cassava for feedstock. However, the use of these areas for growing cassava for bioethanol processing may have an adverse impact on food supply, i.e. indirect consumption in the form of meat and other derived products. Also, production areas for cassava for bioethanol feedstock production should be consistent with Philippine government policy and FAO–led intergovernmental declaration on sustainable and food security compliant biofuels production in Rome last June 3-5, 2008.

The source of energy is another consideration. An auxiliary energy source is recommended because of the large energy requirements for the cassava-into-ethanol process, especially for drying fresh cassava tubers during the rainy season. This is advisably an energy farm wherein a fast growing tree or grass crop shall be grown specifically to provide steam for the boiler or generator. The said energy farm should be a corporate-run operation and the harvested biomass shall be processed, e.g. bailing, chipping in order to provide ready boiler fuel. This means that the scale of the energy farm shall be limited in land area in order to produce biofuel energy equivalent to 160 MT of coal/day or

0.33 Million BTU/day. A fast-growing tree crop may be grown, such as eucalyptus, or a suitable grass. A detailed sub-study is needed in order to determine detailed logistic requirements and costing for the energy farm.

To meet the energy requirements, co-generation should be considered a must in all ethanol plants given the significant amount of biomass production. To further reduce power generation cost, coal maybe used to supplement biogas only if complete environmental safeguards are in place especially on the coal storage and gaseous emissions. The cost of electricity generated by a multi-fired boiler using coal as fuel is estimated at 1 to 1.5 pesos per kwh. This production cost is only about 1/6 of the production cost when bunker is used as fuel.

The third major consideration is impact on the environment given the potential residues from processing. In this respect, the use of compost can be promoted for better energetics, improved environmental effects (GHG) and possibly reduction in cost of production. Loading application of anaerobically treated distillery slops such as liquid fertilizer to specific cassava plantation should be validated. Slops application as liquid fertilizer could be as much as 200 cubic meter per hectare per year as in sugarcane plantation. With this, an estimated savings of as much as 50% could be realized on both capital investment and operating cost of wastewater treatment facility of the ethanol plants.

On the whole, a cassava feedstock and bioethanol industry in the country should develop efficient production and processing capabilities to contend with the low cost of importing ethanol as well as to compete with other nations aiming to export bioethanol to the international market.

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ABSTRACTS
ISSAAS PHILIPPINES NATIONAL CONVENTION 2009

MICROBIAL TREATMENT OF JATROPHA PRESS CAKE AND FISH FEED NUTRITIONAL QUALITY EVALUATION

Bayani M. Espiritu, Alexandra L. Nova, Mannix S. Pedro, and Jovita Movillon
UNIVERSITY OF THE PHILIPPINES AT LOS BAÑOS College, Laguna

This study determined the possibility of using Jatropha press cake for feed production by allowing it to undergo anaerobic fermentation to improve its pH, crude protein content and total sugar content. Three separate experiments were conducted, each consisting of various treatments, and each treatment spanning a total of 21 days. The enrichment study evaluated the effects of using selected nutritional additives such as rice washings, sugar, salt and skim milk in fermenting *Jatropha* press cake in combination of up to 3% of the total *Jatropha* press cake by weight. No significant improvement (in terms of pH and sugar content reduction) was observed when using the additives separately as compared to using all the additives together in one sample. Using all the additives applied together resulted in lower pH and higher decrease in sugar content. Adding enrichment to *Jatropha* press cake prior to fermentation could improve crude protein content and other fermented feed properties. A mixed bacterial inoculant was developed based on the enrichment study and on pH and product smell. Using enrichment and mixed lactic acid bacterial inoculants together produced a feed with lower pH and greatly improved initial sugar content, resulting in better sugar consumption. Adding the mixed inoculant and enrichment to *Jatropha* press cake prior to fermentation significantly improved the fermented feed properties. The effects of adding non-protein nitrogen or urea (NPN) with mixed lactic acid bacterial inoculants was also evaluated. This treatment produced the lowest desirable pH and better crude protein levels. Overall, the treatment that produced the best results in terms of pH, decrease in sugar content, crude protein increase and smell was *Jatropha* press cake wetted with 3% rice washings and 3% mixed lactic acid bacterial inoculants.

PANGASINAN STATE UNIVERSITY ORGANIC FERTILIZER PROJECT EXTENSION STRATEGIES AND INITIATIVES

Prof. Elisa S. Della and Dr. Cesar G. Della
PANGASINAN STATE UNIVERSITY Sta. Maria, Pangasinan

Pangasinan State University has a critical role to play in countryside development, consistent with the university mission of ".. providing better service in the technical and professional training in the arts, sciences, humanities, and in the conduct of scientific research and technological studies and community service". One of the banner projects is the Organic Fertilizer Production Project (OFPP) which aimed primarily to develop technologies and promote the utilization of organic fertilizer through different techno-transfer strategies and initiatives to attain sustainability in agriculture. The paper showcases the extension strategies and initiatives which has been generated for the last 9 years. The technology refers to the organic fertilizer which is promoted in collaboration with LGUs and other stakeholders for utilization and adoption among farmers and other interested individuals. It discusses the different components to effect desired development outcomes for the rural communities. These involved (1) capability building/training of farmer-clienteles; (2) establishment of organic fertilizer production plants and assistance to LGUs Material Recovery Facility (MRFs); (3) techno-demo to showcase the effect of PSU organic fertilizer through the university's crop production activities; (4) techno-demo strategies, trainings and actual demonstrations were conducted and distribution of IEC materials in collaboration with cooperating agencies; and (5) monitoring and evaluation on trained farmer cooperatives were undertaken to ensure optimum production and

utilization of the technology. The dissemination, promotion and utilization of the PSU organic fertilizer production technology resulted in (1) farmers and other clienteles equipped with the skills and knowledge on low-cost and adaptable organic fertilizer production technology; (2) organic fertilizer production plants established and LGUs assisting in the production of organic fertilizer using their acquired state-of-the-art equipments; (3) promotion of the utilization and adoption of the OFPT thru technology techno-demo and development, production and distribution of IEC materials; (4) increased number of farmers adopting the technology; and (5) linkages with other agencies were strengthened. It is therefore recommended to: (1) closely monitor and evaluate the performance of trained farmers; (2) intensify the conduct techno-demo at farmers' farms; and, 3) license the product.

SUPPLY CHAIN IMPROVEMENT FOR THE ABACA INDUSTRY IN THE BICOL REGION, PHASE 1: EVALUATION RESEARCH

Arnulfo M. Mascariñas, Viola L. Amano, Jane B. Mascariñas, Carlos V. Cortez, Jr. and Angelo P. Candelaria
BICOL UNIVERSITY Legazpi City

This paper presents the analysis of the supply chain of abaca fiber and abaca-based products in the Bicol Region. Supply chain maps showing the key players and the flow of product, information and payments among them were illustrated. In addition, their roles and responsibilities, logistic issues and external influences faced were discussed. The efficiency, flexibility and overall responsiveness of supply chains and its players were also determined. Abaca fiber flows from the farmers to the end-users through a series of middlemen in a supply chain. The main problem of the industry is the low productivity of abaca farms, which hinders the supply chain players (i.e. farmers, traders, buying stations and GBEs) from meeting the abaca fiber requirement of their customers. This problem is caused by poor fiber quality, inadequate abaca replanting effort, declining area planted to abaca, non-adoption of recommended package of technology, limited value-adding and/or value-creating options at the farm level, and inclement weather. The persisting credit-market tie-up disables the farmers-and other traders to haggle for a better price for their abaca fiber and they are even charged with high shrinkage cost. It was also observed that there is a redundancy of functions performed by the supply chain players. Based on the identified issues, the following policy directions to improve the abaca supply chain with specific focus at the farm level are forwarded: (1) continuous training program on the various aspects of abaca production and post-harvest handling practices; (2) organization and/or strengthening of producers/marketing associations among farmers; (3) provision of alternative livelihood activities; (4) design, development and pilot testing of portable abaca stripping device; (5) rehabilitation of existing abaca areas in mainland Bicol using the recommended package of technologies (POT) and restoring shade cover, and (6) strengthening of information dissemination and extension support.

PRICE DYNAMICS AND COINTEGRATION IN THE MAJOR MARKETS OF AQUACULTURE SPECIES IN THE PHILIPPINES

Yolanda T. Garcia[1] and Nerissa D. Salayo[2]
[1]*College of Economics and Management, University of the Philippines Los Banos (UPLB); and*
[2] *Aquaculture Department of the Southeast Asia Fisheries Development Council (SEAFDEC-AQD), Manila.*

This study explored the interdependencies of aquaculture markets in the Philippines by establishing price cointegration between wholesale and retail prices of three major species commonly farmed in the country, i.e., milkfish, tilapia and shrimp. The co-movements of wholesale prices between and among key markets for each species were also investigated. Moreover, exogeneity in prices was established using Granger-causation model to determine the existence of price leaders among these

markets. Such information are crucial in farm management decisions of producers and traders through better understanding of the efficiency in price formation across production and consumption centers which in turn defines the movements in prices and products among markets. Appropriate policies for the development of markets for the three aquaculture species were also identified. Such policies are expected to contribute towards the attainment of efficient pricing and distribution of benefits among market players and stakeholders. These benefits are expected to manifest through the system of grading standards for fish traded in local markets and in the choice of cost-effective technologies in grow-out and post-production practices.

YIELD PERFORMANCE OF DIFFERENT SPECIAL PURPOSE VARIETIES OF RICE IN ABRA

Alfredo B. Edwin Jr.
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY (ASIST) Lagangilang, Abra

The study determined the performance of PhilRice special purpose rice varieties in terms of yield in Abra under lowland ecosystem. The best varieties would be recommended to rice farmers for growing in the area. Specifically, the study was conducted at the ASIST Research area for two cropping seasons (2007 and 2008). Based on the findings, significant effects were noted on plant height at maturity, number of productive tillers, number of unfilled grains, length of panicle, weight of seeds, harvest index and yield. Moreover, all the varieties were found to be resistant to pest and diseases. NSIC Rc 13, NSIC Rc 17 and NSIC Rc 128 varieties gave the highest yields, which did not significantly differ from each other. These varieties were therefore recommended as planting materials.

SURVEY AND DOCUMENTATION OF AGROFORESTRY SYSTEMS IN APAYAO

David Rodolfo
APAYAO STATE COLLEGE Malama, Conner, Apayao

This study documented the existing agroforestry systems in Apayao. The farming systems in the province can be considered as varied in terms of tenure, unit of production, water availability, and topography. It can be generalized as: a) managed by the households, b) legally/not legally owned, c) with 3 to more than 18% slope, d) rolling to undulating topography, and e) irrigated to non-irrigated or rain-fed. These characteristics are common to upland farming systems. However, unlike other indigenous farming systems, production systems in Apayao are not only for subsistence but also for small to medium-scale production for commercial purposes. The variation can be observed in terms of output disposal, scale of operation, dominant crop and species diversity. These variables can be grouped as system components with their corresponding roles, interactions and distribution. Using these groupings, farming systems in the study area can be categorized as: a) mono crop plantation-based, b) multiple crop plantation-based (multistorey, relay cropping, mixed cropping), c) aqua-silvicultural-based, d) annual home garden, e) perrenial home garden, and f) rice terracing. All the above cropping systems can be considered as multistorey, intensive and diversified. Even the mono-crop plantation-based system has at least three to five plant species with only one major crop. The farming system in the area is a product of: a) changing land-use pattern and vegetative-plant succession with time, b) migration and settlement pattern, c) technological innovation and adaptation pattern, d) market orientation, and d) socio-cultural pattern. The problems encountered by the farmers on production and practice of agroforestry were the occurrence of insect pests and diseases that resulted in low production output or even negative profit, lack of seminars or trainings for the technology to be used in the production system, and lack of fruit and forest tree seedlings to be planted, transportation for marketing and small land holdings.

SELECTION INDEX OF TYPHOON-RESISTANT REFORESTRATION SPECIES AS ADAPTATION STRATEGY ON CLIMATE CHANGE

Alejo N. Balaguer
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Region V, Legazpi City 4500, Philippines

In the Philippines, one of the indicators of climate change is the increased occurrence of stronger typhoons. However, there is no screening method being used to choose the reforestation species suitable for typhoon-prone areas in the country. Four frequently used reforestation species were evaluated for typhoon resistance under field conditions in Bacacay, Albay, Philippines from January 2000 to December 2001. Agoho (Casuarina equisetifolia), mahogany (Swietenia macrophyla), river red gum (Acacia auriculiformis) and yemane (Gmelina arborea) were assessed in terms of five different damage categories as treatments, namely: defoliation, breaking of branches, breaking of stem, leaning, and uprooting. Plots were laid out on top of mountain ridges where the heaviest impact of typhoon was expected. Correlation analysis was used to compare linear associations of the damage categories, total height, basal diameter and species. Agoho was found resistant in all damage categories assessed. It could be recommended in reforesting exposed, high elevation, typhoon-prone areas due to its needle-like foliage, spherical canopy structure, high wood tensile strength and a deep root system. Mahogany was found moderately resistant to typhoon, while yemane and river red gum were non-resistant. Using the different damage categories assessed in the study, an index of species resistance to typhoon was developed. Reforestation species to be planted in typhoon-prone areas should conform to the resistance index to lessen damage and save on financial resources. This could be an adaptation strategy to climate change.

THE POTENTIAL OF WEAVER ANTS (*OECOPHYLLA SMARAGDINA*) AS BIOLOGICAL CONTROL OF MANGO LEAF HOPPERS

Glenn P. Soriano
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY (ASIST) Lagangilang, Abra

The study evaluated the potential of weaver ants as biological control for mango leaf hoppers. Three treatments were used: Treatment A (untreated control), Treatment B (insecticides only) and Treatment C (weaver ants only). Results showed that the highest numbers of mango leaf hoppers before flower opening, during flower opening, and after flowering were noted in treatment A. The highest percentage of mango leaf hopper mortality was observed in Treatment B; The highest number of mango fruits developed at mongo-size was observed in Treatment C. Treatment B produced the highest number of mango fruits at corn-size and the highest number of fruits harvested (134) followed by Treatment C (89), leaving no significant difference between the two treatments. Again, Treatment B had the heaviest production (13.79). Treatment A had the sweetest mangoes harvested with sugar content of 19.15, followed by Treatment B with sugar content of 18.34 and Treatment C having a sugar content of 18.22. However, a very slight difference on the percentage of fruit damaged was noted between Treatments B and C. Treatment C posted the highest net income with a return on investment of 224.39%.

ASSESSMENT OF FISHING PRACTICES ON ENDEMIC FISH SPECIES IN KALINGA

Bernadette C. Aggabao, Ferdinand Ganotice and Helen F. Bais
KALINGA-APAYAO STATE COLLEGE Tabuk City, Kalinga

The fishing and fish production practices on endemic fish species in Kalinga Province were assessed. The study was conducted in eight municipalities of Kalinga where major tributaries of fresh waters are located. Respondents were fisher folks engaged in fishing as their major source of income and also

those who treated it as one of their habits. A survey questionnaire was the major tool in gathering information, while instant interview of the fisher folks was done before the actual conduct of the study. Digital camera was also used to gather additional data relevant to the study. To ensure the veracity of the study, systematic random sampling among the fisher folks in each municipality was done. Kalinga s considered as one of the indigenous fishing communities in the Cordillera Administrative Region (CAR). Rivers connecting from the Chico River going down to the lower streams are very rich sources of indigenous fishes which fishermen usually harvest for their consumption. The traditional practices of using *banni-it, tabbokol*, etc. are observed in rivers and lakes of the province. However, employing the traditional methods is not enough to augment the fisher folk's food needs and income. This study is one giant step to come up with concrete plans to improve fish production in Kalinga; thus possibly improving their socio-economic condition.

BIO- PHYSICAL AND CHEMICAL CHARACTERIZATION OF THE RIVER SYSTEM IN APAYAO PROVINCE

Agustina B. Gutierrez and Maria Christina Z. Manicad
APAYAO STATE COLLEGE Malama, Conner, Apayao

This study determined the bio-physical and chemical characteristics of the major river system and described the habitat of fish and shells in Apayao. Field survey and water analysis were conducted in 10 rivers found in Apayao, namely; Acutan, Nabuangan, Barren, Cabicungan, Laco, Karagawan, Nagan, Binuan, Zumigue and Ziwanan Rivers. Analysis of physico-chemical parameters of the river systems revealed that air and water temperatures range from 22 to 30oC, average water velocity 0.11 – 3.44 m/s, stoney to muddy bottom type, clear water, pH range of 7.32 to 7.97, average DO level and BOD of 6.11 and 2.96 mg/L, respectively. Moreover, these bio-physical and chemical parameters measured in the different rivers fall within the standards set by DENR for unpolluted rivers. The different rivers are inhabited by diverse fish and shell species. Activities within the rivers include fishing, bathing, swimming, washing, and transport of goods by the residents. The rivers provide an abundant water supply for irrigation as well as for domestic uses. There are Dipterocarp species grow in the area, while shrubs and grasses dominate the buffer zone of the rivers. To conserve these freshwater resources, the "Lapat" Sytem is implemented in Apayao.

CLASSIFICATION OF DIFFERENT LAND UTILIZATION TYPES IN THE MULTIPLE USE ZONES OF MT. ISAROG NATURAL PARK, PHILIPPINES

F. B. Perlas, V.R. Foronda, M.T.B. Lirag and M.V.B.Refereza
CAMARINES SUR STATE AGRICULTURAL COLLEGE Pili, Camarines Sur, Philippines
fbperlas@yahoo.com

The transect method of soil survey was used to study the floral species and the soil and land characteristics in the multiple use zones in Mt. Isarog. The observation sites, which were based from the map produced by CARE Philippines, are located in Sto Niño and Villaflorida, Ocampo, Camarines Sur; Payatan, Goa, Camarines Sur; Cawayan, Tinambac, Camarines Sur and in Panicuason, Naga City. The study determined the soil and other environmental characteristics at MINP multiple use zones; the existing floral species in the multiple use zones; land capability, soil fertility rating and soil suitability of the existing floral species, and generated land capability, soil fertility and soil suitability maps of MINP MUZs using the Geographic Information System (GIS). Most of the areas, particularly those located at the lower footslopes, are generally fairly good land and classified as Land Capability Class De. This class denotes a land that requires very careful management and intensive conservation practices for safe cultivation. However, a small portion of the area located on the lower footslope in Sto. Niño is classified as Class Ce, which is a moderately good land but also requires careful management and good conservation practices because it is moderately

eroded. The areas on the upper footslopes in the barangays of Payatan, and Villaflorida and Cawaynan are classified as Class M because of the steep slopes and moderate to severe erosion. These areas are limited to pasture or forest use, but also require careful management.

DISSEMINATING THE RESOURCE MANAGEMENT SYSTEM OF THE TINGGUIANS (LAPAT) THROUGH INSTRUCTIONAL MODULES

Elsa D. Bagioan
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY (ASIST) Lagangilang, Abra

This study described the "Lapa"t system (Tingguian Resource Management System), documented its rituals and practices, analyzed its enabling factors and problems, and developed instructional materials from data gathered. Key informants were purposively identified from among the council of elders, "Lapat" officers, religious sector, ASIST Tingguian students, women, politicians, professionals, community folk, and government and non-government organizations. Data were gathered through interview schedule, focus group discussions (FGD) and informal meetings with key informants and FGD discussants. The collected data were further confirmed by participant observation, site visits and walk through. Results showed that the "Lapat" system protects and sustains the forest, fresh water resources, and environment for the present and future generations of Tingguians. The Council of Elders and "Lapat" officers manage all the activities of "Lapat" and enforce laws of the community by banning the harvest of dwindling forest products. The ban is lifted when forest products are replenished. The "Lapat system" is imbedded in the Tingguian culture. It involves prayer petitions (*bagawas*), information dissemination (*palek*), traditional oath (*sapata*) and fact finding ritual (*duo*). During the sealing of "Lapat" agreements, the whole community celebrates through traditional songs (*salidummay*), ethnic dance (*tadek*) and chants (*oggayam*), and a community luncheon highlights this events. Implementing the "Lapat" system entails problems such as smuggling of timber and non-timber products, population pressure, conflicting traditional and government laws on forestry and mining, kaingin, insurgency, boundary disputes, and weakening of cultural values. But generally, "Lapat" has enabling factors. It is indigenous and utilizes bottom-up and participative approaches with local communities, GO, NGO and religious groups, particularly the Roman Catholic Church, through its Apostolate on Integrity of Creation. It is also supported by the government through the IPRA law. With the gathered information, instructional modules have been developed for use in the social science subjects and have been integrated in the education, agriculture and forestry courses of Abra State Institute of Sciences and Technology (ASIST). ASIST provides a curriculum which is truly Filipino by developing modular instructional materials authored by a local author.

