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QUANTITATIVE TRAIT LOCI CONTROLLING FLOWERING PROPERTIES IN TOMATO

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ABSTRACT

To understand better the factors influencing the days to anthesis and the number of flowers in tomato inflorescences, quantitative trait loci (QTLs) for these traits were studied in winter and summer using a BC_1F_6 population derived from *Solanum lycopersicum* and *S. pimpinellifolium*. Plants from 110 accessions were grown in 4 L pots, trained as single stems, and pinched above the third leaf after the second inflorescence. The number of flowers on the first (NFI_1) and second inflorescences (NFI_2), the number of days from sowing to anthesis of the first inflorescence (DTF) and between the antheses of the first and second inflorescences (DTF_1F_2), and the number of leaves before the first inflorescence (LN_{01}) and between the first and second inflorescences (LN_{12}) were counted. Nine additive QTLs were detected, three of which (LN_{01}, LN_{12}, and DTF_1F_2) exhibited additive × environment interaction. Two additive LN_{12} QTLs showed epistatic effects. Epistatic effects were also identified for three QTLs pairs for DTF_1F_2, LN_{01}, and inflorescence branching (DBI), all of which had no additive effects. These results suggest that the number of leaves preceding the first inflorescence (LN) and the period between the flowering of the first and second inflorescences (DTF_1F_2) are subject to environmental modification and that QTL × environment and epistatic effects should be considered when pyramiding QTLs to breed early flowering tomatoes.

Key words: breeding, epistasis, flowering time, inflorescence, QTL × environment interaction

INTRODUCTION

Recently in Japan, some farmers maximize their yield by harvesting tomato fruits only from the first inflorescence or from the first to the third inflorescences and transplanting seedlings at high densities in plastic houses several times a year (Watanabe, 2006). This high-density short-term cultivation method (the HDSC method) offers several advantages: healthy and vigorous seedlings with flower buds can be cultivated even in summer, during which tomato plants grown in plastic houses for long periods lose their vigor; and the short cultivation period helps to reduce the damage caused by pests and diseases. Thus, the HDSC method may be an effective way of cultivating tomato plants in humid tropical countries, such as those in Southeast Asia, where tomato plants are prone to high-temperature stress and pest damage.

In tomato plants, the shoot apical meristem of the primary shoot usually produces 7–11 leaves and then transforms into the first inflorescence. Vegetative growth is succeeded by the axillary bud (sympodial meristem) in the axil of the last-initiated leaf (Heuvelink, 2005). The number of leaves preceding the first inflorescence (LN_{01}) in tomato seedlings usually increases in summer in response to high temperatures (Oda *et al*., 2005). Therefore, tomato seedlings raised in summer flower later than those raised in other seasons, leading to a reduction in early yields. To overcome this problem, Oda *et al*. (2005) proposed that tomato seedlings should be raised in plug trays in the highlands and then transported to the lowlands in summer.

Because the tomato stem exhibits a sympodial growth habit, the sympodial shoot terminates at the second inflorescence after developing approximately three leaves. However, the number of leaves formed between the first and second inflorescences (LN_{12}) occasionally diverges from three, with an increase in LN_{12} at a small LN_{01} (Klapwijk and Wubben, 1984). Calvert (1964) reported that the initiation of the second inflorescence is delayed in the Ailsa Craig cultivar when the initiation of the first inflorescence is accelerated by low temperatures, resulting in an increase in LN_{12}. With the HDSC method, a small LN_{12} is necessary to achieve a high early yield because high LN_{12} may prolong the period between the flowering of the first and second inflorescences (DTF_1F_2). However, little is known about the effects of genotype and the genotype × environment interaction on LN_{12} and DTF_1F_2. Furthermore, the number of flowers per inflorescence (NFI) should be high to produce a high yield with the HDSC method. Wittwer and Teubner (1957) reported that low temperatures increased NFI, whereas Fukushima and Masui (1962) found that low night temperatures during the first two weeks after cotyledon expansion did not affect NFI of the first inflorescence. Lohar and Peat (1998) compared the effects of night temperature on NFI among heat-sensitive and heat-tolerant cultivars, and concluded that genotype × environmenl interactions affect NFI.