DIVERSITY OF NITROGEN-FIXING PLANTS IN AGRO-FORESTRY SYSTEM IN ABRA

Alfredo B. Edwin, Jr.
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY (ASIST) Lagangilang, Abra

The study was conducted to generate information on the diversity of nitrogen-fixing plants in agroforestry farms in 12 municipalities of Abra from 14 January to 30 April 2009. Respondents of the study were the owners and farmers of the agroforestry farms. The study made used of the descriptive design in benchmarking, characterization, documentation and evaluation of nitrogen-fixing plants. Descriptive statistics was employed. A structured interview schedule was used and supplemented by actual observation. Results showed that agroforestry farms in Abra contained diverse nitrogen-fixing plants. These plants included edible legumes, forage, medicinal plants and trees. These had definite characteristics, as well as ecological niche. The most common nitrogen-fixing plant found in the municipalities surveyed was kakawate or madre de cacao. Other plants grown were ipil-ipil and food legumes such as string beans, pigeon pea, mung bean, lima bean, hyacinth bean, wing bean, peanut and winged beans. Baguio beans, mani-mani, acapulco, tayum-tayum and sampaga were rarely

grown. Dolores, Luba and Tubo municipalities had the most number of nitrogen-fixing plants growing in agroforestry farms. Few nitrogen-fixing plants were seen in La Paz, San Isidro and Pennarrubia. Since these were lowland municipalities, fruit trees and field crops were usually grown in the agroforestry farms. Other crops cultivated included vegetables, plantation crops such as pineapple, fruit trees, grain crops, spices and forest trees.

EFFECTS OF SOIL AMENDMENTS ON THE GROWTH OF *JATROPHA CURCAS*

Nina M Cadiz
Institute of Biological Sciences UNIVERSITY OF THE PHILIPPINES LOS BANOS

An earlier study using copper contaminated soil from Mogpog, Marinduque was carried out to determine the effect of mycorrhizal amendment on the growth of Jatropha curcas. In addition, an experimental set-up carried out in Mogpog, Marinduque was done to study the effects of various soil amendments in jatropha. Since there was no work that looked into the effects of various soil amendments using garden soil that was previously treated with elevated levels of copper (0, 50, 100 and 500 ppm), a parallel potted experiment was carried out in the nursery area of the National Institute of Molecular Biology and Biotechnology, UPLB. Soil amendments were applied in fully established cuttings of jatropha. The treatments included not only mycorrhiza but complete fertilizer, compost and their combinations. Growth performance was assessed in terms of plant height and stem diameter (cm). The results showed that mycorrhizal application alone did not greatly improve the growth performance of the plant as compared with the control. In addition, compost amendment together with mycorrhiza showed better performance of jatropha than mycorrhiza alone. As expected the best growth performance was exhibited by all treatment combinations.

ENVIRONMENTAL SUSTAINABILITY AND CONSERVATION THROUGH INDIGENOUS NATURAL RESOURCE MANAGEMENT (INRM) IN THE CORDILLERAS: OPTIONS FOR PARTICIPATORY COMMUNICATION

D.M. Macandog, M.S.C. Tirol, E.R. Abucay[1], E.B. Bernardo, J.P. Talubo, K.G. Engay and K. Brown
UNIVERSITY OF THE PHILIPPINES LOS BAÑOS College, Laguna

Sustainable resource management is embedded in the tradition, culture and beliefs of the indigenous communities in the Cordilleras. The richness of natural resources in the region is coupled with Indigenous Natural Resource Management (INRM) strategies that help conserve and sustain their environment for decades. The paper presents the development and application of participatory approaches in the development of Information Exchange and Campaign (IEC) materials on INRM at the community level. IEC materials including posters, flyers, comics and radio spot were developed using a variety of participatory approaches such as Key Informant (KI) interview, Focus Group Discussion (FGD), community poster development, community folk story development and community translation. The Muyong or Pinugo is an indigenous forest management strategy in the Cordilleras recognized internationally. Various publications report that this INRM strategy does not only provide sources of food, fiber, fuel wood and construction materials to the communities but also helps minimize soil erosion and water runoff; maintains soil fertility, plant and animal biodiversity, and provides steady water source of the rice fields below for several generations. Another INRM strategy practiced by indigenous communities in the Cordilleras is the tapak-tapak system. Wild sunflower) is used as organic fertilizer. Foliar cuttings are applied either in the rice seedling beds or directly to the fields, and allowed to decompose before the start of the planting season. As an organic fertilizer, it helps maintain soil fertility, gives vigorous growth to rice and sustains rice yield. Participatory approaches are essential in acquiring first-hand information essential in the development of acceptable and effective forms of community IEC materials (e.g. community poster, flyers and story book) for environmental sustainability and conservation. With the tacit nature of indigenous

knowledge as in INRM strategies in the Cordilleras, effective transformation of such knowledge into community level communication tools is necessary.

FISH AND SHELL PRODUCTION PRACTICES IN APAYAO PROVINCE

Maria Christina Z. Manicad and Agustina Gutierrez
APAYAO STATE COLLEGE Malama, Conner, Apayao

This study determined the fish and shell production practices in Apayao. Specifically, it identified the native fish and shell species found in the province, and documented indigenous fishing and fish-shell production practices/methods of the fisherfolk. Field survey, interviews and photodocumentation were utilized in this study. There were various kinds of native fish and shell species are found in the freshwater habitats within the province. These included "gurami", "palileng", native "karpa", "paltat", "dalag", "igat", "kiwat", "to' rit", "agudung", "dukiang", "bildat", "balingasa", "ahama", native "kohol", "udang" and "padaw". There were also indigenous fishing gears and fish-shell practices employed by the fisher folks. They utilized "sidu", "sarapa", "sigay", "tabukol", "bukatot", "sedeng", "banni- it", "pana", fish pot, scoop net, "alat", "pana" and "bubo" during fish and shell capture operations. Some still employed "karas", while others used gill net, hook and line or trap nets. However, with the advent of modernization, some fisher folks had already adapted new methods and facilities in fish and shell production using concrete tanks, hapa net or earthen fishponds. There should be a program on preserving and improving of traditional fishing gears and practices as well as retaining the important fish- shell capture and production.

PAPEL BUHID: A PARADIGM FOR THE MANAGEMENT OF NATURAL RESOURCES AND SUSTAINABLE LIVEHOOD AMONG THE INDIGENOUS PEOPLE IN OCCIDENTAL MINDORO, PHILIPPINES

Susanita G. Lumbo, Nelson A. Orfiano and Garry L. Calitang
OCCIDENTAL MINDORO NATIONAL COLLEGE Murtha Campus, San Jose, Occidental Mindoro

The Poverty Alleviation Promotion thru Environmental and Livelihood Program for the Buhid Mangyans (PAPEL Buhid) is an extension program implemented by the Occidental Mindoro National College (OMNC) in partnership with the Buhid Mangyans and Barangay Council of Monteclaro in San Jose, Occidental Mindoro. It is a five-year program launched in December 2006 designed to help in the rehabilitation and conservation of upland resources and in the generation of sustainable livelihood of the Buhids. It specifically aims to improve agricultural production and health condition, promote adoption of appropriate upland technologies, and introduce sustainable livelihood using locally available resources. All projects implemented are designed to address the most pressing problems identified by the Buhids during the participatory appraisal such as poor health, low farm productivity and income, poor soil quality and land erosion. PAPEL Buhid has established a community nursery for forest and fruit-bearing trees and herbal plants, backyard vegetable garden, and mahogany and banana plantation. It has conducted livelihood trainings on handicraft, organic fertilizer production, seedling grafting, and practical cooking; seminar on health and nutrition, prevention of community diseases, parenting, and values orientation; and jingle making and singing contest. Observed effects of program include the planting of forest and fruit trees in the idle lands, practice of organic agriculture, adoption of environment-friendly technologies, generation of livelihood, increased awareness on environmental conservation, and building of greener and cleaner village.

NATURAL RESOURCE MANAGEMENT AND COMMUNITY-BASED LIVELIHOOD OPTIONS AS CROSS-CUTTING APPROACHES IN REACHING OUT TO THE INDIGENOUS PEOPLE OF OCCIDENTAL MINDORO

Susanita G. Lumbo, Mary Yole Apple M. Declaro, and Venessa S. Casanova

OCCIDENTAL MINDORO NATIONAL COLLEGE Murtha Campus, San Jose, Occidental Mindoro

This paper argues that the use of ecosystems-based, community-centered, and holistic approaches bring out livelihood sustainability and natural resources conservation and management among the indigenous peoples of Occidental Mindoro, particularly those that belong to the five major tribes including Hanunuo, Buhid, Batangan (Tau-Buhid), Iraya, Ratagnon, and HaGuRa. The extension activities of Occidental Mindoro National College (OMNC) are implemented in partnership with the government, non-government and private organizations. This multisectoral partnership spearheaded the promotion of training and extension programs on Sloping Agriculture Land Technology (SALT), soil and water conservation, and biodiversity conservation; and community-based livelihood options like banana plantation, organic fertilizer production, food processing, and handicraft among the IP communities. This paper also highlights the distinct cultural and social traditions of the Mangyans in relation to the environment, which, when ignored may lead to failure of the interventions. The project experiences suggest that the success of any development program is dictated by realistic and need-driven programs. The participation of the communities, particularly the women groups is highly observed in the implementation of economically-viable projects such as production of high value crops and handicraft production.

GERMPLASM COLLECTION, IDENTIFICATION AND CHARACTERIZATION OF NATIVE RICE

Zacarias Baluscang, Jr. and Juana S. Angagan
APAYAO STATE COLLEGE Malama, Conner, Apayao

This study dealt with the collection, characterization and evaluation of yield performance of 10 native upland rice varieties. The rice varieties were collected from different barangays within Apayao Province. These were planted with formulated homemade organic fertilizer in the rice terraces of the Apayao State College. Results showed that the native rice landraces were resistant to diseases and could withstand drought, although they differed in vegetative and grain characteristics. Calanasan had the highest mean yield per plot followed by Bolinaw and Sabadilla. There were significant differences among means of weight of 1000 rice grains of nine native upland rice landraces at 0.05 level of significance. LSD showed that means of Treatments 1 and 2 (Sinumay and Azucena), 4 and 5 (Sabadilla and Balatinaw), 6 and 7 (Tangtang and Calanasan) and 8 and 9 (Oskil and Biit) significantly differed, while those of treatments 2 and 3 (Azucena and Bolinaw), 3 and 4 (Bolinaw and Sabadilla), 5 and 6 (Balatinaw and Tangtang) and 7 and 8 (Calanasan and Oskil) did not. There were significant differences between the means of weight of grains from every plot of the nine upland native rice varieties compared to LSD at 0.05 level of significance. It showed that means of Treatments 3 and 4 (Bolinaw and Sabadilla) were not significantly different, while Treatments 1 and 2 (Sinumay and Azucena), 2 and 3 (Azucena and Bolinaw), 4 and 5 (Sabadilla and Balatinaw), 5 and 6 (Balatinaw and Tangtang), 6 and 7 (Tangtang and Calanasan), 7 and 8 (Calanasan and Oskil) and 8 and 9 (Oskil and Biit) were significantly different. Based on the results, Calanasan, Sabadilla and Bolinaw are recommended for adaptation to other rice fields and for propagation. It is recommended that further studies be conducted to identify the varieties of these native upland rice.

FLORAL INVENTORY IN RICE TERRACES AND ITS ENVIRON AT TANGLAGAN, CALANASAN, APAYAO

Brent Begay, Agustina B. Gutierrez and Satur Bangyad
APAYAO STATE COLLEGE Conner, Apayao

This study assessed the floral composition and the environment in the Tanglagan Rice Terraces, Calanasan, Apayao Province. Transect and quadrats/inventory plots were laid in the study site. There were 22 floral species inventoried within the rice terraces. Of these 22 plants, 10 were members of Family Poaceae (also known as Graminae), 4 species of Family Asteraceae and 1 species each of Families Amaranthaceae, Dennstaedtiaceae, Euphorbiaceae, Onagraceae, Pontederiaceae and Appiaceae. In the immediate environment of the rice terraces, 27 plants species were documented that included trees, shrubs, palms, vines, grasses and herbs. They belonged to Families Sterculaceae, Araceae, Lauraceae, Palmae, Leguminosae, Musaceae, Myrtaceae, Piperaceae, Sapotaceae, Rutaceae, Convolvulaceae, Euphorbiaceae, Moraceae, Mimosaceae, Fabaceae, Anacardiaceae, Caricaceae, Cucurbitacea, Asteraceae and Poaceae. The plants in the immediate environment were commonly used as sources of food, beverages, fuel (firewood and charcoal), medicines and fibers. In terms of density and frequency within the rice terraces, *Oryza sativa* and *Paspalum conjajatum* registered the highest density, while the highest frequency and relative frequency were exhibited by *O. sativa*, *P. conjajatum*, *Fimbristylis miliaceae* and *Cyperus iria*.

FRY QUALITY OF PROMISING POTATO SELECTIONS GROWN FROM THREE LOCATIONS OF BENGUET

E.J. Sagalla, D., L. P. Matsal and D. K. Simongo
BENGUET STATE UNIVERSITY La Trinidad, Benguet, Philippines
Email: ejsagalla@yahoo.com.ph, dsimongo@yahoo.com.ph

The study identified the location in Benguet that produced potato selections with the best fry quality; the potato entry with the best fry quality, and the effect of interaction between locations and potato entries on fry quality. The potato tubers harvested in Loo had the highest dry matter content and fry yield. In addition, the fries produced from these tubers were much liked by the sensory panelists. The fries produced from tubers harvested in Bonglo and Sagpat were moderately crispy, moderately perceptible, moderately oily, slightly firm, slightly brown and were moderately liked by the panelists. The potato entries CIP 2.21.6.2 and Igorota showed good fry quality based on high dry matter content and high fry yield. Both produced fries which were much liked much by the panelists. Growing CIP 2.21.6.2 and Igorota in Loo is recommended to produce production of tubers with good fry quality.

IDENTIFICATION AND CHARACTERIZATION OF DYE-YIELDING PLANTS IN APAYAO

Marjorie T. Aswigue and Agusta B. Dangiwan
APAYAO STATE COLLEGE Malama, Conner, Apayao

The study identified natural dye-yielding plants in the upper municipalities of Apayao using the descriptive survey method. Findings revealed that Coffea robusta, a small tree 3-5 meters tall and with elongated leaves 15-20 cm long and 7-9 cm. wide, produced a brown dye from its bark and grain peel. “Pakak” or “antipolo” yielded an orange-brown dye from its bark. Gmelina arborea likewise produced a light brown dye from its bark. The narra tree also gave a yellow dye extracted from its bark. Anabiong tree, 10-15 meters tall, produced orange-brown dye from its bark, while bugnay, a tree growing to 6-8 meters high, yielded a light brown dye from its bark. Lubeg, a small tree which can grow anywhere and bears fruits that turn maroon when ripe, also produced red-violet dye.

INDIGENOUS KNOWLEDGE (IK’S) AND BIODIVERSITY CONSERVATION PRACTICES IN THE RICE TERRACES OF ABRA

Alfredo B. Edwin, Jr.
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY (ASIST) Lagangilang, Abra

The study documented indigenous knowledge and conservation practices in the rice terraces of Abra. It was conducted from 02 Dec. 2008-30 Apr. 2009 in 12 Abra municipalities where rice terraces were located and traditional varieties were planted. Respondents were the rice farmers growing traditional rice in the terraces. The study used the descriptive survey method of research, together with semi-structured interview and observation as instruments to collect data. Results showed that most of the traditional rice varieties cultivated by farmers had been used since time immemorial and passed on through generations. Moreover, farmers applied numerous indigenous knowledge and practices such as depositing pulled weeds in the bunds, sowing whole panicle in seedling production, "alluyo" system, "rakem" harvesting and flail threshing, utilization of farm wastes as organic fertilizer, and use of botanical pesticides. Farming practices, beliefs and attitudes were observed in conserving traditional rice varieties like observing dates for starting any field work, cooking native delicacies to offer in the farm area, harvesting beliefs and "ubaya". Traditional rice varieties were conserved by fencing, crop rotation and continuous cropping; multiplying the number of species, storing the bundled sower seeds by hanging for the next planting season, applying botanical pesticides, and conserving the trees in the watershed for sustainable rice production. The declining number of farmers growing traditional rice was influenced by agronomic, socio-economic and cultural factors. There should be an effort to conserve traditional rice. Collaboration among concerned agencies to strengthen conservation measures for these rice varieties must be done.

INDIGENOUS KNOWLEDGE AND BIODIVERSITY CONSERVATION PRACTICES IN APAYAO RICE TERRACES: A GENDER LENS PERSPECTIVE

Juana Angagan
APAYAO STATE COLLEGE Malama, Conner, Apayao

This study identified and described the indigenous knowledge and conservation practices of indigenous people in the rice terraces of Apayao Province. On forest resources, some portions of the forest where the indigenous people obtain wild fruits and vegetables have been converted into swidden farms for planting rice, bananas, legumes and fruit trees. Of the 43 species of wild food plants eaten by the indigenous people, only 19 species have been identified by the researchers. There are 50 species of medicinal plants. Fibers from wild *Ananas comosus* (pineapple) in the forest are also extracted by the indigenous women as thread for sewing clothes. Fibers of white *Ficus minahassae* (Agimit) are sewn into panties, while these of *Abroma augusta* (Anabo) and *Musa textiles* (Abaca) are twined into ropes. In Kabugao and Calanasan, the barangay officials serve as the forest watchers. Any intruder is fined. In Conner municipality, a joint program on environmental protection is being implemented by the LGU, ASC and NGO. The members of the Save Apayao Peoples Organization are very vigilant in protesting against forest destroyers. There are 15 species of vegetables planted in between the 15 identified trees. These are fertilized with ashes from burned trees. Tributaries confluently flowing to the river are clean for indigenous people do not apply toxic chemicals in farming. These folks use trap net, hooks and fish cage in catching fish. Swidden farmers are prohibited from cutting trees within 100 meters of the watershed to protect the source of water. Indigenous farmers apply environment-friendly practices in farming such as green manuring to enrich the soil. The swidden farmers burn the forest for upland rice, bananas and legume plantations. They use the ashes as fertilizer. The common animals raised are carabaos, hogs, chicken and dogs. The indigenous people treat diseases by using plants and vinegar. Diverse medicinal plants have been used by old folks to cure illnesses. Four plants have been utilized as pesticides. Indigenous men and women help in conserving biodiversity in Apayao through the "Lapat" system.

INSECT-PESTS MANAGEMENT FOR *JATROPHA CURCAS* L.