Several studies have been conducted at the QTL level on the flowering times of the tomato. QTLs for days to flowering (DTF) have been detected on chromosomes 1–5, 7, and 10–12 in interspecific crosses involving *Solanum lycopersicum* and wild species, such as *S. pennellii*, *S. pimpinellifolium*, *S. chmielewskii*, and the hybrid IVT-KT_1 (Cagas *et al*., 2008; de Vicente and Tanksley, 1993; Doganlar *et al*., 2002; Grandillo and Tanksley, 1996; Jimenez-Gomez *et al*., 2007; Lindhout *et al*., 1994). Jimenez-Gomez *et al*. (2007) and Cagas *et al*. (2008) demonstrated the colocalization of DTF and LN QTLs. Cagas *et al*. (2008) also investigated the effects of season on DTF and LN in a BC_1F_4 population derived from a cultivated tomato and *S. pimpinellifolium*, and found that DTF QTLs colocalized with QTLs for other traits, such as leaf length, number of lateral shoots, plant height, and fresh weight.

Grandillo and Tanksley (1996) detected three NFI QTLs on chromosomes 3, 6, and 9 using an interspecific F_2 cross between *S. lycopersicum* and *S. pimpinellifolium*. In contrast, van der Knaap and Tanksley (2003) identified a total of nine NFI QTLs on chromosomes 1–5, 7, and 9 in a similar population. To the best of our knowledge, QTLs for the period between the flowering of the first and second inflorescences (DTF_1F_2) and LN_{12} have not yet been studied. In this study, we examined DTF, DTF_1F_2, LN_{01}, LN_{12}, NFI, and inflorescence branching (DBI) in different seasons to identify these traits at the QTL level.

MATERIALS AND METHODS

Plant Material and Growth Conditions

The BC_1-derived recombinant inbred lines used in this study have been described previously by Cagas *et al*. (2008). In brief, 110 BC_1F_6 lines were derived from an initial cross between the commercial cultivar *S. lycopersicum* 'M570018' and its close wild relative *S. pimpinellifolium* (PI124039), and the backcross of the F_1 generation to 'M570018'. The resultant BC_1F_1 population was advanced by the single-seed method to produce the BC_1F_5 population, which was used for genotyping. The subsequent BC_1F_6 generation was used for phenotypic evaluation.

Phenotypic Evaluation of Flowering Properties

Seeds from 110 and 108 BC_1F_6 families, together with those of their parents, were sown into 10.5 cm pots filled with commercial compost (Soilmix, Sakata Seed Co., Yokohama, Japan) under greenhouse conditions on December 29, 2007 (winter experiment) and on May 8, 2008 (summer experiment). The seedlings were transplanted to 4 L pots (18 cm in diameter) containing the same

commercial compost on February 17, 2007, and June 12, 2008 (50 days and 35 days after sowing, respectively). In both experiments, the plants were trained to one stem and pinched above the third leaf after the second inflorescence.

The experimental design was a randomized complete block, consisting of five replications. Days to flowering (DTF) were counted as the number of days from sowing to first anthesis, whereas DTF_1F_2 was the number of days between the first anthesis in the first inflorescence and the first anthesis in the second inflorescence. The number of leaves preceding the first inflorescence (LN_{01}) and the number of leaves between the first and second inflorescences (LN_{12}) were counted at the end of the experiments. The numbers of flowers in the first (NFI_1) and second (NFI_2) inflorescences were monitored at each inflorescence. The branching of the inflorescence was evaluated in both the first (DBI_1) and second (DBI_2) inflorescences, with a score of 1 given for a simple cyme inflorescence and of 2 for a double-branched cyme inflorescence.