Manuel V. Agsaoay
TARLAC COLLEGE OF AGRICULTURE Camiling, Tarlac

This study was conducted in two locations, Bamban and Capas in Tarlac, for three years using the seedling stage up to the second fruit-bearing cycles of *Jatropha curcas* L. to evolve management strategies for insect pests attacking the crop. Cultivation and other co-influencing factors were considered as criteria for the site selection. Three insect species namely: mealy bug, aphid and cutworm, were declared major pests as revealed by critical pest damage assessment, which registered considerable economic yield threshold reduction of 15.29% (mealy bug), 12.75 (aphid) and 18.99% (cutworm). Prey-predator feeding interactions showed appreciable reduction of host with efficiency ratings ranging from 47.5 – 50% in mealy bug, 40-50% in aphid to 50-70% in cutworm. The relationship between temperature and the rate of development particularly on cutworm eggmass hatchability contained good fit. It only took 1.5 days at 28.5^{O}C for the first instar larval stage to emerge. Critical damage index among the tree major insect pests were within the range of 12.75 – 18.99%, which established the economic threshold level (ETL) - equivalent to 20 colonies/100 plants (mealy bug), 30 colonies/100 plants (aphid) and 5-6 larvae/50 plants (cutworm) - plant feeder-ratio as basis for action order forecast.

INVENTORY OF TEXTILE FIBER YIELDING PLANTS IN KALINGA

Helen F. Bais, Marymina P. Odiem and Bernadette C. Aggabao
KALINGA APAYAO STATE COLLEGE Tabuk City, Kalinga

Fiber crops are industrial field crops grown for their fibers used in the manufacture of paper, cloth, rope and textiles. In the Philippines, the fiber crops industry is one of the major pillars of the economy, generating employment and foreign exchange. The Philippines has been the world's top producer of abaca: however, Ecuador's share in the world market has been increasing, threatening the Philippines' position. Aside from abaca, other natural fibers in the Philippines that may be tapped are ramie, jute, kenaf and minor fiber crops used by the pulp, paper and textile industries. This project identified potential natural fiber crops in several municipalities of Kalinga. The fiber crops were collected and their agroclimatic characterized. It was found out in the study that Pinukpuk municipality is populated with native banana or bowstring hemp based from the number of specie individual population followed with coir, pineapple, pita floja, rattan jute and cotton respectively. Tinglayan municipality is rich in term of true hemp or marijuana while Tabuk, Balbalan, Pasil and Rizal are good sources of abaca or manila hemp. Lubuagan municipality is the least source of abaca or manila hemp. The following species have the following scientific classification to wit: a).Cotton-common name; scientific name: Gossypium; vernacular name: Kapas; It has four species namely: Gossypium barbadense,G.hirsutum,G.arboeum ande G.herbaceum. b). Jute/ C. olitoruis (for upland specie)Okra-common name; scientific name: Corchorus capsularis olitoruis; vernacular name:Okra or saluyot ; c). Abaca –Common Name: Manila hemp; Scientific name: Musa textiles; Vernacular name: Saba ti sunggo; 4. Agave–Common Name: Maguey; Scientific name: Agave fourcroydes/ Agave cantala; Vernacular name: Espa-espada; d).Pineapple-common name; scientific name: Ananas comosus; vernacular name: Pinya; e). Pita Floja -common name; scientific name: Aechmea magdalenae; vernacular name: Pinya-pinyahan; , f). Coir -common name; scientific name: Cocus mucifera; vernacular name: Bunot ti nyog; g). Broom root -common name; scientific name: Muhlenbergia macroura; vernacular name: ruot;

MACROFLORAL RESOURCES IN THE TANGLAGAN WATERSHED, CALANASAN, APAYAO

Agustina B. Gutierrez, Satur Bangyad and Brent Begay
APAYAO STATE COLLEGE Malama, Conner, Apayao

The study determined the macrofloral resources in Tanglagan Watershed, which supports the rice terraces in Calanasan, Apayao Province. It utilized the descriptive- survey method. Around 52

macrofloral species belonging to 16 families and 29 genera were documented from the sampling stations established in Tanglagan Watershed. The different families include Family Dipterocarpaceae, Moraceae, Euphorbiaceae, Lauraceae, Guttiferae, Meliaceae, Casuarinaceae, Combretaceae, Araliaceae, Sterculiaceae, Fabaceae, Fagaceae, Ebenaceae, Mimisaceae, Urticaceae and Celtidaceae. Majority of the species documented belonged to Families Dipterocarpaceae and Moraceae. Species distribution was as follows: 1) to Family Dipterocarpaceae of genera *Shorea, Dipterocarpus, Parashorea* and *Hopea*; 15 to Family Moraceae of genera *Ficus* and *Artrocarpus;* 10 to Family Euphorbiaceae of genera *Homalanthus, Macaranga, Bischofia, Margaritaria, Glochidion, Antidesma, Endospermum* and *Croton* and 1 to Family Celtidaceae of genus *Trema*, Family Lauraceae of genus *Litsea*, Family Guttiferae of genus *Garcinia*, Family Meliaceae of genus *Toona*, Family Casuarinaceae of genus *Casuarina*, Family Combretaceae of genus *Treminalia*, Family Araliaceae of genus *Polycias*, Family Sterculiaceae of genus *Abroma*, Family Fabaceae of genus *Erythrina*, Family Fagacea of genus *Lithrocarpus*, Family Ebenaceae of genus *Diospyros* and Family Mimosaceae of genus *Albizia*. The genus *Ficus* has the most number of species identified.

MAXIMIZING AGRI – FISHERY INPUTS THRU SUSTAINABLE LAND USE IN AN ISLAND COLLEGE FARMING SYSTEM

Esperanza P. San Juan
COLLEGE OF BUSINESS & ACCOUNTANCY, CATANDUANES STATE COLLEGES
Virac, Catanduanes catanduanes _state _colleges @yahoo.com

Land use and agricultural production are important factors considered in an island based farming systems to sustain production. This paper presents multidisciplinary projects addressing consequences of the agri – fish production projects at the Catanduanes State Colleges with respect to ecology, environment and economy. Land use projects such as crop rice production, fishery production, fish breeding and nursery production, horticulture production, livestock and poultry production generated an 18.81 % of return on investments despite ecological stress such as heavy rainfall, flashfloods, typhoons and varying temperatures.

MORPHOLOGICAL DIVERSITY AND INDIGENOUS KNOWLEDGE ON RICE LANDRACES IN BENGUET, PHILIPPINES: TOWARDS SUSTAINABLE CONSERVATION AND UTILIZATION

Belinda A. Tad-awan, Esther Josephine D. Sagalla and Menard P. Tosay
BENGUET STATE UNIVERSITY La Trinidad, Benguet

Cognizant of the global concern to conserve indigenous rice genetic resources, this research was implemented to collect and characterize germplasm of rice landraces or indigenous rice varieties in Benguet; determine the morphological diversity and relationships among the collections; maintain a gene bank of the collected landraces, and identify indigenous knowledge associated with the landraces. Germplasm collection was done in the 12 municipalities of Benguet from July 2008 to March 2009. In-situ and ex-situ morphological characterization and diversity and cluster analysis were performed on the 157 indigenous rice varieties collected. Sabul and Tudoy had desirable characters such as long, wide and heavy grains. Pitkikil and Mayok exhibited long roots and many tillers. Low level of diversity was obtained, indicating homogeneity among the rice landraces. Most of the rice landraces were collected from the traditional rice growing municipalities and were associated with indigenous farmers' practices. These practices included *Kintoman* (dry season planting) and *Talon* (wet season planting); the use of the traditional instrument *rakem* in harvesting; the use of wooden mortar and pestle in threshing rice panicles, and the *soo* method or the traditional way of drying panicles. The different rice landraces are presently maintained ex-situ and morphological characters have been entered in a data base for future use. The information generated in this research will serve as bases for future studies on the improvement of grain quality, utilization

of rice landraces for various purposes and the identification of an heirloom rice variety for Benguet. In the future, the indigenous rice from Benguet may also find a niche in the global market. Relative to policy development, the results may serve as benchmark information to generate or improve policies on conservation, production and utilization of indigenous rice in the locality.

MULTIPLICATION RATE OF SELECTED POTATO ENTRIES TO RAPID MULTIPLICATION TECHNIQUE

C. G. Kiswa and D. K. Simongo
NPRCRTC-BSU La Trinidad, Benguet, Philippines Email: dsimongo@yahoo.com.ph, ckiswa@yahoo.com

Eight selected potato entries were evaluated for their performance in rapid multiplication technique. The entries 2.21.6.2, 380241.17 and the check variety Igorota had the most vigorous growth among the entries. Furthermore, Igorota gave the highest number of stem cuttings produced in three months with 152 stem cuttings/25 mother plants. It was followed by the entries 676070 and 380241.17 with 100 and 97 stem cuttings respectively. Other entries (2.21.6.2, 5.19.2.2, 573275, Granola and Ganza) produced stem cuttings from 45 to 86 stem. Significant differences were obtained on tuber yield of the different entries under greenhouse. The entries 5.19.2.2 and 676070 had the highest number of tubers with 30 and 27 per m^2 respectively. The lowest were from entries Igorota, 573275 and 2.21.6.2 with tubers ranging from 18 to 23 pieces per m^2.

PERFORMANCE EVALUATION OF SWEET SORGHUM LINES FOR BIO-ETHANOL AND GRAINS UNDER PANGASINAN CONDITION (3 TRIALS)

CG Della, ES Della, Romolida, J Pascua and HS Cascolan
PANGASINAN STATE UNIVERSITY Lingayen, Pangasinan

The study sought to conduct evaluation trial of five (5) sweet sorghum lines under Pangasinan condition to determine their agronomic characteristics and identify and recommend varieties that are suitable for ethanol production. This paper highlighted the results of the three (3) trials conducted from October 2007 to February 2009. Analysis of variance in the 1st and 2nd trials showed that there were significant differences among varieties observed for plant height, stalk yield, stripped stalk yield, stalk juice volume, stalk juice yield, Brix, stillage yield, grain yield and seed size. In the 3rd trial, however, stalk yield and stripped stalk yield parameters showed that there were no significant differences among the varieties tested. The mean agronomic characteristics of the 5 varieties evaluated showed that ICSV 700 performed better in terms of plant height. Consequently, ICSV 700 and ICSV 93046 were the top performers in terms of stalk yield, stripped stalk yield, stalk juice volume, stalk juice yield, and *Brix. The varieties SPV422 and NTJ2 performed better in terms of stillage yield in the 1st trial while SPV 422 obtained the best performance in the 2nd trial. However, for the 3rd trial, ICSV 93046 performed better as compared to the other varieties. On grain yield parameter for 1st and third trials, SPV422, ICSR93034 and NTJ2 were among the top yielders. Data on grain yield was not taken in the second trial due since it was attacked by the birds. Whereas, in terms of seed weight, ICSR 93034, performed better in the 1st and 2nd trials, while SPV 422 performed better in the 3rd trial.

CRYOPRESERVATION OF BOAR SEMEN BY PELLET FREEZING

Danilo L. Lamela
DR. EMILIO B. ESPINOSA, SR. MEMORIAL STATE COLLEGE OF AGRICULTURE AND TECHNOLOGY (DEBESMSCAT), Mandaon, Masbate

This research was conducted to develop a simple cryopreservation protocol for boar spermatozoa without adverse effects on motility and fertilizing capacity; investigating the optimum glycerol concentration (1,3,5 & 7%), equilibration time (15, 30 & 60 min), and suitable volume (100, 300 & 500 ul) of boar semen for pellet freezing needed for post-thaw motility of boar spermatozoa. Morphological characteristics of the sperm were also considered as a factor affecting sperm motility and fertility. Further investigation was done on the penetrating capability of cryopreserved boar spermatozoa using in vitro matured porcine oocytes. Three percent level of glycerol added to the final dilution equilibrated at either 30 min or 60 min significantly resulted ($P<0.01$) in an acceptable percentage of motility, while the three pellet sizes/volumes can be used to cryopreserved boar spermatozoa without adverse effects on its motility. Morphological evaluation of sperms revealed that frozen-thawed semen has much lesser ($P<0.05$) normal sperms than the fresh semen of the same boar. Frozen-thawed semen attained a penetration rate of 36.15 percent.

ADAPTABILITY TRIAL OF NEW PIGEON PEA ACCESSIONS IN ABRA

Eusebia R. Pagluanan
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY Lagangilang, Abra

The study evaluated the performance of six new pigeon pea accessions (ICP 8863, ICPL 7091, ICPL 88093, ICPL85063, ICPL 7035 and farmers variety) suited in Abra to identify the best performing accessions in terms of growth and yield and recommended the best accessions for planting by legume farmers in Abra. Results showed that ICPL 7035 accession was the tallest at 24 days after planting. It also produced the highest number of marketable and non-marketable pods, the heaviest weight of fresh and dry seeds, the heaviest weight of green pods and highest yield in per plot and per hectare. On the other hand, accession ICPL 87091 produced the longest pod and the most number of seeds per pod. It was the earliest to produce flowers, set pods, filled seeds and mature pods. Based on the findings, accession ICPL 7035 and ICP 87091 could be grown by legume farmers in the upland areas of Abra.

AGLIBUT SWEET TAMARIND

(The Commercialization of the Philippines 1st Sweet Tamarind Variety Registered Under NSIC-BPI)

Norman G. De Jesus, Rogelio D. Cosio, Filomena K. Reyes, Zosimo M. Battad and Honorio M. Soriano, Jr.
PAMPANGA AGRICULTURAL COLLEGE Magalang, Pampanga

The Pampanga Agricultural College developed the 'Aglibut sweet' tamarind and is now promoting its widespread planting not only in Central Luzon, but also in other parts of the country. 'Aglibut sweet' is the first sweet tamarind registered in the Philippines. The project was undertaken to extensively promote and commercialize 'Aglibut sweet'; monitor and evaluate the promotion and commercialization of 'Aglibut sweet'; identify problems encountered in the production, promotion and commercialization of 'Aglibut sweet'; recommend solutions to the identified problems of promoting and commercializing 'Aglibut sweet' and formulate more effective and efficient measures or strategies for the promotion and commercialization of 'Aglibut sweet' the project monitoring and evaluation results. To commercialize the Philippine sweet tamarind involved training of interested farmer-entrepreneurs, conduct of field days, establishment of demonstration farms, commercialization project proposal development and submission to external funding agencies, free technical consultation for walk-in buyers and previously-trained growers, credit assistance in the form of seedlings loan, technical backstopping necessary for the establishment and development of off-campus scion groves/nurseries at selected local government units (LGUs) and state colleges and universities (SCUs). Other promotional activities for the commercial production of 'Aglibut sweet' included the sale of seedlings; production of IEC materials; participation in technology commercialization forum;

trade fair and exhibits, and media advertisement. Despite the advantages and potentials of growing 'Aglibut sweet', however, the Philippines has yet to develop a strong industry for this commodity of great economic importance. The government should, therefore, promote the commercialization of this crop on a wider scale.

EFFECTIVENESS OF SUGAR MILL INDUSTRY WASTE AS RAWMATERIALS FOR CANE CHARCOAL BRIQUETTE

Lyndon G. Solis
PAMPANGA AGRICULTURAL COLLEGE Magalang, Pampanga

The study deals with the utilization of sugar mill industry waste particularly bagasse and sludge as raw materials for the production of charcoal briquette. The waste product from Sweet Crystal Integrated Sugar Mill Corporation in Planas, Porac, Pampanga was utilized in the study. Five treatments were used to determine the best combination of bagasse, starch and sludge in the production of cane charcoal briquette and this was tested using friability test and boiling test. The best formulation was then compared to the commercially available charcoal briquette. Results revealed that among the five treatments, T2 (75% starch and 25% sludge) gave the best result in terms of boiling test. Furthermore, it also revealed that in terms of dust, chip and unbroken charcoal, T2 ranks first as compared to the commerically available charcoal briquette (T6). Similarly, in terms of boiling test T2 can boil 3850.00 liters of water using 350 grams charcoal compared to T6 which can only boil 1725.00 liters. The amount of binder has significant effect on the strength and burning effectiveness of the cane charcoal.

FIELD EVALUATION OF SELECTED UBI (DIOSCOREA ALATA) ACCESSIONS IN ACID SOILS AND SALINE-PRONE AREAS

Perlas, F. B., R. B. Ruiz and R. E. Pante
CAMARINES SUR STATE AGRICULTURAL COLLEGE Pili, Camarines Sur
fbperlas@yahoo.com

In the context of agricultural problem soils, Salinity and acidity are the dominant problems in agricultural land use. This study was conceptualized to determine the possibility of utilizing some problem soils into ubi production. Selected ubi accessions were assessed for their performance in acid soils and saline-prone areas. Accessions 5, 6, 8, 9, 10 and 12 were in a saline-prone area (Balongay clay in Sta. Teresita, Canaman, Camarines Sur), while Accessions 6, 10, 11, 12, 13 and 21 were raised in an acid soil (Caroyroyan clay loam at Pacol, Naga City). Results revealed that planting ubi both saline-prone areas and in acid soils, would be beneficial to farmers. Accessions 6 and 10 were both economically viable, as having the highest returns on investment among all the treatments.

FACTORS AFFECTING YIELD PERFORMANCE OF MANGO FARMS IN BATANGAS, PHILIPPINES

Flordeliza A. Lantican and Bates M. Bathan
College of Economics and Management UNIVERSITY OF THE PHILIPPINE LOS BAÑOS

This paper determined the factors affecting yield performance of mango in Batangas, discussed the problems/constraints encountered by mango farmers, and provided policy directions to enhance the productivity of mango in the province. From 1990 to 2008, mango production in Batangas registered a positive annual growth of 4.22%, which could be attributed to increase in area at 5.07% and number of bearing trees at 4.53% per annum. Yields per hectare and per tree declined yearly by 0.92% and 0.37% respectively in the same period. In 2007, mango production reached 26,732 mt covering 11,970 hectares and 711,780 bearing trees. Yields attained were 2.23 mt/ha and 0.04 mt/tree. The Cobb-Douglas production function was estimated based on the primary data collected from 51 mango

farmers from Batangas City, Rosario and Bauan in 2008 using Ordinary Least Squares method. The determinants of mango yield per hectare included in the model were: nitrogen fertilizer, labor, number of bearing trees, flower inducer cost, chemical cost, soil type, presence of intercrops, planting distance and age of bearing trees. Fertilizer, labor and costs of flower inducer and chemicals significantly and positively influenced the yield performance of mango farms in the province. The right amount, frequency and timing of fertilizer, flower inducer and chemical applications were very critical in achieving better yield. Older bearing trees also required more material inputs than younger bearing trees. The sum of the production elasticities (0.68) denoted the decreasing returns to scale stage of mango production. This implies that a 10% increase in all inputs would result in yield improvement of mango by 6.8%. Mango farmers interviewed reported that high costs of material inputs, high pest and disease infestation, and limited access to credit constrained them from improving the productivity in mango farming. Given these problems, this paper provides the following policy recommendations: (1) promotion of Integrated Pest Management (IPM); (2) strengthening farmer's/industry's association to facilitate transfer of production technologies, and (3) better access to credit.

COCONUT YIELD RESPONSE ANALYSIS IN DAVAO PROVINCE, PHILIPPINES

Corazon .T. Aragon and Rizza Trumata
College of Economics and Management UNIVERSITY OF THE PHILIPPINE LOS BAÑOS

This paper discusses the coconut yield response to various explanatory variables using multiple regression analysis on data from Davao Province for Crop Year 2007. The Cobb-Douglas production function was estimated using Maximum Likelihood Estimation (MLE) method. The explanatory variables included the total number of bearing trees per hectare, the amount of fertilizer applied per hectare, labor use per hectare, age of coconut bearing trees, variety and coconut intercropping. Results of the multiple regression analysis showed that the total number of bearing trees per hectare, amount of fertilizer applied per hectare, age of the coconut bearing trees, and practice of coconut intercropping significantly and positively affected coconut yield measured in nuts per hectare in the study area. The regression coefficient of fertilizer was also the production elasticity of fertilizer in a Cobb-Douglas production function. The production elasticity of fertilizer of 0.168 implied that a 1% increase in the amount of fertilizer applied would increase coconut yield by 0.168%, holding other factors constant. The coconut farmer-respondents applied inorganic and organic fertilizers. The sum of the production elasticities of all production inputs included in the model (0.689) was the returns to scale. Since the sum of the production elasticities was less than one, the production function exhibited decreasing returns to scale. This means that if all the production inputs included in the production function were increased by 1%, coconut yield would increase by 0.689%. The positive regression coefficient of coconut intercropping indicates that this farm practice increased coconut yield compared to coconut monocropping. This could be explained by the higher mean rate of fertilizer applied by coconut farmers who practiced intercropping (230.81 kg/ha) as compared to those who practiced coconut monocropping (192.88 kg/ha). Policy recommendations in this paper include the continuous promotion by the Philippine Coconut Authority of yield-augmenting technologies or farm practices such as coconut intercropping and fertilization of coconut trees using inorganic and low-cost organic fertilizers like NaCl or table salt.