Marker Analysis

The overall genotyping protocol was as described by Cagas *et al*. (2008). In brief, DNA from the 110 BC_1F_5 lines and parent lines was extracted from 0.1 g of leaf material using the Nucleon PhytoPure plant DNA extraction kit (Amersham Biosciences, Buckinghamshire, UK), following the manufacturer's protocol. The PCR consisted of 200 ng of template DNA, 2 μM forward and reverse primers, 0.2 mM dNTP mixture, 1.8 mM $MgCl_2$, 1 μL of 10× NH_4 buffer, and 0.25 units of Bio*Taq* DNA Polymerase (Bioline, London, UK) in a 10 μL total reaction solution. The PCR consisted of one cycle of 94 °C for 5 min, followed by 35 cycles of 94 °C for 30 s, 50–55 °C for 45 s, and 72 °C for 45 s, and one last cycle of 72 °C for 5 min for final extension.

Ninety-three polymorphic markers (46 SSR, 13 COSII, 33 CAPS, and two SNP) were used to construct a linkage map. Polymorphic COSII and CAPS markers were identified by digestion with 14 restriction enzymes, *Afa*I, *Alu*I, *Bam*HI, *Bgl*II, *Dra*I, *Dpn*II, *Eco*RI, *Eco*RV, *Hinc*II, *Hin*dIII, *Hinf*I, and *Kpn*I, at 37 °C for 12 h. The amplified products were separated on a 13% acrylamide/bisacrylamide running gel (18 × 6 cm) with a 5% acrylamide/bisacrylamide stacking gel in a NB-5010 Nihon Eido (Tokyo, Japan) electrophoresis apparatus for 3 h at 120 V. The gels were stained with SYBR Green I (Lonza, Rockland, Maine, USA) and visualized under UV.

QTL Mapping

QTL analysis was performed with the QTLNetwork 2.0 software (http://ibi.zju.edi.cn/software/qtlnetwork) based on a linkage map calculated using MAPMAKER/EXP ver. 3.0b (Lander *et al.*, 1987). QTLNetwork uses a mixed-model-based composite-interval mapping technique capable of estimating additive, epistatic, and QTL × environment interaction effects. The walking speed and test window size were set as 1 cM and 10 cM, respectively. A filtration window size of 10 cM was used to distinguish whether two adjacent test statistic peaks were derived from two QTLs. One thousand permutation tests were performed on each trait in the combined data from the two seasons to calculate the critical F value at $P < 0.05$. Accessions between experiments not used were treated as missing data.

Statistical Analysis

Single-factor analysis of variance (ANOVA), Least Significant Difference (LSD), and Pearson correlation coefficient analysis were performed using SPSS for Windows (release 11.01).

RESULTS

Trait Variation

All the traits analyzed followed continuous normal distributions typical of quantitative traits, except for DBI_1 and DBI_2, in which the distributions were left skewed (data not shown). *S. pimpinellifolium* (PI124039) flowered earlier than *S. lycopersicum* 'M570018' (Table 1). DTF was generally shorter in summer, with the BC_1F_6 family and its parents flowering 10 days earlier than when grown in winter. DTF_1F_2 was 4–5 days shorter in summer than in winter for the BC_1F_6 family and its parents, and shorter in *S. pimpinellifolium* than in *S. lycopersicum*.

LN_{01} was almost the same for both parents, regardless of the growing season. The genotype × environment interaction on LN_{12} was statistically significant. Compared with winter LN_{12}, *S. lycopersicum* had an average of 0.6 more leaves in summer, whereas *S. pimpinellifolium* had an average of 1.1 fewer leaves in summer. The number of flowers in the first inflorescence (NFI_1) was much smaller in *S. lycopersicum* than in *S. pimpinellifolium* in both seasons. The genotype × environment interaction in NFI_1 was significant, with a larger difference between parents in summer. Conversely, no environmental effect or genotype × environment interaction was evident in NFI_2. The occurrence of double-branched cymes (greater DBI value) was higher in winter than in summer in the BC_1F_6 families and its parents for the first inflorescence, but no differences were observed for the second inflorescence.