EVALUATION OF DIFFERENT FRUIT ADDITIVES IN THE PREPARATION OF LEMONGRASS (*CYMBOPOGON CITRATUS*) BEVERAGE

Ronald Ocampo and Normalina P. Usita
APAYAO STATE COLLEGE Malama, Conner, Apayao

This study was intended to make juice blends by combining lemongrass and fruit juices/plant extracts blend. It was conducted at the Apayao State College during the first semester of school year 2006-2007. The Complete Randomized Design with five treatments was used: T1 - pure lemongrass extract

(LE), T2 - LE + pandan extract, T3 - LE + citrus juice, T4 - LE + pineapple juice and T5 - LE + lubeg juice. Results revealed that T5 had the highest mean rating in taste, color and overall market acceptability and T4 for aroma as rated by 20 judges. ANOVA showed highly significant results in terms of taste, color, aroma and market acceptability. From the findings, it can be concluded that lemongrass extract used in the juice preparation can be improved by adding fruit juices/plant extracts. The following recommendations are forwarded: disseminate the results of this study to food processors, researchers and other interested stakeholders; disseminate to schools, offices and other institution the use of lemongrass as juice especially as the plant has been known for its curative potentials and has been used in tea production and other herbal products; determine the chemical composition and the shelf life of the prepared juice; undertake processing, packaging and marketing of the lemongrass + juice blends; conduct similar studies using other herbs and additives.

SUGARCANE YIELD RESPONSE ANALYSIS IN MAJOR SUGARCANE-PRODUCING PROVINCES IN THE PHILIPPINES

Nora Carambas and Corazon Aragon
College of Economics and Management UNIVERSITY OF THE PHILIPPINE LOS BAÑOS

This paper discusses the sugarcane yield response to various explanatory variables using multiple regression analysis on 2006-07 farm survey data gathered from 105 sugarcane farmers in eight sugarcane-producing provinces in Luzon (Cagayan, Tarlac, Pampanga, Batangas, Bicol) and Mindanao (Bukidnon, Davao, Cotabato) or nine milling districts (Carsumco, Tarlac, Pampanga, Don Pedro, Balayan, Pensumil, Bukidnon, Davao, Cotabato). The Cobb-Douglas production function was estimated with tons cane per hectare as the dependent variable. The explanatory variables included the amount of nitrogen fertilizer applied per hectare, labor use per hectare, tractor use dummy variable, chemical cost per hectare, method of planting dummy (i.e., new planting vs. ratoon method), farm topography dummy variables and soil type dummy variables. The reference planting method was the ratoon method while the reference topography and soil type are flat topography and clay loam soil type. Results of the multiple regression analysis showed that labor use per hectare and chemical cost per hectare significantly and positively affected sugarcane yield. The regression coefficient of labor was also the production elasticity of labor in the Cobb-Douglas production function. The production elasticity of labor of 0.5369 implied that a one percent increase in labor use per hectare will increase sugarcane yield by 0.5369%, holding other factors constant. The positive and significant regression coefficient of the type of planting method indicated that higher sugarcane yields were obtained using new planting method compared to the ratoon method. The most ideal topography and soil type for sugarcane production are flat and clay loam, respectively. As expected, the regression coefficients for slightly rolling and rolling topography were negative and significant, indicating that higher sugarcane yields were obtained in farms with flat topography, other factors held constant. The regression coefficient for clay soil was likewise negative and significant, implying that sugarcane farms with clay loam soil type had a higher yield than those with clay soil type, other factors held constant.

EFFICACY TEST OF GROWTH PROMOTANTS ON THE YIELD OF HYBRID RICE IN KALINGA

Jovita E. Saguibo and Ernesto T. Miguel
KALINGA APAYAO STATE COLLEGE Tabuk City, Kalinga

The efficacy of growth promotants (Brasinollide, Planergy, GA3, Muriate of Potash, Crop Giant) on the yield of hybrid rice during the 2008 wet season in Taniok, Tabuk, Kalinga was assessed. Specifically, the study validated the efficacy of commercially distributed growth promotants and evaluated their effect on the yield of hybrid rice (M7 variety). It used the Randomized Complete Block Design with three replications in an area of 520 m^2. Results showed no significant differences among the parameters height, panicle number, filled and unfilled grains, and weight of the grains.

However, differences between replications were noted, but these were attributed to other related factors and not on the growth promotants. The variation in the height of the plants, number of panicles, number of filled and unfilled grains, weight of the grains, and yield did not transform the effect of promotants into a significant result. Further analysis showed that the use of growth promotants could have initiated the occurrence of insect pests particularly rodents due to the effects on the physiology and morphology of the rice plants. Based on the results of the study, growth promotants are not necessary when planting the M7 variety. Growth promotants should be applied earlier, but further studies should be conducted to validate their effects.

DEVELOPING A VIABLE MARKET FOR *JATROPHA* FEEDSTOCK PRODUCTION IN THE PHILIPPINES

Nena O. Espiritu, Ma. Cynthia S. Casin, Aresna B. Palacpac,
Leni N. Garcia and Eumelia B. Corpuz
Forestry Development Center, College of Forestry and Natural Resources
UNIVERSITY OF THE PHILIPPINES LOS BAÑOS College, Laguna

The transport sector accounts for the highest consumption of energy at 80% of the total oil supply in 2007. Hence, there is pressure to pursue the blending mandates of the Biofuels Law. Among the potential energy crops, *Jatropha curcas* L. has been promoted as a feedstock for biodiesel production. Even with the dearth of information on the economic, socio-political, and technical aspects of *Jatropha*, many LGUs, private companies, as well as entrepreneurs, were emboldened to embark on Jatropha production which could help boost rural employment and income on the one hand, and a sustainable source of clean energy on the other. This study conducted an estimation and valuation of the economics of *Jatropha* feedstock production and a socio-economic impact analysis of *Jatropha* production, promotion and development both from the growers' and project implementers' perspectives. Investment analysis showed that *Jatropha* production is not a viable business investment at the current government-buying price of P4.50/kg of seeds. The total expenses in terms of labor operations and materials are greater than the expected revenues from the sale of seeds. Analysis of policies also showed that because of the prevalent view that biofuel feedstock production is a threat to food supply, market and non-market incentives are more pronounced for downstream investors like venture capitalist in processing plant than the upstream investors or the growers of *Jatropha*. In the light of these findings, the study has formulated several recommendations towards making a viable investment market for *Jatropha* seed production.

EVALUATION OF SELECTED POTATO ENTRIES GROWN ACROSS LOCATION FOR ITS CHIPPING QUALITY

E.T. Botangen, I.C. Gonzales and D. K. Simongo
NPRCRTC-BSU La Trinidad, Benguet, Philippines
Email: gentbotang@yahoo.co.ph, inesgonzales@yahoo.com.ph, dsimongo@yahoo.com.ph

Five potato selections (573275, 676070, 380241.17, 2.21.6.2, 5.19.2.2) and three check varieties (Ganza, Granola, Igorota) from multilocational trials in Bonglo, Loo and Madaymen, Benguet were evaluated for dry matter content, chip recovery and sensory characteristics. The assessment was done at the NPRCRTC processing laboratory in March 2007. The potato selections showed differences in dry matter content, chip recovery, as well as sensory characteristics. Dry matter content was observed to be high (20-23%) in Igorota, 676070, 5.19.2.2, 573275 and 2.21.6.2 It was lowest in Granola and Ganza (16 – 19%). Highest chip recovery (32 – 35%) was observed in entries 5.19.2.2, 380241.17, 2.21.6.2 and Igorota. For the sensory characteristics, potato entries 380241.17, 5.19.2.2, 2.21.6.2, Ganza and Igorota had the best quality with slightly browning (1 – 2%) to no browning, slightly oily

and acceptable to highly acceptable chips. In contrast, the entries 676070, 573275 and the check variety Granola gave unacceptable chips characterized by excessive browning and oily chips.

FACTORS AFFECTING YIELD PERFORMANCE OF BANANA FARMS IN ORIENTAL MINDORO, PHILIPPINES

Bates M. Bathan and Flordeliza A. Lantican
College of Economics and Management UNIVERSITY OF THE PHILIPPINE LOS BAÑOS
College, Laguna

This paper presents the factors affecting yield performance of banana farms located in Oriental Mindoro, identifies the problems/constraints encountered by banana growers, and provide policy directions that would enhance the productivity of banana in the province. Banana production in Oriental Mindoro posted a positive growth of 3.50% per annum mainly due to expansion in area planted, which also grew at 4.10% per year from 1990 to 2008. Yields per hectare and per hill showed annual negative growth rates of 0.01% and 0.44%, respectively, in the same period. In 2007, banana production reached 163,729 mt covering 18,371 hectares and 7.43 million hills. Yields were registered at 8.91 mt/ha and 0.022 mt/hill. Based on survey data of 80 banana growers from the municipalities of Bansud, Socorro, Pinamalayan and Bacu in Oriental Mindoro in 2007, multiple regression analysis was done. The Cobb-Douglas production function was estimated using the Ordinary Least Squares (OLS) method. Explanatory variables included in the model on a per hectare basis were nitrogen fertilizer, labor, planting material cost, number of stalks, tenurial status, types of banana cultivars grown, presence of intercrops, topography, soil type, distance between hills, education, farming experience, age of farmer, gender, household size and distance of farm to residence. Increased fertilizer and labor usage, adoption of diversified banana farming, establishment of ideal farm characteristics (i.e., clay loam or sandy clay loam soil, distance between hills of ≥ 20m2 and longer distance from farm to residence), and tenurial status in favor of owner operators significantly and positively affected banana yield in Oriental Mindoro. The sum of the production elasticities (0.76) was significantly different from one as revealed by the t-test results. The function coefficient of the OLS model implied increasing returns to scale where a 1% increase in all production inputs would raise banana yield by 0.76%. Problems and constraints cited by the banana grower-respondents in Oriental Mindoro included: limited supply of high-yielding and disease-free banana planting materials; high incidence of pests and diseases, and inadequate knowledge on proper production practices/technologies in banana farms. Hence, the following policy directions are recommended: provision of technical and budgetary support to the propagation and distribution of banana varieties which are better yielding and highly resistant to virus and other systemic diseases; adoption of site specific IPM and dissemination of information on control of banana pests and diseases; conduct of training on good agricultural practices (GAP), and formation of banana cluster to effectively forge strong linkages between banana growers and suppliers of quality planting materials and production technologies.

IMPROVING THE QUALITY OF NIPA (*NYPHA FRUTICANS* L.) WINE

Ronald O. Ocampo and Normalina Usita
APAYAO STATE COLLEGE Malama, Conner, Apayao

This study was aimed at improving the quality of nipa wine. Specifically, it determined what fruit juices could be added to nipa wine to improve its quality; compared the sample treatments in terms of taste, color and aroma; determined the cost of production of the different samples. The different treatments were: T0 - nipa wine (NW) control, T1 - NW + mulberry fruit extract, T2 - NW + pineapple, and T3 - NW + calamansi. The samples were evaluated by a panel of 30 judges in terms of taste, aroma and color. Data were analyzed using ranking and rank difference was further tested using the Friedman's rank test. Results revealed that T1 was the most preferred sample in terms of taste and

color and T2 on aroma. The least preferred treatment was the control. Rank differences showed highly significant result in taste, aroma and color. Hence, nipa wine could be further improved using fruit juice additives. The following recommendations are forwarded: undertake mass production of the improved nipa wine as part of the income-generating activities of the college; promote the improved nipa wine especially in trade fairs; determine the alcohol, sugar and other nutrient contents of nipa wine which are needed in the product label; design and develop packaging materials for added market value; conduct researches on other fruit additives; conduct similar studies on other wines of less economic value.

TECHNICAL EFFICIENCY OF GENETICALLY IMPROVED FARMED TILAPIA CAGE CULTURE OPERATIONS IN THE LAKES OF LAGUNA AND BATANGAS, PHILIPPINES

Reynaldo L. Tan, Yolanda T. Garcia, Marjorie-Ann L. Dator, Isabel Mildred A. Tan and Diemuth E. Pemsl
College of Economics and Management, University of the Philippines Los Banos,
M.S. Environmentsal Studies, University of the Philippines Los Banos and [5] The WorldFish Center

In an earlier paper, a descriptive ex post study to assess the adoption and farm-level impacts of Genetically Improved Farmed Tilapia (GIFT) in the Philippines was conducted covering the top three producing regions: Region II (Isabela, Nueva Viscaya and Quirino); Region III (Nueva Ecija and Pampanga), and Region IV (Laguna and Batangas). This paper focuses on Region IV and takes a closer look and more in depth analysis of the tilapia cage culture operations in Lakes Sampaloc and Palakpakin in Laguna, and Laurel and Agoncillo in Taal Lake, Batangas. The technical efficiencies of the culture operations were estimated using translog stochastic frontier production function and the statistically significant factors affecting technical inefficiency were determined. Comparisons were made according to the four strain groups identified in the previous study: GIFT, GIFT-derived, non-GIFT and unspecified tilapia strains. In all four study areas, deviations from the frontier production functions were practically due to technical inefficiency. Thus, the strategy to improve their productivity is to address the factors that have been identified in their respective technical inefficiency functions.

PROMOTION OF VEGETABLE ENRICHED FOOD PRODUCTS IN THE PHILIPPINES FOR FOOD SECURITY AND ENVIRONMENT CONSERVATION

Violeta B. Salda.
BENGUET STATE UNIVERSITY La Trinidad, Benguet, Philippines

The establishment of the Benguet Vegetable Processing Center (BVPC) in Benguet Province helps bring forth the government's food security and poverty alleviation programs to the grassroots by utilizing local resources into affordable and nutritious vegetable enriched food products. It was designed to strengthen and expand its capability to meet the challenges of the marketplace through development and improvement of food products and processes allowing the delivery of better products to the customers. It produces its own natural ingredients and infuses them in the end products with burst of health and wellness. It serves as an alternative market outlet for the farmers of their excess vegetable production, encourages contract growing and backyard organic farming, explores the use of edible indigenous vegetables, but strongly rejects crops with high pesticide residues. As a start, the Center processes 80 to 150 kg wheat flour based enriched with different vegetables and protein-rich foods on an 8 hour work with 18 hired graduates and unemployed mothers. Nutritive values of

these various products increased but varied depending on the ingredients and vegetables used. These products are being market-tested in partnership with local supermarket establishments and groceries, with income that sustains the operations of the Center. For a year of its existence and assessment, it has purchased 6,611 kilograms worth P88,883 of vegetables from farmers in the Cordillera Administrative Region, Regions 1 and 2. Vegetable and root crop contract growers are increasing from 1% to 5% a year, most of them experimenting on a year-round production system to back up the productivity plan of the Center. BVPC's establishment served as an eye opener to local government units that now started establishing their own processing plants for community livelihood. From November 2008 to August 2009, BVPC provided trainings to 400 participants from 19 municipalities as toll processors who will also produce veggie-enriched noodles to their respective regions.

MANAGEMENT PRACTICES IN POTATO PRODUCTION OF THREE POTATO VARIETIES BY FARMERS IN BENGUET, PHILIPPINES

D. K. Simongo, B. T. Gayao and D. T. Meldoz
NPRCRTC-BSU La Trinidad, Benguet, Philippines
dsimongo@yahoo.com.ph, btgayao@hotmail.com, d.meldoz@yahoo.com

Farmers' management practices of growing potato varieties Igorota, Solibao and Raniag were documented. Information gathered came mainly from seven farmer-respondents selected based on their length of experience in growing the varieties and their willingness to share their knowledge and experience. Among the three varieties, Igorota was kept and maintained by farmers until the sixth cropping season. Solibao and Raniag were planted only once or for three cropping seasons. Solibao was less preferred in the market, while Raniag was a low yielder in high elevations (> 2000 masl). Farmers claimed that the yielding ability of Igorota could be maintained until the sixth cropping if seed tubers were sourced out from different farm locations and elevations every cropping season. Observations showed that the three varieties had higher yields during the October to February planting. Igorota and Solibao had robust vegetative growth but lower tuber yield during the wet season and resistance to late blight; hence farmers practiced longer fungicide spraying intervals. Farmers harvested Raniag as early as 75 to 90 days after planting, Igorota at 80-110 days, and Solibao at 90-120 days. Dehaulming one to two weeks before harvesting, curing by covering piled tubers in cement floor one month prior to transport, and spraying with a fungicide two weeks before harvesting were done to reduce bruises and feathering. Igorota was observed suitable for in-ground storage despite its 3-month dormancy period. The tubers of Igorota and Solibao turned green faster than Granola. Cropping pattern practices dictated the need for up to 6-month seed tuber storage. Hence, one farmer practiced one-level piling of the seeds in seedbed racks under diffused light storage in cooler temperature to prolong the dormancy of Igorota to more than three months. Further observation showed that the growing period was shortened when Igorota seed tubers were already shriveled.

YIELD PERFORMANCE OF SELECTED LOWLAND RICE VARIETIES AS AFFECTED BY PHOSPHORUS AND POTASSIUM

Ferdinand Ganotice, Loreto B. Juan & Manuel Bilagot
KALINGA APAYAO STATE COLLEGE Tabuk City, Kalinga

This study evaluated the performance of selected lowland rice varieties as affected by the rates of inorganic fertilizer applied. It was laid out using the Randomized Complete Block Design in Factorial with 22 treatment combinations and 4 replications Variety PJ7 was found to be taller than the other variety, M3, at maturity. There was no significant difference in the number of tillers per plant between the two varieties. M3 displayed longer panicle compared with PJ7. Yield per plot showed no significant effect on the variety used. No significant effects of fertilizer levels on height at maturity, length of panicle, number of tiller per plant and yield per plant were observed. The 22 treatment combinations did not differ significantly in all the measured plant characters. However, variety M3

fertilized with 120-80-80 kg per hectare gave the heaviest grain weight (6,908 kg per hectare). On the other hand, variety PJ7 (V2F2) yielded 6,266 kg per hectare. A higher ROI (P114.47) was noted in variety M3 fertilized with 120-80-80 kg of inorganic fertilizer per hectare.

MULTI-LOCATION YIELD TRIAL OF POTATO ENTRIES GROWN ACROSS LOCATIONS AND SEASONS IN THE PHILIPPINE HIGHLANDS

D. K. Simongo, and I. C. Gonzales
NPRCRTC-BSU, La Trinidad, Benguet, Philippines
Email: dsimongo@yahoo.com.ph, inesgonzales@yahoo.com.ph

The study evaluated the agronomic yield of and incidence of late blight and leafminer in selected potato entries across locations/zones and seasons. It also recommended to the National Seed Industry Council (NSIC) the entries for official variety release. Five potato entries grown and selected from preliminary yield trials were evaluated from 2006 to 2009 under different ecological zones/elevations: from low mountain zone (1350 masl), mid-mountain zone (below 2000 masl) and high mountain zone (2000 and above masl) for wet and dry seasons. Treatments were laid out following the Randomized Complete Block design (RCBD) with 40 tubers per replication in all locations and seasons.. Entries 380241.17, 2.21.6.2, 676070 and 5.19.2.2 were the best performers in terms of survival, vigor, canopy cover, and leafminer and late blight incidence. These four entries significantly out yielded the check varieties Igorota (processing type), Ganza (newly approved variety) and Granola (table type/ farmers variety). Dry matter content was found comparable with Igorota, the check variety. Based on the results entries 380241.17, 2.21.6.2, 676070 and 5.19.2.2 are highly recommended for potato production under low, mid and high mountain zones during wet and dry seasons. These are recommended for the National Seed Industry for variety release.