Correlations among Traits

DTF negatively correlated with DTF_1F_2 in both seasons (Table 2). LN_{01} and LN_{12} negatively and positively correlated with DTF_1F_2, respectively, in winter but positively correlated with DTF in summer. NFI_1 and NFI_2 were highly correlated with each other in both seasons. NFI_2 negatively correlated with DTF in both seasons but with DTF_1F_2 only in winter. The occurrence of double-branched cymes in the first inflorescence (DBI_1) positively correlated with NFI_1, whereas DBI_2 positively correlated with NFI_2 in both seasons. DBI_1 positively correlated with DBI_2.

Table 2. Correlation coefficients among eight flowering traits in the BC_1F_6 families in winter, 2007 (above diagonal), and in summer, 2008 (below diagonal).

Trait	DTF	DTF_1F_2	LN_{01}	LN_{12}	NFI_1	NFI_2	DBI_1	DBI_2
DTF		–0.20*	0.12	0.06	–0.09	–0.20*	–0.19*	–0.30**
DTF_1F_2	–0.56**		–0.30*	0.37**	–0.10	–0.22*	0.12	–0.04
LN_{01}	0.61**	–0.14		0.09	–0.18	–0.09	–0.16	0.17
LN_{12}	0.43**	0.04	0.37**		0.03	0.12	–0.03	0.01
NFI_1	–0.09	–0.03	0.08	–0.14		0.56**	0.63**	0.18
NFI_2	–0.23*	–0.07	–0.17	–0.23**	0.60**		0.18	0.36**
DBI_1	–0.07	–0.01	–0.01	–0.23*	0.26**	0.17		0.19*
DBI_2	–0.18	0.12	–0.04	–0.12	0.16	0.34**	0.36**	

* significant at $P < 0.05$, ** significant at $P < 0.01$.

Table 1. Descriptive statistics of phenotypic values for flowering traits of the parents and BC_1F_6 families.

Trait	**P_1**		**P_2**		**BC_1F_6**		**Contrast**				
	Winter	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**P_1/P_2**	**P_1/BC_1F_6**	**P_2/BC_1F_6**	**E**	**G × E**
DTF	66.0±0.7	56.2±2.6	66.0±0.7	56.2±2.6	66.0±0.7	56.2±2.6	*	*	*	*	N.S.
DTF_1F_2	12.6±0.9	8.5±1.6	8.3±1.7	3.4±3.8	11.9±2.2	6.9±2.5	*	N.S.	*	N.S.	N.S.
LN_{01}	8.6±0.5	8.3±0.7	6.8±0.5	8.0±0.7	8.4±0.9	8.6±1.4	N.S.	N.S.	*	N.S.	N.S.
LN_{12}	2.8±0.4	3.4±0.8	4.0±0.8	2.9±0.4	3.3±0.5	3.5±0.7	N.S.	N.S.	*	N.S.	*
NFI_1	6.4±1.5	5.1±0.7	16.3±0.5	18.1±4.7	8.1±2.4	6.5±2.2	*	*	*	N.S.	*
NFI_2	6.2±0.4	5.5±1.1	2.3.5±7.1	19.8±7.3	7.6±2.0	8.1±3.0	*	*	*	N.S.	N.S.
DBI_1	1.2±0.4	1.0±0.0	1.3±0.5	1.0±0.2	1.1±0.2	1.0±0.1	N.S.	N.S.	N.S.	*	N.S.
DBI_2	1.0±0.0	1.0±0.0	1.0±0.0	1.0±0.0	1.1±0.1	1.1±0.1	N.S.	*	*	N.S.	N.S.

P1, *Solanum lycopersicum*; P2, *Solanum pimpinellifolium*; E, environmental effects; G × E, genotype × environment interaction;
*, significant at $P < 0.05$; N.S., not significant at $P < 0.05$.