MARKETING SYSTEM OF AGROFORESTRY PRODUCTS IN SELECTED SITES IN APAYAO

Reymalyn C. Aman
APAYAO STATE COLLEGE Malama, Conner, Apayao

This study determined the marketing systems for agroforestry products in Apayao. A total of 100 farmer-respondents from Brgys. Tanglagan, Calanasan; Karikitan, Conner; Atok, Flora and Marag, Luna were selected in stratified random sampling. A structured interview schedule was used to elicit data. Simple descriptive statistics such as frequency counts, percentages, ranking, and means were used in the interpretation of data. Most of the respondents were male, belonged to the working age group (21–50), and with high literacy rate because all of them were able to enter schooling and most were high school graduates. Thirty-six percent of the respondents had an annual income ranging from P16, 000.00 to P36, 000.00. Most had farm sizes ranging from 0.5 to 1.5 hectares. About 18 respondents from Tanglagan and 12 from Marag practiced the improved fallow system of farming; 12 from Karikitan, intercropping and 10 from Atok, plot method. Upland rice was the main crop of the majority of the respondents from Tanglagan and Marag; fruit crops in Karikitan and banana in Atok. Gmelina was the tree grown by the majority of respondents in all study sites, while citrus, lanzones, rambutan, cacao, coffee, coconut and banana were the leading fruits grown. Majority (14) of the respondents in Tanglagan claimed rice as their promising product; fruit crops for 23 in Karikitan; banana for 22 in Atok, and rice and corn for 24 in Marag. In terms of marketing, fruit products in all the study sites were generally sold to middlemen going to the sites, who usually paid in cash. Production and marketing problems/constraints encountered were: occurrence of uncontrolled pests and diseases attacking their crops, resulting in low production output; high wastage due to the perishable nature of agroforestry products; lack of trading facilities, and low market value. Respondents also complained of the high production inputs, including the wages of workers. It is highly recommended that sustainable production of existing agroforestry products with market

potentials be undertaken and produce new products to sell through existing markets. Likewise, support services should be provided including the training and education of farmers on Integrated Pest Management (IPM); market facilities such as trading post; improved farm-to-market roads, etc; institutional services for farmers, such as cooperatives and credit system, efficient and effective market info system, etc. to strengthen their trading power as well as shorten the market channels, and appropriate price policies.

THE MUSCOVADO SUGAR CONSUMER MARKET IN THE PHILIPPINES: IMPLICATIONS FOR POLICY AND MARKET DEVELOPMENT

Isabelita M. Pabuayon
COLLEGE OF ECONOMICS AND MANAGEMENT, UP LOS BANOS

This paper provides an analysis of the consumer market for Muscovado Sugar in the Philippines using the Usage, Attitude and Image (UAI) marketing research tool. The findings provide the basis for formulating policy and market development initiatives to enhance the growth of the muscovado sugar industry. Based on UAI market surveys conducted among class ABC urban households, usage rate of muscovado sugar was low or only 23% of the respondents. This was due to low level of awareness about this sugar and existing brands and discontinued use among those who tried it. Majority of those who were aware of and used muscovado had favorable perceptions about it. Favorable comments were related to its applications ('ingredients for delicacies'), health benefits ('healthy and nutritious'), and wholesome quality ('natural/chemical-free'). Others had negative comments that included its 'coarse texture', 'dubious quality', and being 'expensive'. Users were motivated by factors related to the following: (1) health and environment, (2) altruism (desire to improve the socio-economic condition of farmers producing it), and (3) lifestyle (using it fits my lifestyle). Satisfaction rating for the MS brands currently used was generally high, with factors such as availability, taste, being certified and aroma as top-ranking. Non-trial of MS was due to current habits and beliefs ('not used to MS'), price ('expensive'), distaste for the product, its non-versatility, dislike for its color, and unavailability. The findings imply that a bigger market share for MS could be possible if awareness level could be raised and constraints to continuing use could be addressed. The industry must adopt a unified and collective action agenda to pursue specific measures and obtain the needed policy support from the government. The recommended measures relate to the muscovado sugar industry as a whole, the individual market players and the public/government sector.

POSTHARVEST LOSS ASSESSMENT OF POTATO ENTRIES GROWN ACROSS LOCATIONS IN THE PHILIPPINE HIGHLANDS

E. J. D. Sagalla, , R. Baldo, J. Y. Del-amen, and D. K. Simongo
BENGUET STATE UNIVERSITY La Trinidad, Benguet, Philippines
Email: ejsagalla@yahoo.com.ph,jydelamen2007@yahoo.com.ph, dsimongo@yahoo.com.ph

The study assessed the postharvest losses in potato entries, determined the effect of location on postharvest losses of potato entries, and determined the interaction between potato entries and location of production on postharvest loss. CIP 380241.17, Phil 2.21.6.2 and Phil 5.19.2.2 had the lowest yield loss from harvest to 18 weeks of storage. Moreover, potatoes harvested from Loo had the lowest yield loss immediately after harvesting and during storage. Both location and entry were important factors in selecting potatoes for low incidence of decay and weight loss. CIP 380241.17 and 5.19.2.2 could be stored when market price was low and sold there after based on their low weight loss after 18 weeks of storage. Careful harvesting and appropriate method for harvesting should be important considerations in reducing postharvest loss.

PRODUCTION PRACTICES, NEEDS ASSESSMENT AND TECHNOLOGY SYNTHESIS OF SELECTED VEGETABLES, LEGUMES AND ROOT (VELERO) CROPS IN ABRA

Susana A. Edwin
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY Lagangilang, Abra

The research study documented the production practices, need assessment and technology synthesis of selected vegetable, legume and root crops (VELERO) in Abra. One hundred eighty five (185) VELERO growers from Bangued, Danglas, Dolores, Lagangilang, La Paz, Licuan, Pidigan and Tayum municipalities were selected as respondents. Results showed that 53% of the respondents practiced organic farming to increase their family income, but 92% did not undergo training related to organic farming. The farm size for VELERO production was 0.25 hectare and 92% had no soil analysis. Eggplant, tomato and bitter gourd (ampalaya) were grown because of high demand in Abra. Majority of the respondents produced their own seeds. Intercropping was the most practiced system. One hundred three (103) respondents used native and hybrid varieties available in their locality. Most of them used animal manure to supply nutrients for their crops. The most common farm problems were marketing and high price of inputs. Technical information was obtained from fellow farmers and neighborhood. Lack of information about the project to be implemented, lack of demonstration farms and water supply were some of the problems in the community that hindered government project. About 98% did not avail of the services on organic farming for VELERO. Thus organic farming ranked first in the training course wanted by the respondents and to be demonstrated in the community.

UTILIZATION OF PILI PULP FLOUR AND OIL FOR COOKERY

Concepcion J. Cambaliza, Tarcela F. Detera,Mateo Luis G. Janer, and Fely A. Habla
BICOL UNIVERSITY Legazpi City

A study on pili pulp flour and oil revealed that these counld be produced from fresh pili fruit. It was recommended that pili pulp flour and oil be used for home and small scale consumption and preparation of food products. Thus food products utilizing pili pulp flour and oil as ingredients were evaluated together with stabilizer, emulsifier, extender and food flavouring. A total of ten (10) recipes were developed, seven (7) of which utilized pili pulp flour while three (3) used pili pulp oil. The replications were prepared for each recipe, after which sensory evaluation was done using the score sheets. Out of the ten food products, pili choco drops, mayonnaise dressing and muffins were rated as “much liked”. It was highly recommended that the above food products be verified and pilot tested for commercialization, the rest of the recipes be improved and shelf life and nutritive value of flour and oil be evaluated.

COMPARATIVE PERFORMANCE OF BIOFERTILIZERS UNDER ANAEROBIC CONDITIONS

Ferdinand Ganotice, Loreto B. Juan and Jovitta E. Saguibo
KALINGA APAYAO STATE COLLEGE Tabuk City, Kalinga

This study determined the comparative performance of biofertilizers under anaerobic conditions. Statistical analysis showed significant results on the average rice plant height per sample plant, fresh weight of grains (kg), and weight of filled grains. But significant results on the number of panicle per sample plant, number of filled grains per panicle, and number of unfilled grain per panicle were observed. Rice plants from T6 (Bio-N + ½ RR) produced the heaviest grains (181.33 kg/ha), while T1 and T4 both yielded the lightest grains (140.00). The following are recommended: 1. Planting of hybrid rice in Kalinga because of high yield and heavy grains. 2. Biofertilization under anaerobic condition for rice production using the recommended rates of Bio-N, Vital- N, Bio- Con, and Exquisite. 3. The use of T6 (Bio-N + ½ RR) based on its heaviest grains produced per sample plant (7253 kg/ha). 4. Conduct of follow-up studies under more cropping seasons.

ASSESSMENT OF FRESHWATER RESOURCES IN THE PROVINCE OF KALINGA

Ferdinand Ganotice, Helen F. Bais and Bernadette C. Aggabao
KALINGA APAYAO STATE COLLEGE Tabuk City, Kalinga

Aquatic resources in terms of (fish, shells and crustaceans) research and development in Kalinga has not been given much priority simply because aquaculture is not a major industry in the province compared to agriculture and forestry. However, with the dwindling land available for agriculture, pollution of aquatic ecosystems, increasing population and lack of protein food source, there is a need to develop the traditional culture systems for aquatic resources food production. Chico River is the major river traversing Kalinga with approximate length of 89.50 km. Its main tributary is the Pasil River which starts from Sadanga, Mt. Province then to Tomiangan, Pasil joining the Chico River with an approximate length of 40 km. Generally, these water bodies are acceptable for the culture of aquatic life. The study surveyed and documented the possible sources of edible fish and shell species in Kalinga with potential for aquaculture, and determined the ecology of freshwater fish and shell species in terms of the physical and chemical characteristics of their natural habitat as prerequisite to culturing them ex-situ. Results showed that samples from the eight major tributaries submitted on 18-19 February 2009 are classified as Class C waters based on DENR A.O. No. 34 (Series 1990) Revised Water Usage and Classification. They are therefore recommended for the propagation, treatment and growth of fish and other aquatic resources. Fresh waters can sustain livelihood activities and promote food security for its people. Culturing endemic and some endangered fish, shell and crustacean species is thus recommended.

INDIGENOUS KNOWLEDGE ON THE PRODUCTION AND PROCESSING OF ENDEMIC FIBERS IN APAYAO PROVINCE

Marjorie T. Aswigue and Agusta B. Dangiwan
APAYAO STATE COLLEGE Malama, Conner, Apayao

The study determined the indigenous practices on the production and processing of endemic fibers in Apayao. The descriptive survey method was used. The indigenous fibers utilized in the province included anabo, agimit, apnit, pakak, kapok, abaka and apinyan. Agimit fibers are extracted from the bark by pounding the latter after stripping from the trunk. Then these are washed and dried in the sun. They are used by the old folks as underwear, headband and belt. Abaca fibers are extracted by slicing the fresh trunk, then inserting the latter in a manual fiber extractor and pulling the fibers afterwards. The fibers are woven into baskets, bags, and decorations, twisted into ropes. Anabo fibers are extracted from the plants by soaking the latter in water for 5-7 days. The fibers are washed thoroughly with water and dried in the sun to be made into ropes, bags and décors. Kapok fibers are also extracted from the fruit using a crude manual device - a stick formed like a cross, placed in a container half-filled with dried kapok fruits. The stick is turned or twisted to separate the seeds from the fibers, which are then used to stuff pillows, cushions and toys. Pakak fibers are extracted from the plants by pounding the bark to soften it. The fibers are washed, dried and made into head bands, underwear or rope. Apinyan fibers are extracted from the leaves by applying sharp materials such as sharpened bamboo on the upper part of the leaves until only the strands are left. The strands are used as thread or ropes. Lapnit fibers are extracted by soaking or splitting the trunk into four or five parts depending on the size. The outer layer is removed or discarded; the other layers are used as ropes, bags and decors.

AWARENESS, PERCEPTIONS AND ATTITUDES OF UPLAND FARMERS IN APAYAO TOWARDS AGROFORESTRY

Reymalyn C. Aman

APAYAO STATE COLLEGE San Isidro Sur, Luna, Apayao

This study was conducted in three selected areas in Lower Apayao to determine the awareness, perception and attitudes of upland farmers towards agroforestry. A total of 132 farmer–respondents were selected through systematic random sampling design. A structured interview schedule was designed to gather data on household characteristics, farming system and specifically on the awareness, perception, and attitude towards agroforestry. Descriptive statistics such as frequency counts, percentages, ranking, and mean were determined which and used in the final interpretation of data. The farmer-respondents were mostly male, middle-aged, married with low educational attainment and large household size. Most had low income from a small farm, owned their farmlands, and upland rice was the main crop planted and main source of income. Almost half of the respondents were not aware or had not heard of agroforestry as a farming system. However, those who were aware or had heard about agroforestry fully understood it. Majority were in favor of adopting forestry as a farming system and had plans of adopting it. Their general perception of certain agroforestry characteristics was neutral to positive. A little more information and explanation could help develop a positive perception towards agroforestry and eventually lead to its adoption. As to attitudes towards the adoption of agroforestry as a farming system, most of the farmer-respondents showed a positive attitude towards the idea. For those with negative and neutral attitudes towards agroforestry, many claimed that was something new, doubted its effectiveness and believed that it would be risky to adopt it. In general, the attitude towards agroforestry practices was neutral with a descriptive rating of 2.11. This suggests the need for more information and explanation to encourage a more favorable attitude towards agroforestry. Recommendations of this study include the need to conduct an intensive information, education and communication (IEC) campaign about agroforestry to increase the level of farmers' awareness; farmers training on agroforestry and integrated pest management (IPM); cross visits to successful agroforestry farms in places with similar bio-physical conditions; should be conducted to develop positive attitudes towards agroforestry; important conditions should be provided to farmers such as: provision of inputs to agriculture and forestry components and security of land tenure; provide assistance in marketing agroforestry products; provide on-farm post-technical and training assistance on Integrated Pest Management System (IPM). Another research which focuses on agroforestry adoption patterns should be conducted to develop a more powerful explanatory model of agroforestry adoption.

ASSESSMENT OF HEALTH AND NUTRITIONAL KNOWLEDGE AND PRACTICES OF MOTHERS IN SELECTED BARANGAYS OF RIZAL, LAGUNA

Belinda A. Lalap and Marcelina C. Miranda
UPLB-BIDANI, IHNF, CHE, UPLB

The study was conducted to assess the knowledge and practices of mothers with 0-24 month's old children on health and nutrition in Barangay Tala, Talaga and Pook, Rizal, Laguna. Specifically, it aimed to determine the factors (e.g. age & educational level of mothers, family income) that affect mothers' Knowledge and Practices on breastfeeding, weaning, and care of children and to identify the relationship of nutritional status of children and knowledge and practices of mothers. Data was gathered through an interview using a questionnaire and anthropometric measurement of children and mothers. Mothers' anthropometric measurements such as weight and height were also considered as basis for determining children's nutritional status. Generally, the study revealed that there were only 10% underweight children aged 0-24 months old. More than one-third of the mothers was high school graduate and 19% did not finished high school. Almost half of mothers were in the age range of 22-29 years old. The age of mothers at first pregnancy was 19 years old. However, 45% of mothers experienced pregnancy once and 24% of them had been pregnant twice while 30% of mothers experienced pregnancy for three to nine times. Nevertheless, it did not mean that their children were equal to the number of pregnancy because some of them experienced miscarriage. Most of the

mothers were housewives and 41% belonged to above poverty threshold. Majority of the mothers were equipped and practiced proper care during and after pregnancy. Majority of the mothers were not equipped with knowledge and practices on breastfeeding. Likewise, giving the complementary foods to young children in the right time was not observed. However, mothers personally took care of their children and thereby giving the proper child care particularly when sick. Specific actions like intensive and appropriate designed nutrition counseling and seminar for malnourished families were still highly recommended to increase the knowledge and practices of mothers on breastfeeding and giving complementary foods. Further studies on evaluation of mothers' knowledge and practices on health and nutrition are essential for proper planning and implementation of nutrition intervention for prevention and eradication of malnutrition.

BASELINE DATA GENERATION OF AGROFORESTRY SYSTEMS IN ABRA

Jose Lucas Demetrio B. Millare
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY Lagangilang, Abra

The study identified, described and evaluated the agro-forestry systems practiced in the province of Abra. Data gathering was done through personal interviews using a prepared interview schedule. Inputs provided by the key informants were supplemented by field visits and personal observations. Different farming systems and activities were documented through pictures and these were the basis of validating and evaluating the information gathered. The snowball sampling technique of data gathering was employed. Four distinct agro-forestry farming systems were practiced in the province: a) multi-storey, b) hedgerow cropping, c) live fence/boundary planting, and d) contour terracing systems. Two variants of the multi-storey system emerged: a) indigenous system wherein no orderly pattern of crop arrangement is practiced and this has evolved as a result of the long experience of the farming communities, and b) introduced systems which follows an orderly pattern of crop arrangement and has evolved as a result of research/experiment and can be adopted by others. These findings conform to the agroforestry classification proposed by Nair 1984, Getahun and Reshid 1988, and Lundgren and Raintree as cited by Lasco and Visco 2003. A modified hedgerow cropping was employed by the farmers. Strips of grass vegetation were used as hedgerow plants instead of woody perennials. In sloping grounds, contour terracing was practiced. Stones were piled at the base of the terrace forming stonewalls and the agricultural crops were planted along the terrace. Live tree-boundary planting was commonly practiced to demarcate boundaries of land properties and to provide protection and privacy to valuable products. Others planted trees around their farms or home lots such as around the house, garden, cropland or orchard to protect their crops from strong winds and to demarcate areas where general access was discouraged.

CURRICULUM ENHANCEMENT TOWARDS INTEGRAL EDUCATION IN AGRICULTURE IN COLLABORATION WITH ORGANIZATION OF INDUSTRIAL, SPIRITUAL AND CULTURAL ADVANCEMENT (OISCA)

Eusebia R. Pagluanan
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY Lagangilang, Abra

Abra was declared as one of the ten poorest provinces in the country. One approach explored was the establishment of domestic and foreign linkages like OISCA to generate employment and skills enhancement. A continuing training of ASIST graduates in agriculture to ensure employability was proposed. The program started its operation in Abra in 1984. ASIST was a grantee of Japan's program on Human Resource Development and Agriculture and Industrial Training for ASIST graduates to get further training along their fields of specialization in various agencies in Japan. It gave them the competitive edge in employment here and abroad, aside from the inter-cultural exposure. The advanced management styles and technologies being used in Japan bridged the gap between theory and practice, which is seen as the weakness of Philippine agricultural education.

ASIST is the only institution in Abra offering agriculture and agriculture-related courses interfaced with four functions. The linkage with OISCA has invigorated the employment prospect of agriculture graduate, as well as the enrollment of the College of Agriculture. It is sustained through a committed effort of the College to improve its instruction delivery program so that the quality of its graduates sent to OISCA can meet expectations. Since 2002 up to the present, OISCA and ASIST have been continuously working together to support this program. Constant dialogues are done to plan future activities as well as thresh out problems. The high regard and confidence earned by ASIST from OISCA should be sustained through continued bilateral talks. Furthermore, trainees coming back to our country after training in Japan are absorbed by sister companies based in the Philippines, assuring them of employment and serving as a showcase of viability of the program.

CLOSING THE GAP BETWEEN SCIENCE AND POLICY FOR ENHANCED ACTION ON CLIMATE CHANGE AMONG UPLAND COMMUNITIES

Maricel A. Tapia
College of Forestry and Natural Resources.UNIVERSITY OF THE PHILIPPINES LOS BAÑOS
Email: acel_tapia@yahoo.com

Climate change is considered the most serious, most pervasive environmental threat that the world faces today. The Philippines is not exempted from its impacts, more so being prone to natural and man-made disasters due to its location and geography. This calls for measures on how our society could reverse these adverse impacts or adapt to a new climate regime. As suggested by recent assessments, “the cost of inaction would be many time cost of action”. Central to these measures is the heightened interest for evidence-based policy underscoring that “policies that are informed by evidence help in the effective identification of needs and in the formulation of better strategies, as well as in helping reduce poverty and saving lives by lowering delivery costs and improving targeting” (Livny et al. 2006). Meanwhile, a review of natural resource policies by Lasco et al. (2008) revealed that climate change is yet to be mainstreamed into the Philippine development policy arena. Thus, this study explores how to effectively bridge the science and policy gap for enhanced action on climate change among upland communities in the Philippines. Forests are said to be critical ecosystems adversely affected by the change climate, and in them also reside the most vulnerable and the “poorest of the poor” people who are highly exposed to climate change risks. This sector is therefore a critical target for preparedness, adaptation and mitigation efforts for climate change. Information that will be generated from this study will give light on the status of climate change research, particularly with focus on upland communities, and what has been achieved in translating its results into policies and/or actions. Knowledge on this will help identify gaps that need further attention in responding to climate change risks or if current responses address the immediate needs of the upland communities.

COMMUNICATING CLIMATE CHANGE TO COMMUNITIES: A SURVEY ON CLIMATE CHANGE KNOWLEDGE AND PERCEPTION OF LOCAL DEVELOPMENT PLANNING COORDINATORS IN LAKESHORE CITIES AND MUNICIPALITIES OF LAGUNA, 2009

Olga C. Lomboy
UNIVERSITY OF THE PHILIPPINES LOS BANOS College, Laguna

Climate has become an important concern at both regional and global levels. However, the challenge for the scientific community and the government is how to localize climate communication and engagement. This study hopes to generate findings that provide specific guidance to science communicators and government officials on how to best communicate knowledge about global climate change to local development practitioners. A survey study with the Local Planning and Development Coordinators of 19 lakeshore cities/municipalities of Laguna was carried out to assess

their knowledge and perceptions on climate change and to determine the actions taken by their local government in response to the climate issue. Results show that the respondents have a moderate level of knowledge about climate change. Aside from conferences and seminars, the main source of information on climate change is the media through newspapers and television. In general, the respondents have expressed a high level of concern on the potential effects of climate change to their city/municipality but due to other priorities, strategic actions to adapt or mitigate the effects of climate have not been done.

COMMUNITY AWARENESS AND ACCEPTANCE OF THE KASC VISION MISSION, INSTITUTE GOAL AND BSA PROGRAM OBJECTIVES OF THE INSTITUTE OF AGRICULTURE AND FORESTRY

Carmelita T. Ayang-ang, Ernesto T. Miguel,Loreto Juan and Bernadette Aggabao
KALINGA-APAYAO STATE COLLEGE Tabuk City, Kalinga

The Kalinga Apayao State College's vision mission, goals and objectives are essential to the community where it exists. Reinforcement can be better realized if the whole community as stakeholders fully understand and accept the mission vision, goals and objectives of the School. This survey used a simple descriptive research method. Respondents were composed of 77 professionals from the different agencies in the province of Kalinga. Most of them fell in the 31-40 age bracket, with Master's degrees, and were aware of the existence of KASC VMGO particularly the College Vision Mission unlike in the Institute of Agriculture and Forestry Program Goal and Objectives. The respondents' main source of information were leaflets/flyers and information bulletins distributed by the college. With regards to the understanding of the VMGO, the respondents rated all the items. The KASC Vision and Mission were rated the highest (very high understanding). The BSA Program objectives had the lowest degree of understanding, but still managed to obtain a "high" rating. Although the respondents showed high awareness and understanding of the VGMO, particularly the College Vision Mission and moderate awareness of the Institute of Agriculture and Forestry Program Objectives, efforts should be exerted to improve their awareness through enhanced information dissemination and campaign. There should be deeper discussions with the stakeholders for them not only to understand but also to retain the principles.

HOUSING THE HOMELESS VICTIMS OF NATURAL DISASTER: THE RESETTLEMENT PRACTICES IN THE PHILIPPINES

Gloria Luz M. Nelson
Department of Social Sciences, CAS U.P. Los Baños, College, Laguna
glmnelson2001@yahoo.com.hk

The Philippines is very prone to natural disasters with an average of 20 typhoons. From 1995 to 1999, there were seven disastrous typhoons per year on the average. As a consequence, flooding is very common in both urban and rural areas. The National Mapping Resource and Information Agency said that one hundred and two areas or a total 181 towns will be most vulnerable with 2 meters sea level. Several thousands of families had lost their homes, properties and livelihood in the three provinces in the Philippines due to natural disasters that occurred in 1991, 2004 and 2006. The eruption of a dormant volcano, Mount Pinatubo in 1991 brought about recurrent lahars flows. Almost half a million families have to be resettled. In 2004, a super typhoon named Winnie buried the town of Infanta in Quezon province. In 2006, there were about 200,000 families from the surrounding municipalities in Mount Mayon, that suffered from flashfloods as an aftermath of typhoon Reming. The response of the Philippine government and non-government organizations to this urgent need is a long process of resettlement which usually takes an average of 2- 5 years. The paper further describes how the resettled families rebuild their lives through cooperation, solidarity and resiliency of the community members. Assistance of the NGOs was found to be indispensable because of their initiatives in providing sustainable livelihood to alleviate the widespread poverty in the resettlement

sites. The paper identified lessons that can be shared to other persons who will be in a similar situation and at the same time intervention strategies prior to typhoons and flooding; and volcanic eruption are suggested.

GENDER ROLES IN THE TEXTILE INDUSTRY IN APAYAO

Ronald O. Ocampo, Magdalena Edan and Evelyn P. Alvarez
APAYAO STATE COLLEGE San Isidro Sur, Luna, Apayao

This study examined the dynamics of the community, farms and households to understand the roles of men and women in the textile industry. Specifically, it determined the activities of men and women in the textile industry; determined the time spent by men and women allotted to their daily tasks, and analyzed the roles of men and women in the textile industry. The descriptive method of research was used with the gender analysis tool kit as the main data gathering tool. Purposive sampling was done in selecting the 30 respondents of the study. Results showed that women are heavily involved in textile-related activities especially weaving but men also share in the responsibility. Men assist in the production of textile products. But they devote much of their time to farming - their primary source of income. Based on the findings, women are the key players in the textile industry. They are the ones involved in most of the textile-related activities, particularly weaving. Men also share in the responsibility in the textile industry by assisting the women perform their work.

EFFECT OF NUTRITION EDUCATION AND COUNSELIING ON THE BLOOD SUGAR OF DIABETES PATIENTS

Cynthia M. Custodio

The incidence of Diabetes mellitus has been increasing among various population groups nationwide and worldwide as cited by national and international survey studies of the Food and Nutrition Research Institute in the Philippines and the World Health Organization as well. The population of the municipality of Los Banos was not spared from the menace of diabetes. Increasing number of patients from all walks of life seek medical attention to find cure for the disease. This study was made to explore the possibility of finding ways to alleviate, if not cure, the health concerns of individuals afflicted of diabetes. As a member of the medical team to answer the medical problem of diabetes patients, medical nutrition therapy was actively taking part in the healing process. In this study, nutrition education and counseling was conducted to a group of individual diabetes out-patients. The available medical charts and laboratory biochemical test results as ordered by the physicians were used as reference guide before the conduct of the nutrition education session. Nutrition profile form, illustration materials and nutrition guidelines were used to explain the therapy method to individual patients. Another group of individual out-patients were asked to answer the same nutrition profile form where the medical and socio-demographic information were indicated. They were given brief and quick advice regarding questions concerning nutrition and diabetes. The fasting blood sugar (FBS) tests were taken after one month. Results showed that ninety-three percent of the NIDDM out-patients studied who availed of nutrition medical therapy conducted by an RND were able to achieve normal blood sugar after different days of observation.

TECHNOLOGY ADOPTION OF ALTERNATIVE PLANTING MATERIALS AND PROCESSING VARIETIES IN THE PHILIPPINE HIGHLANDS

D. T. Meldoz, B. T. Gayao and D. K. Simongo
NPRCRTC-BSU La Trinidad, Benguet, Philippines
Email: d.meldoz@yahoo.com, btgayao@hotmail.com, dsimongo@yahoo.com.ph

This study determined the level of technology adoption of rooted cuttings, generation zero seeds and true potato seeds as an alternative to clean seed tubers of locally developed potato varieties Igorota, Solibao and Raniag. A survey was conducted in the seven potato-producing municipalities of Benguet and Mountain Province, namely: Atok, Bakun, Bauko, Buguias, Mankayan, Kabayan and Kibungan. Results showed that rooted cuttings had the highest adoption level with 38% of the farmers having tried planting them at least once, followed by GO seeds (19%) and TPS (2%). Around 44% and 62% of the farmers were aware of rooted cuttings and GO seeds, respectively, but did not try planting principally because of lack of resources to grow seeds (clean area, cash and manpower). With respect to varieties, Igorota had high adoption level (82%), while Solibao and Raniag had low adoption levels (25 and 18%, respectively). High adoption level for Igorota was attributed to its high yield and tuber characteristics, which were acceptable in the market. Solibao has elongated tuber, while Raniag has low yield. Attendance to training and seminars, as well as membership in organizations, had higher influence on technology adoption levels than farm area and land ownership. Trainings contributed a lot to the increased awareness and adoption of rooted cuttings and Igorota variety.

SOCIAL NETWORK ANALYSIS OF RESEARCH COLLABORATION AMONG FILIPINO AGRICULTURAL SCIENTISTS

Jaderick P. Pabico
College of Arts and Sciences UNIVERSITY OF THE PHILIPPINES LOS BAÑOS
jppabico@uplb.edu.ph

A social network is composed of people or groups called “actors”, each of which has some kind of connections called “ties” to some or all of the actors. In this study, we constructed a network of collaboration between Filipino agricultural scientists using computer archives of scientific papers in Philippine agriculture spanning the recent 4-year period from 2006 to 2009 involving 235 papers written by 645 authors. In this network, two scientists (actors) were considered connected (have ties) if they had coauthored one or more papers together. We found the following statistical properties of the network:

1. The Filipino agricultural scientists had written an average of 1.39 papers (maximum=13);
2. The scientific papers had an average of 3.81 authors (maximum=15); and
3. The Filipino agricultural scientists had collaborated with an average of 2.70 scientists (maximum=28).

To understand the pattern of connection and communication between scientists, we utilized computational techniques from statistical physics and the results were:

1. The maximum and average typical distances between scientists through the network were 12 and 4.89, respectively. Typical distance means the length of a “referral chain” of intermediate scientists through whom contact may be established. One needed to talk to an average of five scientists to get an audience with another, but needed to talk to at least 12 to guarantee an audience with any. The average value of 4.89 was smaller than the well-known six-degrees of separation among actors in networks exhibiting the small-world characteristics. This means that scientific information would not have to travel far through the network to reach those who could benefit from them.
2. The betweenness centrality of the network was 0.04, suggesting that 4% of the scientists were the most influential in the network acting as information hubs.

TAPPING THE POTENTIALS OF THE WEAVING INDUSTRY IN APAYAO

Ronald O. Ocampo
APAYAO STATE COLLEGE San Isidro Sur, Luna, Apayao
e-mail Address: gfrichron2@yahoo.com

The province of Apayao is endowed with rich natural resources. Dubbed as the "Cordilleras' last forest frontier", Apayao continues to preserve its luscious natural beauty as well as its rich cultural diversity. The province's main occupation is agriculture with rice and corn as the main crops produced. Other industries include furniture making, food processing, small-scale mining, blacksmithing and weaving. The weaving industry (basket, handicraft and loom weaving) is not only seen as a potential income generating activity, but also in upholding the province's cultural identity. To tap the potentials of the weaving industry, an assessment was undertaken that included: documentation of the current situation of the industry; identification of the strengths, weaknesses, opportunities and threats to the industry (SWOT analysis) identification of science and technology gaps to generate interventions that would strengthen the industry. Results showed that the weaving industry is still in its formative years, untapped or not yet fully developed. The industry can harness the fiber and dyestuff sources in the province and enhance weaving. Present activities as part of enhancing the weaving industry include training on fiber processing, identifying and utilizing dye-yielding plants for coloring fabrics, and developing the ethnic weaving designs.

100 TECHNOLOGIES FROM UPLBCA

Apolinario l. Lantican, Matilde V. Maunahan, Myrna S. Galang, Dennis V. Cantre, Gil L. Magsino, Marilyn M. Beltran, Hospicio G. Natural Jr., Nenita L. De Castro, Florencia P. Elliot, Marife T. Ombico, Teodora M. de Villa and Ruby G. Dela Cruz
UNIVERSITY OF THE PHILIPPINES LOS BAÑOS College, Laguna

The UPLB College of Agriculture (CA), as the undisputed center of excellence in agriculture education and development, has already produced numerous technologies intended for the farmers and other stakeholders. For this particular paper, only 100 technologies developed by CA thru the century will be featured in consonance with the centennial celebration of UPLB. As early as 1915-1916, the then Department of Entomology witnessed the initial historic successes of biological control when some American entomologists visited Los Baños and discovered a parasitic wasp, *Scolla manilae* Ashmead. When introduced in Hawaii, this wasp led to the control of the white rub (*Anomala orientalis* Waterhouse). In the 1920s and 1930s, plant stocks and livestock, which were products of long years of breeding by researchers of the College, were made available to Filipino farmers. Among those stocks favorably received were Philamin cattle, Berkjala pig and Los Baños cantonese chicken. From then on, the College has been conducting research activities that served as important base for the development of agricultural science and scientific farm practice in the Philippines that also benefited other countries in Southeast Asia and the world. Other research milestones include high yielding crop varieties, improved/new varieties of ornamentals, flower inducers of mango and pineapple, biological control of pests, integrated pest management, postharvest technologies, plant and animal genetic resources, quality improvement and safety of wine and other ready to drink beverages, functional food from traditional and indigenous materials, high quality animal products, fertilizers, decomposers and soil enhancers, analytical techniques and packages and detection kits for plant, food, feed, and water pathogens. These technologies are anchored on sustainable development through utilization and management of locally generated resources, biodiversity conservation, participatory extension approaches, and strengthening of agricultural support systems.

PARTICIPATORY DEVELOPMENT BROADCASTING: AN EXTENSION SUPPORT STRATEGY FOR TECHNOLOGY PROMOTION TOWARDS AGRICULTURAL DEVELOPMENT

Matilde V. Maunahan, Severino M. Flores, Nenita L. de Castro, Simeona C. Seminiano, Myrna A. Tenorio, Teodora M. de Villa, Marilyn M. Beltran, Ruby G. dela Cruz, Imelda M. Gesmundo, Marife T. Ombico, Balbino C. Geronimo, and Lerma L. Moran
UNIVERSITY OF THE PHILIPPINES LOS BAÑOS College, Laguna

Even with the recent developments in information and communication technology, radio continues to be a most accessible and potent medium for sharing technical information and knowledge, and educating farming communities. This paper relates the experiences of putting up, test broadcasting, and piloting a participatory community radio program with local government units, research and development agencies, and the farmers themselves as partners, with the end in view of disseminating agricultural and development information relevant to the needs of the local communities and promoting modern agriculture as a viable enterprise. The process involved mentoring and training-workshops on: participatory program development; community- and agriculture-based radio program planning using participatory rapid rural appraisal to determine the information needs and listening preferences of the community; and program organization, planning, production, management, and monitoring and evaluation. The program is still evolving, a continuing learning experience for all partners, resulting in empowerment and capability building particularly in community-based participatory radio program production. An effective vehicle for technical/expert and resource sharing, it also created opportunities for increased networking and coordination among the different stakeholders. The program also paved the way for new linkages, future collaborative projects, and further agricultural extension researchable areas.

PROFILES OF ENDEMIC FRESHWATER ECOSYTEMS IN ABRA

Cornelia Solivas-Tubaña
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY Main Campus, Lagangilang, Abra
E-mail Address: cornelia_asist@yahoo.com, asistmain@yahoo.com

Abra is endowed with inland waters as habitats of freshwater endemic flora and fauna that are used as food. The Abra River has several tributaries that pass along the province and serve as the main source of livelihood of fisherfolks, and source of irrigation system of farmers. Baseline data on the profiles of fishing areas, endemic freshwater resources, and fisherfolks in Abra were gathered to promote and conserve environmental resources. The Abra River, creeks, streams, and rice fields teem with endemic freshwater resources. Thirty-eight fish species are present, of which the most common are “bunog”, “karpa”, “palilleng”, “igat” and “kampa”. The special endemic fish called ‘ludong’ is still common in the province. “Agurong”, “bennek”, “bisukol”, “leddeg” and “suso” are the common shells. “Kuros” and crabs are crustaceans, and “pakko” and “baktel” are the aquatic plants mostly used as food. Most of the fisherfolks have been permanently residing in their barangays for more than 30 years, married, with 1-5 members in their households, and have obtained basic education. They have been in fishing for 10-20 years, but farming is still their main source of income. However, those in fishing have higher income. Few have attended training on fish growing and marketing. Majority have joined associations and some are barangay officials. Their catch is used for home consumption, sold or bartered either as fresh or grilled. Selling is done right in the river, local public market or house-to-house, mostly by housewives and middlemen. Freshwater resources are threatened by human-induced activities such as pollution, mining and other activities, as well as by heavy siltation. Hence, the endemic aquatic species are now at the brink of extinction. There is, therefore, a pressing need to protect, sustain and conserve these resources in situ and ex situ for more sustainable aquaculture.

REPETITIVE HARVESTING: AN EFFICIENCT METHOD FOR SEED TUBER PRODUCTION IN POTATO

Cynthia G. Kiswa, Paz A. Dalang, Jocelyn C. Perez, Grace S. Backian and Lito M. Pacuz
NORTHERN PHILIPPINES ROOT CROPS RESEARCH AND TRAINING CENTER-BENGUET STATE UNIVERSITY, La Trinidad, Benguet, Philippines

Repetitive harvesting or staggered harvesting is a technique of enhancing potato to produce more tubers or force cultivars with poor tuber set to yield more tubers. This study determined the effect of repetitive harvesting method on G-zero tuber yield in the greenhouse and its subsequent yield in the field and the profitability of this method. Two trials were done where the potato plants were repeatedly harvested 2 to 4 times depending on the variety in between the growing period until it reached the senescence stage. The potato varieties 'Granola', 'Igorota', 'Solibao' and 'Raniag were used. First harvesting of tubers was done after 5-8 weeks from planting. Duration of harvest depended on the maturity period of the variety. Succeeding harvests were done every after 2 weeks until the maturity stage. Storage performance and subsequent yield of tubers derived from repetitive harvesting was likewise compared with tuber yield from conventional method of harvesting (one-time harvesting at senescence period). Repetitive harvesting significantly influenced the number of tubers harvested but not on the weight of tuber per unit area. In the first trial, repeatedly harvested 'Igorota' and 'Granola' yielded an average of 367 and 410 tubers per m2 against one time harvesting with 154 and 167 pieces, respectively. The same trend was observed in the second trial where repetitive harvesting in four varieties (Granola, Igorota, Solibao and Raniag) yielded more than twice the number of tubers than when harvested at one time. Furthermore, as harvesting increased from one to four times, the total number of tubers harvested also increased, consequently increasing net income by 17-30% inspite of additional labor cost incurred.