QTL Analysis

Nine main QTLs with additive effects were detected by QTL mapping using QTLNetwork software (Table 3). These nine QTLs were mapped to chromosomes 1, 3, 4, and 12. Three QTLs (*ln_{01}-3*, *ln_{12}-1.1*, and *dtf_1f_2-12*) exhibited significant QTL × environment interaction effects, in which the presence of *S. lycopersicum* alleles increased LN_{01} by 0.2216 leaves in winter, and increased LN_{12} and DTF_1F_2 by 0.1039 leaves and 0.6505 days, respectively, in summer. No QTL × environment interactions were detected for DTF, NFI_1, or NFI_2. Two QTLs for DTF were identified in the intervals between markers C2_At5g49480 and SSR105 on chromosome 1 (*dtf-1*), and between markers SSR306 and LEOH37 on chromosome 4 (*dtf-4*). These QTLs explained 6.64% and 3.55% of the phenotypic variation, respectively. *S. lycopersicum* alleles at *dtf-1* and *dtf-4* on chromosomes 1 and 4, respectively, increased DTF. A DTF_1F_2 QTL (*dtf_1f_2-12*) was detected in the interval between CLET8K4 and CT99 on chromosome 12. This QTL explained 2.08% of the phenotypic variation, and the presence of *S. lycopersicum* alleles increased DTF_1F_2. One LN_{01} QTL (*ln_{01}-3*) was detected in the interval between C2_At5g51110 and SSR111 on chromosome 3, and explained 16.31% of the phenotypic variation. At the same location on chromosome 3, Cagas *et al*. (2008) found LN_{01} QTLs using the earlier BC_1F_4 generation of this population. *S. pimpinellifolium* alleles at the *ln_{01}-3* QTL increased LN_{01} by 0.5636 leaves because of its additive effect. Two LN_{12} QTLs were detected in the intervals between C2_At5g49480 and SSR105 (*ln_{12}-1.1*) and between SSR308 and SSR117 (*ln_{12}-1.2*) on chromosome 1. These two QTLs explained 9.08% and 12.28% of the phenotypic variation, respectively. *S. lycopersicum* alleles at *ln_{12}-1.1* and *ln_{12}-1.2* increased and decreased LN_{12} by 0.3121 and 0.2393 leaves, respectively. One QTL for NFI_1 (*nfi_1-4*) was detected in the interval between Hero and LEOH361 on chromosome 4, whereas one QTL for NFI_2 (*nfi_2-4*) was detected in the interval between SSR603 and SSR306 on the same chromosome. *nfi_1-4* and *nfi_2-4* explained 15.18% and 7.89% of the phenotypic variation, respectively, and the presence of alleles from *S. pimpinellifolium* at these QTLs increased NFI. One QTL associated with inflorescence type, *dbi_1-4*, was detected in the same interval as *nfi_1-4* on chromosome 4. This QTL explained 4.83% of the phenotypic variation, and alleles from *S. pimpinellifolium* increased the occurrence of double-branched inflorescences.

Epistatic QTLs Controlling Flowering Properties

A total of four digenic epistatic interactions were identified for LN_{01}, LN_{12}, DTF_1F_2, and DBI_1 (Table 4). Variations explained by these epistatic interactions ranged from 2.89% for LN_{12} to 8.98% for LN_{01}, which are lower than those for the additive QTLs. The two main LN_{12} QTLs detected in this study (*ln_{12}-1.1* and *ln_{12}-1.2*) showed epistatic effects and explained 2.89% of the phenotypic variation. For DBI, an epistatic interaction was detected between QTLs *dbi_1-1.2* and *dbi_1-2*, and this pair also exhibited epistasis × environment interaction. The epistatic and epistasis × environment interaction effects of this QTL pair explained 4.83% and 5.78% of the phenotypic variation, respectively, indicating a high contribution of these effects. The epistatic or additive × additive effects were positive for LN_{01} and negative for LN_{12}, DTF_1F_2, and DBI_1.