REVEALED WILLINGNESS TO PAY FOR SAFE DRINKING WATER IN LAGUNA WATER DISTRICT'S SERVICE AREA, 2008

Genny G. Bandoles[1] and Corazon L. Rapera[2]
PHILIPPINE COUNCIL FOR AGRICULTURE, FORESTRY AND NATURAL RESOURCES RESEARCH AND DEVELOPMENT, gennybandoles@yahoo.com;
COLLEGE OF ECONOMICS AND MANAGEMENT, UP LOS BANOS, corarapera@yahoo.com

Despite claims by the Laguna Water District (LWD) that piped water is safe for drinking, many households with piped water in Los Banos, Bay and Calauan municipalities in Laguna regularly buy and consume purified drinking water. This indicates that piped water quality is perceived to be poor and that households are willing to pay for safe drinking water. This study described the households' perception of the piped water, the reasons for these perceptions, and the measures that households employed to avert risks from drinking poor quality piped water. It also estimated the households' revealed willingness to pay (revealed WTP) for safe drinking water. Data came from a random sample of 392 households constituting 1.9% of all households with piped water in the three municipalities. Perceptions on piped water and the use of measures to improve water quality were analyzed using the descriptive method. The averting expenditure method was used to estimate the revealed WTP of households for safe drinking water. Results showed that 72% of sample households perceived piped water as not fit for drinking because of problems with its clarity, odor, taste and purity. This perception caused households to employ averting measures such as filtering, decanting, boiling, using a home water purifier, fetching water from a manually operated shallow tube well or hand pump, and purchasing bottled distilled water or commercial purified water, the last being the most common measure. The revealed WTP of sample households in all three towns totaled P14,117 per week or P734,094 per year, or at least P36 per week per sample household, on the average. Applying this value proportionately to the remaining population of households with piped water, total WTP amounted to almost P37,981,868 per year. The revealed WTP for safe drinking water was very high because piped water was clearly perceived by many to be unsafe for drinking.

ADAPTATION OF UPCOMING HYBRID RICE UNDER TABUK CONDITION

Ferdinand Ganotice, Loreto B. Juan & Jovita E. Saguibo
KALINGA APAYAO STATE COLLEGE Tabuk City, Kalinga

This study determined the adaptation of upcoming hybrid rice varieties under Tabuk condition in Kalinga Province. The Randomized Complete Block Design and the following treatments were used in the study: T1 - HLX1, T2 - HLX2, T3 - HLX3, T4 - HLX4, T5 - HLX5. Results showed that T3 produced the highest number of tillers and T4 the lowest. T3 produced the longest panicle at 22.64 and T2 the shortest at 21.97. T2 yielded the highest number of filled grains per panicle with a mean of 26.7 and T1 the lowest at 3.6. Unfilled grains per panicle were highest in T4 (136.25), but lowest in T2 (90.5). On the degree of spikelet opening, T5 showed the widest spikelet opening and T2 the closest. T2 had the heaviest grains and T5 the lightest. On the return of investment, T2 obtained the highest at 533.94% while T5 had the lowest at 25.50%. T2 has been recommended for planting in Kalinga during the wet season based on its performance – highest number of filled spikelets, heaviest grains and highest ROI (533.94%) compared to the other treatments. However, a similar study should be conducted during the dry season for verification purposes.

ADAPTIVE MANAGEMENT TOWARDS INSTITUTIONALIZING RESOURCE EFFECTIVE (ADMIRE) *JATROPHA CURCAS* SEEDLING PRODUCTION

Arturo SA Castillo[1], Roselyn F. Paelmo[2], Gerardo G. Paelmo[1] and Roberto G. Visco[1]
[1]Institute of Renewable and Natural Resources, College of Forestry and Natural Resources, UP Los Baños; [2]Institute of Agroforestry, College of Forestry and Natural Resources, UP Los Baños

Globally with the inevitable pressures of climate change, humanity becomes conscientious in instilling an ecological everyday life. Recently, the trend is towards prospering a green economy. The Philippines has laid its significant contribution to the global mandate of preserving ecological stability. It has crafted the Biofuels Act of 2006, which makes mandatory the use of biofuel blends in the transport sector. Alternative energy sources are also being developed globally, to wit solar, wind, hydro and denrdothermal, among others. Meanwhile, one of the potential alternative energy sources which pro-actively caters to the mitigation and adaptation of climate change is the planting of biofuel species. The planting site for the said species is located at the marginal upland areas in the country - a vast area of at least 400,000 hectares. Such will require the supply of readily available quality planting stocks. Amongst the potentially promising biofuel species is Jatropha curcas. However, the production protocol for this biofuel is yet to be established in the country. The project, initiated by the Philippine National Oil Company-Alternative Fuels Corporation and the UPLB Foundation Inc. through the Institute of Renewable Natural Resources, established the production protocol that could serve as standard for the development of nursery customized to the Philippine condition particularly for *Jatropha curcas*. Through transdisciplinary approach and adaptive management, the project cost-effectively produced 5.3 million Jatropha seedlings. Silvical characterization showed that the asexually produced seedlings flowered earlier than the sexually produced seedlings. Moreover, the production module indicated that the 6-ha nursery area could economically raise the 5.3 million Jatropha seedlings.

SUSTAINING THE SOCIO-CULTURAL AND NATURAL RESOURCE CONSERVATION OF THE ISNAGS THROUGH THE NARIHA SAY-AM FESTIVAL OF PUDTOL, APAYAO

Ronald Ocampo and Rema Bascos
APAYAO STATE COLLEGE San Isidro Sur, Luna, Apayao

The Narimag Highlanders Association (NARIHA) Say-Am Festival is celebrated every 18th of December by the Isnags of the upper barangays of Pudtol, Apayao. It is intended to promote the *Lapat* system as an indigenous conservation method of protecting natural resources and proliferating the Isnag's socio-cultural activities. Top government officials of the province join in the festival. Highlights of the occasion are the dancing of the "taddok the talip" and the exchange of discourse among the top provincial officials headed by the governor disclosing the meaning and significance of every event in the Say-am ceremony. Significantly, the event revives cultural traditions and unites the

people of Apayao (iYapayao) of different cultural orientations and background in protecting the twin rivers of Nagan and Maton, including the Agora Wildlife Sanctuary. The NARIHA Say-am is an effective tool of merging principles across cultural differences in Apayao. Likewise, it is also a helpful means of conserving the Agora Wildlife Sanctuary watershed supporting irrigations for farmlands and protecting both terrestrial and aquatic organisms for biodiversity conservation.

PERFORMANCE OF SWEET SORGHUM ACCESSIONS UNDER ABRA CONDITION DURING WET SEASONS

Cornelia Solivas-Tubaña and Lillian Advincula-Anquillano
ABRA STATE INSTITUTE OF SCIENCES AND TECHNOLOGY Main Campus, Lagangilang, Abra
E-mail Address: cornelia_asist@yahoo.com., asistmain@yahoo.com.

Performance trial of five newly introduced accessions of sweet sorghum [Sorghum bicolor (L.) Moench], a dryland crop, under Abra condition was conducted at ASIST, Lagangilang, Abra. The study determined sweet sorghum's performance in wet season to ensure a year-round supply for bio-fuel production. It was also done to facilitate the transfer of technologies on sweet sorghum for mass production. There were no significant differences on the height of all accessions at maturity. However, ICSV 700 and NTJ2 accessions had the longest panicles. NTJ2 and ICSR93034 accessions had the best plant stand with significant differences. ICSV 700, SPV 422 and ICSR 94034 accessions flowered earlier with highly significant differences. NTJ2 accession was the most resistant to shoot fly damage, as well as stem borer damage, among the accessions, with significant differences. No significant differences in the lodging tendency were noted among the accessions. SPV422 and NTJ2 accessions showed the biggest stalks, with highly significant differences. NTJ2 accession had the highest stalked stripped yield, with highly significant differences. NTJ2, SPV422, and 93034 accessions gave the highest fresh weight, dried weight and weight of 100 seeds, which were highly significant differences. NTJ2, SPV422 and 93034 accessions were recommended for farmers' use to promote sweet sorghum bio-fuel production.

STOCK ASSESSMENT OF *TRIPNUESTES GRATILLA* OF MALAUMAUN ISLAND, CASTILLA, SORSOGON

Arnelyn Dolotallas Doloiras and Ronnel R. Dioneda, Sr.
BICOL UNIVERSITY Legazpi City

The stock status of the economically important sea urchin (Tripnuestes gratilla) of Malaumaun Island was assessed using the analytical length-based stock assessment through the FISAT-ICLARM Fish Stock Assessment Tool (version 1.2.2, Gayanilo et al., 1996). The Malaumaun stock is one of the only few remaining healthy stocks known in Bicol after the overexploitation in the 1990's of the Albay's east coast stock. Important growth and mortality parameters were extracted and used in determination of sustainable yield indices. A total of 3221 length measures or individuals, representing 10 months times series data were used in the analysis. The growth parameters computed for the species are $L\infty$= 9.65 cm and K = 1.02, indicative of fast growing tropical invertebrate species. Mortality parameters computed were total mortality (Z) = 3.36, natural mortality (M) = 2.52 and fishing mortality (F) = 0.84. Exploitation rate was computed at E = 0.25. The exploitation level indices under exploitation as described by the conventional fish stock assessment exploitation standard which sustainable level ranges from 0.3 to 0.5 (Beddington and Cooke, 1983 and Guland, 1971). The computed length at first capture (L50) of 6. 32 cm is bigger than the size at first maturity (6.0 cm), showing that the species had contributed to the spawning before the minimal harvesting. Recruitment pattern is year round with peak occurrence at second quarter of the year. The study recommends an increase in harvesting from E = 0.25 to L0.50 = 0.406, which will result to an increase of 17% yield-per-recruitment, by harvesting 38.42% of the existing biomass. Harvestable individuals on per year basis shall not exceed 1229 at sizes bigger than 6.5 cm. Test culture of the organism, using the recommended harvestable

level can be tested to evaluate its potential as alternative livelihood to fishing communities. Further refinement of the bio-ecological bases of sea urchin management is also recommended.

COMMUNITY RESOURCE –BASED ORGANIC FERTILIZER PRODUCTION: A SUSTAINABLE WASTE MANAGEMENT AND FARMING PRACTICE IN OCCIDENTAL MINDORO

Benedicto R. Batiles, Jr. and Ronaldo G. Orpiano*
OCCIDENTAL MINDORO NATIONAL COLLEGE San Jose, Occidental Mindoro

The use of farm wastes as organic fertilizers is a practice that offers reduction in crop production costs, increasing yield and income and reduction of source of pollution. Its use is a promising strategy to achieve the universal goal for environmental preservation and conservation. This paper summarized the different experiments conducted on the utilization of farm wastes in improving crop production. These materials were composted and were tested to different crops by the Occidental Mindoro National College. Varying rates of mixtures and inoculants were tested in separate experiments. Likewise, the acceptance of farmers was assessed based on their responses as to the use of inoculated mixtures and their participation in related seminar-workshops. Results revealed that the use of composted farm waste materials like carbonized rice hull, rice straw, vegetable trimmings and different animal manure had significantly improved the yield of different crops. Its effect was found comparable to the use of inorganic fertilizer. Moreover, the use of isolated indigenous microorganisms and plant extracts were found comparable to the expensive and imported inoculants. As to diffusion, the compost and the technology of using compost enhancer were accepted by farmers at high level, indicated by the high attendance of farmers to extension activities and the increasing number of individuals and farmer organizations who are using self prepared inoculants. Many owners of commercial and backyard scale livestock farm are now transforming their waste into compost. Students of the OMNC had likewise found a source of income in collecting compost material.

FOOD CONSUMPTION PATTERNS AND HOUSEHOLD FOOD SECURITY IN CALABARZON

Julieta A. Delos Reyes and Marc Savio G. Himatay
Dept. of Agricultural Economics, CEM, UPLB

The study determined the household food security in CALABARZON by assessing the calorie intake of the selected households. Secondary data covering 251 CALABARZON households were obtained from the 2003 Family Income and Expenditures Survey of the National Statistics Office and the 2003 Food Consumption Survey of the Food and Nutrition Research Institute. These were subjected to descriptive, Gini coefficient for inequality and multiple regression analyses. The average annual per capita income in CALABARZON was estimated at P36, 212, while the average food expenditure was P37.9 per person per day. The average food consumption was 923 grams per person per day and among the major food groups consumed were: cereal and cereal products (45%), fish, meat and poultry products (23%), and fruits (13%). The mean one-day per capita intake was 1,894 kilocalories, but the poor had an average of 1,572 and the non-poor households, 1,953 kilocalories per day. It was further revealed that 60% of the households in CALABARZON were food insecure, 74% of which came from poor households and 57% from non-poor families.

UPLAND CROP PRODUCTION: OPPORTUNITIES FOR ORGANIC AGRICULTURE

Ronald Ocampo, Mirasol Agpuldo and Rema Bascos
APAYAO STATE COLLEGE San Isidro Sur, Luna, Apayao

This study described the crop production system in the uplands of Apayao; determined extent of chemical inputs in upland crop production system, and identified the doable interventions to develop organic agriculture in the area. Field survey was done to 42 upland dwellers in the municipalities of Luna, Pudtol, Flora and Sta. Marcela. Data were gathered using interview and observation coupled with photo documentation. Results showed that most upland farms planted traditional varieties of rice, legumes and vegetables. Production system was labor-intensive and did not rely much on chemical inputs. The use of pesticides was only done when there was severe pest and disease. In the light of the findings, the following recommendations are forwarded: conduct farm assessment to identify farms suitable for organic agriculture; establish market for organically produced crops in the area to encourage farmers to go organic; coordinate with LGU and other agencies to assist farmers for organic certification.; encourage farmers to go organic production; conduct RDE on organic crop production system to increase farm productivity of farmers.

MUSCOVADO SUGAR PRODUCTION AND MARKETING IN SELECTED AREAS OF THE PHILIPPINES: A VALUE CHAIN ANALYSIS

Alessandro A. Manilay and Antonio Jesus A. Quilloy
College of Economics and Management UNIVERSITY OF THE PHILIPPINES AT LOS BANOS

In the context of reducing poverty among sugar farmers, the production and marketing of muscovado sugar is considered an entry point for increasing farm income. The favorable retail price of the commodity in the domestic market creates a pull-up effect on the farmgate price that is beneficial to the farmers. In addition, the demand for the product is growing worldwide as the number of health foods consumers increases. This budding market niche presents an opportunity to the Philippine muscovado sugar farmers and other related industries. Despite the positive, supply has not caught up with the demand both in the domestic and world market. This study was conducted to analyze the production and marketing dynamics in Antique, Negros Occidental and Sultan Kudarat, the three largest suppliers of muscovado sugar in the country. The expected economic benefits from muscovado production are not equally shared among farmers within the selected study areas. Antique farmers have lower farm productivity and receive lower farm gate prices compared to farmers in Negros Occidental and Sultan Kudarat. Sugar processing continues to be a backyard operation where health, sanitation and air pollution is rarely addressed. Organic farming remains to be practiced only by a few sugarcane farmers. Because market niche already exists for muscovado sugar, farmers tend to continue using the conventional farming method over organic farming unless the whole market niche begin to clamour for organically produced sugarcane. Only exporters have become sensitive to the market for organically certified muscovado sugar because these are the segment of traders who are in touch with markets requiring organically grown products. Local traders, do not discriminate over organically grown sugar. The farm to market linkage is highly organized wherein each stakeholder has clearly defined functions and that market information flows freely. Vertical integration is more pronounced in Antique than in Negros and Sultan Kudarat. Although farm-market integration within a cluster is existent, intercluster linkaging is limited. Farm production costs differ among the three clusters included in the study which is indicative that farming methods vary among the clusters. The Philippines is less efficient in employing its resources to produce sugarcane than other selected muscovado-producing countries, namely, Brazil, Colombia, India, Indonesia and Thailand except for Mauritius. Ceteris paribus, production efficiency enables a country to sell its product at a lower cost and at the same time receive a normal profit.

EXPORT COMPETITIVENESS OF PHILIPPINE SEAWEEDS BEFORE AND DURING THE IMPLEMENTATION OF AGRICULTURE AND FISHERIES MODERNIZATION ACT (AFMA), 1992-2006

Cesar B. Quicoy and Diane Lara L Monis

College of Economics and Management, UNIVERSITY OF THE PHILIPPINES AT LOS BAÑOS
College, Laguna

This study determined the export competitiveness of Philippine seaweeds before and during the implementation of AFMA. The study used regression analysis to determine the effects of AFMA and other variables on the volume of exports of seaweeds. To measure the competitive advantage of Philippine seaweeds, the study used the revealed comparative advantage and cost competitiveness analysis. Domestic production of seaweeds increased from 1992 to 2006. The volume of exports of seaweeds and other algae used for food posted an increasing trend due to increasing imports of China. The volume of exports of seaweeds/other algae were positively related with AFMA and foreign exchange rate. Foreign exchange rate was positively related to the volume of exports of seaweeds and other algae used for food at ten percent while volume of exports of Indonesia was negatively related. For the periods considered, RCA values of Philippine seaweeds were all greater than one, signifying that it was still highly competitive in the global market. However, it posted a declining trend. The RCA value of Philippines seaweeds was significantly much higher at one percent probability level compared to the RCA value of Indonesian seaweeds. Although, the level of export competitiveness of Philippine seaweeds were higher than Indonesian seaweeds, its increasing level of export competitiveness poses a threat to the export of Philippine seaweeds. Philippine seaweeds have competitive advantage in production and trading based on the RCR values greater than one for both periods. The problems faced by the seaweed industry were increasing competition with other countries, continued smuggling of seedlings for planting and raw seaweeds for processing in the Asian neighbors, higher prices of raw dried seaweeds, shortage of supply as raw materials for local processors and deteriorating quality of local seaweeds. In order to enhance the export competitiveness of seaweeds industry, the following recommendations are suggested: (1) increase government support to enhance productivity of quality seaweeds; (2) reduction of smuggling of seaweeds through strict enforcement of the law; (3) increase the budget allocation for the five AFMA components to enhance the competitiveness of the Philippine seaweeds; and (4) strengthen small seaweed farmers/industry associations in the country.

VALUE CHAIN ANALYSIS OF SEAWEEDS IN ZAMBOANGA

Karlo Adrian B. Pobre and Ma. Eden S. Piadozo
College of Economics and Management, UNIVERSITY OF THE PHILIPPINES AT LOS BAÑOS
College, Laguna

Seaweed farming is an important source of livelihood for Zamboanga farmers. The Zamboanga peninsula is the third major seaweed-producing region in the Philippines, contributing 12 percent to the total national production and 20% of Mindanao produce. This paper assessed the value chain of seaweeds in Zamboanga City and Zamboanga Sibugay. Specifically, it identified the key players in the marketing chain, determined the factors affecting the farmer's choice of marketing outlet, evaluated the profitability of marketing seaweeds and the value added at the different stages of the marketing chain, and identified the key problems and constraints that affected the value chain activities. Zamboanga Peninsula had more than four key players in the seaweed industry. These included the farmers, traders (wholesalers, assembler-wholesalers, exporters) and processors. Two of the largest processing plants were located in Zamboanga City and were producing semi-refined carageenan. At least five companies were exporters of seaweeds in dried form. The logit analysis revealed that ethnicity and household income influenced the farmer's choice of marketing channel. Farmers preferred selling to fellow Chavacanos. Those with high household income were found to favor the exporters in Zamboanga and other regions outside the city. Dried seaweeds provided the farmers with high net return at P539,600. Among the traders, the exporters received the highest net return in spite of the high marketing cost incurred because of the high selling price they obtained. In terms of value addition, the exporters contributed the highest value added as they transformed

seaweeds into an exportable form. Compared to the other market players, the value added realized by exporters was about eight times higher than that generated by wholesalers, and twice that of the assembler-wholesalers. Among all product flows, the highest value addition was highest at P63.12/kg with the farmers selling to wholesalers and then to the exporters. For raw seaweeds, the flow from the farmers, wholesalers, assembler-wholesalers and exporters generated the highest value addition. The farmers, however, received the lowest share of the exporters' price. Poor quality control and the increase in transport cost adversely affected the marketing operation of seaweeds.