DISCUSSION

Tomato plants usually develop 7–11 leaves before the formation of the first inflorescence (Heuvelink, 2005). The number of leaves preceding the first inflorescence (LN_{01}) is reportedly affected by the genotype and environmental factors, such as light and temperature (Heuvelink, 2005), but little is known about the number of leaves between the first and second inflorescences (LN_{12}). In this study, LN_{01} QTL *ln_{01}-3* and LN_{12} QTL *ln_{12}-1*, mapped to chromosomes 1 and 3, respectively, exhibited both additive and additive × environment interaction effects. Furthermore, one epistatic interaction each was observed for LN_{01} (*ln_{01}-2* and *ln_{01}-5*) and LN_{12} (*ln_{12}-1.1* and *ln_{12}-1.2*). To the best of our knowledge, this is the first report to identify QTL × environment interaction effects and epistatic effects for LN_{01} and LN_{12}. Additive, additive × environment interaction, and epistatic effects explained 16.31%, 3.47%, and

Table 3. Estimated additive and additive × environment interaction effects of QTLs for flowering properties of tomato in two different seasons (environments).

Trait	QTL	Interval	Position (cM)	a	h_a^2	ae_1	ae_2	h_{ae}^2
DTF	*dtf-1*	C2_At5g49480–SSR105	46.9	2.05	0.07			
	dtf-4	SSR306–LEOH37	36.8	1.25	0.04			
DTF_1F_2	dtf_1f_2*-12*	CLET8K4–CT99	86.8	0.69	0.02	–0.65	0.65	0.03
LN_{01}	ln_{01}*-3*	C2_At5g51110–SSR111	76.8	–0.56	0.16	0.22	–0.22	0.03
LN_{12}	ln_{12}*-1.1*	C2_At5g49480–SSR105	45.9	0.31	0.09	–0.11	0.10	0.02
	ln_{12}*-1.2*	SSR308–SSR117	93.7	–0.24	0.12			
NFI_1	nfi_1*-4*	Hero–LEOH361	2.0	–1.14	0.15			
NFI_2	nfi_2*-4*	SSR603–SSR306	25.7	–0.72	0.08			
DBI_1	dbi_1*-4*	Hero–LEOH361	0.0	–0.03	0.05			

Position (cM) denotes the genetic distance in centiMorgans on each chromosome. a, ae_1 and ae_2 denote additive effects and additive × environment interaction effects of QTLs in winter and summer, respectively. h_a^2 and h_{ae}^2 represent the contribution ratios of aa and aae.

Table 4. Estimated epistasis and epistasis ´ environment interaction effects of QTLs for flowering properties of tomato in two different seasons (environments).

Trait	QTL	Interval	Position (cM)	QTL	Interval	Position (cM)	aa	h_{aa}^2	aae_1	aae_2	h_{aae}^2
DTF_1F_2	dtf_1f_2*-6*	SSR47–SSR128	3.0	dtf_1f_2*-11*	SSR80–C2_At5g44880	11.6	–0.92	0.05			
LN_{01}	ln_{01}*-2*	SSR5–SSR32	107.8	ln_{01}*-5*	C2_At3g55360–SSR162	58.2	0.40	0.09			
LN_{12}	ln_{12}*-1.1*	C2_At5g49480–SSR105	45.9	ln_{12}*-1.2*	SSR308–SSR117	93.7	–0.14	0.03			
DBI_1	dbi_1*-1*	LEATPACAB–C2_At5g49480	17.4	dbi_1*-2*	ORFX2–T1566	220.6	–0.04	0.05	–0.03	0.03	0.06

8.98% of the total phenotypic variations in LN_{01}, respectively, whereas the corresponding values for LN_{12} were 21.36%, 2.03%, and 2.89%. This indicates that LN is subject to environmental modification.

It also shows that both the additive and epistatic effects are important genetic bases of LN_{01}, whereas the additive effect plays an important role in the genetic control of LN_{12}. Of the DTF_1F_2 QTLs, additive, additive × environment interaction, and epistatic effects explained 2.08%, 2.61%, and 5.40% of the total phenotypic variations in DTF_1F_2, respectively. This result suggests that epistatic effects play an important role in the genetic control of DTF_1F_2, although DTF_1F_2 is also subject to environmental modification. The negative epistatic effects suggest that two epistatic loci with homozygous alleles from the same parents reduced LN_{12}, DTF_1F_2 and DBI_1. Therefore, it is important that epistatic effects be taken into account when pyramiding the QTLs that control LN_{12} or DTF_1F_2 in breeding tomato plants with low LN_{12} and short DTF_1F_2.