STUDIES ON DETOXIFICATION OF *JATROPHA* PRESS CAKE AND PRELIMINARY FEED TESTING IN TILAPIA (*OREOCHROMIS NILOTICUS* L.)

Bayani M. Espiritu, Stephanie F. Nuñez, Lovely B. Willauer, and Rex B. Demafelis
UNIVERSITY OF THE PHILIPPINES AT LOS BAÑOS College, Laguna

Jatropha curcas meal has crude protein content of 53 to 58%. The press cake, however, has been found to be very toxic to fish, rats and chickens. In this study, *Jatropha* press cake was detoxified using heat treatment, solvent extraction and fermentation with mixed microbial inoculants for three weeks. Using tilapia fingerlings (*Oreochromis niloticus* L.), a two-week experiment was conducted to evaluate the toxicity and nutritional quality of the treated *Jatropha* press cake as fish feeds. Fingerlings were randomly distributed in eight treatment groups and fed the following diets: T1 (standard diet of commercial feed), T2 (fermented cake), T3 (50% commercial feed + 50% fermented cake), T4 (methanol-treated cake), T5 (50% commercial feed + 50% methanol-treated cake), T6 (heat-treated cake), T7 (50% commercial feed + 50% heat-treated cake), and T8 (raw *Jatropha* press cake). The body weight gain (BWG%) and specific growth rate (SGR%) in T1 and T3 were statistically similar, and both were significantly higher than those of the other groups. Feed intake with raw Jatropha meal in diet was significantly reduced for all treatments and fish experienced body weight loss. This was mainly attributed to the presence of phorbol esters, a toxin found in raw *Jatropha* press cake. Percent mortality based on tilapia test was used as the index of toxicity of treated and untreated press cake in this evaluation. Highest mortality of 46.67% was observed in those fed with raw press cake. T3 gave the results closest to that of T1 for all feeding parameters such as body weight gain, specific growth rate and daily food consumption. Fermentation with mixed bacterial inoculants seemed to be the best method for detoxifying *Jatropha* press cake for use as fish feed.

BIO FERTILIZER PRODUCTION

John Foy-os and Ernesto T. Miguel
Kalinga Apayao State College

The Kalinga-Apayao State College (KASC) is the only tertiary educational institution in Kalinga Province. It aims to provide quality education to the Kalinga youth to prepare them for future challenges. The college is also mandated to assist in the economic development of the province. This is the reason why the College continuously strengthens its agriculture curriculum, showcasing new and indigenous technologies to farmers that can help increase their productivity especially the marginalized ones. The project Bio-Organic Fertilizer Formulation aimed to develop a more scientific process of producing bio-organic fertilizer in KASC. By promoting the use of organic fertilizer, KASC aims to fully establish a fully operational organic fertilizer thus contributing to the other programs from the additional income. Four study areas were selected for compost making based on accessibility to supply of substrates and source of water: Agbannawag, Bulanao, San Juan and Isla. It was revealed that composting without any use of activator, but with proper management can be realized in 60 days on the average. The cost and return analysis indicated a high ROI, which means that bio-organic fertilizer is profitable as a business. However, the profit is very much dependent on the amount of fertilizer produced - the more number of bags produced, the greater is the

income. Moreover, the voluminous amounts of rice straw – either burned or left to not in the field – harvested from two cropping seasons in a year can help ensure a steady supply of raw materials for bio-organic fertilizer production.

AGRICULTURE ON WHEELS

Apolinario L. Lantican, Imelda M. Gesmundo, Florencia P. Elliot, Marilyn M. Beltran, Gil L. Magsino, Hospicio G. Natural Jr., Ellen C. Ros, Dalmacio L. Santiago and Simeona C. Seminiano
UNIVERSITY OF THE PHILIPPINES LOS BAÑOS College, Laguna

The College of Agriculture (CA), UPLB recently initiated the project titled "Agriculture on Wheels" in selected towns in Laguna to bring CA expertise to the field by sharing information and technical know-how to the farmers; inform the farmers of the facilities, services and programs that could cater to their needs; and provide an accessible professional consultation to the farmers and agriculture extension workers/technicians. The first phase of the this project was conducted last September 14, 2009 in Bagumbayan, Sta. Cruz, Laguna where more or less 200 farmers from Calauan, Bay, Victoria, Pila, Lumban and Kalayaan, Laguna participated. In the second phase was held in Brgy. Bucal, Nagcarlan, Laguna, approximately 80 farmers from the towns of Rizal, Nagcarlan, Liliw and San Pablo City attended. The third and last phase of the project was held in Mabitac, Laguna where more or less 200 farmers from the towns of Sta. Maria, Siniloan, Pangil, Pakil, Famy, Mabitac joined. The farmers from the said districts raised varying problems affecting their crops and livestock. Most prominent of these include golden snail that attacks their rice plant, tomato virus disease, papaya ringspot disease, banana bunchy top virus, and beetle that eats the roots of some vegetables like tomato and pole sitao. Experts on crops, livestock and food processing from the College of Agriculture were in full force to answer the questions raised by the farmers. The farmers brought along with them specimens of their affected crops for the experts to diagnose and provide solutions to their problems. The "Agriculture on Wheels" is CA's way of bringing back to the farmers the support they have given to CA in general through their taxes. Furthermore, the lessons learned from this project could eventually lead to a bigger "Agriculture on Wheels" in CALABARZON.

IMPLICIT ATTITUDES OF FORESTRY STUDENTS TOWARD THE FORESTRY PROFESSION

Floribel D. Paras
UNIVERSITY OF THE PHILIPPINES LOS BAÑOS
Email: fdparas@gmail.com

To determine the attitudes of an individual or a target group, researchers typically administer a self-report evaluation in the form of a survey questionnaire, which is an example of an explicit measure of attitude evaluation. However, the last two decades of attitude evaluation has made known that implicit measures of social and individual cognition such as the Implicit Association Test (IAT: Greenwald, McGhee, & Schwartz, 1998) can be as accurate, and compatibly used along with its explicit counterparts for more comprehensive attitudinal evaluations. This paper explores the applicability of using the IAT in measuring the implicit attitudes of UPLB Forestry Students toward the forestry profession. Results of the implicit and explicit tests will be reported and the extent of their implications in forestry will be explored.

RECEPTION OR RESISTANCE? A STUDY ON THE ACCEPTABILITY OF THE NEW WHO-CGS AMONG THE BARANGAY NUTRITION SCHOLARS OF CALAMBA CITY, LAGUNA

Marie T. Bugas

Food and Nutrition Research Institute-DOST

Improved health and nutritional (H/N) status of Filipinos specifically of children is always the optimum goal of H/N workers. Growth assessment of children involves measuring their weight and height/length and comparing these to growth standards. The Philippines initially used the Local Standards and in 2003, the International Reference Standards/National Center for Health Statistics (IRS/NCHS) was adopted. This required retooling of guidelines, growth tables and charts and trainings of the H/N workers. In 2006, the World Health Organization released a new Child Growth Standards. This study determined the acceptability of the new WHO-CGS among the BNSs; to identify factors for either reception or resistance to the use of the new standards; and to establish measures to facilitate ease, efficient and effective use of the new standards. An interview was conducted among 60 female BNSs from 46 barangays of Calamba City, using a developed self-administered survey questionnaire. Their main responsibilities are monthly weighing of children; survey for family profiles;H/N education classes; assist in both supplementary feeding programs and distribution of vitamins. Most of them have already served as BNSs for six to 10 years, as volunteers, receiving an honorarium of 500.00/month while 65% are receiving other benefits and incentives. Only 15% are recipients of H/N awards. Information on community profile were also gathered. Likewise, data on the availability of health center/ Rural Health Unit in their barangays, and the health/medical personnel present, the barangay budget allocation for H/N activities and H/N awards given to the barangay. Both their H/N knowledge and skills were obtained from Trainings/Seminars (T/S) attended. Only 27% had training on the Growth Reference/ Standards, while 52% had the IRS/NCHS training. Although only 50% agreed on the change of standards, it is still a reception among the BNSs. They have a positive attitude, considered it part of their job and are willing to study its use and application. They are however expecting that it will be easily understood and that a training will be provided. Overall, the BNSs showed that they are for the welfare of the Filipinos, for the development of the community from the improved process and system, for their improved knowledge and provision of services, and for the improved nutritional status of the children. It is recommended that the study be duplicated in other areas once the respondents have the training on the new WHO-CGS.

IMPACT OF THE TECHNO-GABAY PROGRAM ON THE PRODUCTION OF CABBAGE IN CAMARINES SUR, PHILIPPINES

Arnulfo M. Mascariñas, Viola L. Amano, Jane B. Mascariñas, Carlos V. Cortez, Jr. and Angelo P. Candelaria
Bicol University Research and Development Center (BURDC), Bicol University College of Agriculture and Forestry (BUCAF), Bicol University College of Education (BUCE),

This paper focuses on the results of the impact assessment of the Techno Gabay Program (TGP) involving the Farmer Information and Technology Service (FITS) in Camarines Sur. The TGP is one of the banner programs of the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) which was conceived and implemented because of the need to: provide information and technology services in Agriculture, Forestry, and Natural Resources (AFNR) sector via an effective mechanism; strengthen the link among technology generators, technology servers and technology adopters; and complement the efforts of local government units (LGUs) and Rural-Based Organizations (RBOs) in providing information delivery and technology services. The impact of the TGP on cabbage production was done by estimating time invariant stochastic production function and linear inefficiency effects model. Results showed that farmers had low awareness on TGP modalities. However, farmers who availed of TGP services had higher yield than before. Higher technical efficiency levels of the clients can be attributed to the TGP services provided by the FITS center. Technical efficiency was influenced significantly by higher quantity of

seeds and nitrogen used and low labor utilization as a result of reduced use of other farm inputs in the production system.

EVALUATION OF THE COMMUNICATION MATERIALS PROMOTING NATIVE WILD SUNFLOWER (THITONIA DIVERSIFOLIA) AS ORGANIC FERTILIZER IN BANAUE, IFUGAO

Eisen Bernard V. Bernardo
College of Development Communication
Email address: eisenvbernardo@yahoo.com

The research is a formative evaluation of the communication materials promoting native wild sunflower (Thitonia diversifolia) as organic fertilizer. Case study design was used to evaluate the communication materials in terms of attractiveness, comprehensibility, acceptability, and intent to practice. The materials pretested (such as posters, leaflet, and storybook) were developed through a participatory communication materials development. The study was conducted using focus group discussion guide and self-administered questionnaires. Community leaders from different barangays of Banaue, Ifugao served as the respondents of the study. Data were analyzed using frequency counts and percentages. Results showed that the communication materials (particularly the posters) quickly catch the respondents' attention. High scores on knowledge tests indicated high comprehensibility among the respondents. Being products of a participatory communication materials development, the materials pretested were highly acceptable for the respondents. Various suggestions were also given by the respondents to further improve the materials.

CAPTURING THE SOCIAL DIMENSION OF UPLAND VELERO CROP PRODUCTION IN KALINGA: A KEY INGREDIENT FOR RURAL DEVELOPMENT

Bernadette C. Aggabao and Ernesto T. Miguel
KALINGA APAYAO STATE COLLEGE

Organic farming is becoming popular in Kalinga, but its adoption is very slow among the smaller farmers. Some farmers have mentioned that it is very expensive because they need to rehabilitate first their highly-stressed farms. This study documented the indigenous organic farming practices and continuous enhancement that could be easily adopted by small farmers because of affordability, besides being home-grown. Specifically, the researchers conducted survey and needs assessment of production practices for selected VELERO crops; synthesized indigenous organic production of selected vegetables, legumes and root crops; determined the post-harvest practices, marketing strategies and pricing trends for selected vegetables, legumes and root crops; determined the household dynamics and attitude of farmers toward organic vegetable, legume and root crop production; made a profitability analysis of organic VELERO. Based on the findings, upland farming system in Kalinga has great potential for organic agriculture although production is labor intensive but does not rely much on chemical inputs. Furthermore, seed materials are conserved for continuous production. The following recommendations are forwarded: conduct an extensive assessment to identify the farms suitable for organic agriculture; establish a market for organically produced crops in the area to encourage farmers to go organic, and coordinate with LGU and other agencies to assistance farmers in procuring organic certification.

SOCIO- ECONOMIC PROFILE OF VELERO FARMERS IN THE UPPER MUINICIPALITIES OF APAYAO

Jaybee Omaweng and Isabel Angway
APAYAO STATE COLLEGE

The socio-economic profile of Vegetable, Legumes and Rootcrops (VELERO) farmers in the upper municipalities of Apayao, namely: Calanasan, Kabugao, and Conner, was determined. The descriptive survey method was used in the study. Results revealed that majority of the VELERO farmer-respondents had more than four children and attained elementary education. Aside from VELERO farming, they raised livestock such as pigs, ducks and chicken and planted rice and corn. VELERO farming was done in their backyards, ricefields and cornfields. Most of the VELERO planted were ingredients of "pinakbet" or "dinengdeng" delicacies including gabi, ube, kamoteng kahoy, beans and pechay. Majority of the farmers practiced organic VELERO production by using decomposed plants/leaves and animal manure, or if they could afford them, bought commercial organic fertilizers from authorized dealers. In terms of length of VELERO farming, farmers had been into VELERO production for more than 11 years. They utilized just a portion of their land for VELERO farming - about less than a square hectare both for family consumption and for sale to augment income.

SURVEY AND IDENTIFICATION OF INSECT PESTS AND DISEASES OF ORGANICALLY GROWN VEGETABLES AND ASSESSMENT OF EXISTING PEST MANAGEMENT PRACTICE

Ernesto T. Miguel, Bernadette Aggabao and Jovita E. Saguibo
KALINGA-APAYAO STATE COLLEGE

A survey was carried out to gain a thorough understanding of the level of farmers' knowledge of insect pests and diseases; establish information on farmers' pest control methods, and identify knowledge gaps. One hundred and forty-two farmers were interviewed in three primary VELERO growing areas in Kalinga Province. Farmers acknowledged aphids and lady beetles to be the primary pre-harvest pests for legumes; for vegetable crops, lady beetles; for root crops, horn caterpillar during foliage stage and white grub during root crop development regardless of the cropping season. Aphids posed the most serious threat to rainy season crops, and were severe under warm, dry conditions and on late-planted crops. Pests remained largely uncontrolled due to lack of knowledge of appropriate control measures. Socio-economic constraints were also cited by both farmers and researchers. Among farmers applying pest control, chemical pesticides were the most common method used in the lowland. But in the upper areas, chemicals were not common and instead the respondents relied on locally available plant material extract, kitchen ash, drenching with water and hand picking. Knowledge of postharvest control practices was greater than of preharvest practices. Although ash and chemicals were the most common control methods, sun drying of plant materials and hanging for smoking were also used by some. There was a huge variation in the dosages used - these were usually either inadequate or excessive, and rarely as recommended. Based on the results of the survey, the researchers stress the urgent need to improve the existing but cheap, effective control measures both for pre- and post–harvest pests of VELERO crops. Furthermore, information on these cheap yet effective control measures should be disseminated extended to smallholder farmers as soon as it is available.

WOMEN PARTICIPATION IN LIVELIHOOD PROJECTS IN THE SCIENCE CITY OF MUÑOZ, NUEVA ECIJA, 2009

Anna Ma. Lourdes S. Latonio
CENTRAL LUZON STATE UNIVERSITY

The fundamental query is to identify factors related to women participation in livelihood projects and determine whether these livelihood projects have contributed to the wellbeing of women and the community, as perceived by the women themselves. Stratified random sampling using proportional allocation was used in selecting the respondents from three barangays of the Science City of Munoz. These barangays have the most number of livelihood programs implemented by the local government. Results showed that women's aspiration and level of participation tends to increase together. Other

factors that increase with level of participation are age, length of residence in the community, and access to information about the projects, while the number of children and household size of women hinders their participation to these livelihood programs. Satisfaction on the implementation of the programs and appreciation in terms of personal and community development through these livelihood programs also increase with the women's level of participation to the activities. Also, Perceived personal gains, community gains and satisfaction on livelihood programs of women involved and not involved in planning, implementation and monitoring are significantly different. Overall satisfaction of women who volunteered and those who were only requested/ encouraged to join are also significantly different. Findings of the study provide evidence useful to the Science City of Munoz leaders, planners and implementers for effective promotion of these livelihood programs with the fundamental goal of helping the community's rural poor through the women in the community.

Publisher:
Multinational Printers
#20 (Lot 7, Blk 6) Galatia St., Phase I
Multinational Village, Parañaque City
Philippines
Telefax: (6302) 821-3462
Email: multiprint44@yahoo.com

JOURNAL OF ISSAAS

REVIEWERS, VOLUME 15, 2009

Name	Affiliation	Field of Specialization
ACDA, Sonia	University of the Philippines Los Banos	Animal Science
AGUNG, I G.A. Mas Sri	Udayana University, Indonesia	Plant Physiology
AMBARAWATI, I G.A.A. Annie	Udayana University, Indonesia	Agricultural Economics
ARAGON, Corazon T.	University of the Philippines Los Banos	Agricultural Economics
BUDIASA, I. Wayan	Udayana University, Indonesia	Agricultural Economics
CADIZ, Nina	University of the Philippines Los Banos	Crop Stress Physiology
CHANPRAME, Sontichai	Kasetsart University, Thailand	Agronomy
DADANG	Bogor Agricultural University, Indonesia	Entomology
DEWA, Ngurah Suprapta	Udayana University, Indonesia	Biopesticides
ITAGAKI Keishiro	Tokyo University of Agriculture, Japan	Agricultural Economics
JAHROH Siti	Bogor Agricultural University, Indonesia	Agricultural Economics
KASIKITWIWAT, Panatda	Kasetsart University, Thailand	Civil Engineering
KOSHIO Kaihei	Tokyo University of Agriculture, Japan	Horticultural Science
LANTICAN, Flordeliza A.	University of the Philippines Los Banos	Agricultural Economics
MIHARA Machito	Tokyo University of Agriculture, Japan	Environmental Conservation
MURAI Tamotsu	Utsunomiya University, Japan	Entomology
NEGISHI Hiromitsu	Tokyo University of Agriculture, Japan	Plant Pathology
PABUAYON, Isabelita M.	University of the Philippines Los Banos	Agricultural Economics
PIADOZO, Ma. Eden S.	University of the Philippines Los Banos	Agricultural Economics
PITIPUNYA, Rangsan	Kasetsart University, Thailand	Agricultural Economics
PITIYONT, Bongotrat	Kasetsart University, Thailand	Environmental Science
PROTACIO, Calixto	University of the Philippines Los Banos	Horticulture
RAÑOLA, Roberto Jr. F.	University of the Philippines Los Banos	Agricultural Economics
SHAMSUDIN, Mad Nasir	Universiti Putra Malaysia	Agricultural Economics
SYAUKAT, Yusman	Bogor Agricultural University, Indonesia	Agricultural Economics
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TRELO-GES, Vidhaya	Khon Kaen University, Thailand	Soil Physics
UNARTNGAM, Jintana	Kasetsart University, Thailand	Plant Pathology
WATTANA Jurarat	Kasetsart University, Thailand	Vocational Education
YAJIMA, Shunsuke	Tokyo University of Agriculture, Japan	Protein Chamistry
YUSOP, Mohd Khanif	Universiti Putra Malaysia	Soil Science
ZAINAL Abidin Mohamed	Universiti Putra Malaysia	Agricultural Economics

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