One QTL each for NFI_1 and NFI_2 were identified at different locations on chromosome 4. *nfi_1-4* colocalized with *dbi_1-4*, reflecting the high correlation between the occurrence of double-branched inflorescences and high NFI_1. The colocalization of these two QTLs also suggests that the *nfi_1-4* locus is closely linked to *dbi_1-4* or that a single QTL exerts pleiotropic effects on the branching of the inflorescence and the number of flowers. Further studies involving the fine mapping of these colocalized QTLs may resolve whether the region contains two linked loci or a single locus with pleiotropic effects. In contrast, *nfi_2-4* is located close to *dtf-4*, suggesting that these two QTLs are closely linked. Because presence of *S. pimpinellifolium* alleles in this location increased NFI_2 and decreased DTF, introgression of this location should be important in breeding early-flowering tomato cultivars producing a large number of flowers.

Grandillo and Tanksley (1996) detected three NFI QTLs on chromosomes 3, 6, and 9 using an interspecific F_2 cross between *S. esculentum* and *S. pimpinellifolium* but did not detect any NFI QTLs on chromosome 4. In contrast, van der Knaap and Tanksley (2003) identified nine NFI QTLs on chromosomes 1–5, 7, and 9 using a similar population. Further study is required to ascertain whether *nfi_1-4* and *nfi_2-4* identified in this study correspond to the NFI QTL detected by van der Knaap and Tanksley (2003).

CONCLUSION

Of the nine additive QTLs detected in this study, three QTLs, i.e., LN_{01}, LN_{12}, and DTF_1F_2, exhibited additive × environment interaction. Additionally, two additive LN_{12} QTLs showed epistatic effects. Epistatic effects were also identified for three QTLs pairs for DTF_1F_2, LN_{01}, and inflorescence branching (DBI), all of which had no additive effects. These results suggest that the number of leaves preceding the first inflorescence (LN) and the period between the flowering of the first and second inflorescences (DTF_1F_2) are subject to environmental modification and epistatic interaction. Thus, QTL × environment and epistatic effects should be considered when pyramiding QTLs to breed early flowering tomatoes.

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BIOACTIVE COMPOUNDS AND ANTIOXIDANT CAPACITY OF PINK PUMMELO (*CITRUS GRANDIS* (L.) OSBECK) CV.“THONG DEE” IN THAILAND

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ABSTRACT

The pink pummelos cv. “Thong Dee” (*Citrus grandis* (L.) Osbeck) at 80% maturity were harvested from Chiang Rai (CR), Nakhon Pathom (NP), Nakhon Nayok (NY), Prachin Buri (PB), and Nokhon Si Thammarat (NST) provinces for consuming in domestic market. The contents of vitamin C, total phenolic compounds and seven flavonoids were determined. The total antioxidant capacities were also determined by both the 2,2-diphenyl-1-picryhydrazyl (DPPH) assay and ferric reducing antioxidant power (FRAP) assay. The highest contents of vitamin C (74.63 mg/100 ml) and total phenolic compounds (94.93 mgGAE/100g fresh weight) were found in pummelos from NST and CR, respectively. Naringin was the major flavonoid compounds in pummelo and had the highest content in sample from NST (71.90 mg/100g fresh weight). The highest antioxidant capacities (DPPH-assay) were found in pummelo from NST and CR whereas there was no significant differences among samples in FRAP-assay. Overall, pummelo form NP had the lowest vitamin C (32.94 mg/100 ml), total phenolic compounds (54.87 mgGAE/100g fresh weight), and antioxidant capacity (DPPH-assay) (164.23 µmolTrolox/100g fresh weight).

Key words: Naringin, total phenolic compounds, vitamin C

INTRODUCTION

Natural antioxidant compounds are present in all parts of all higher plants. They have been found to protect against a variety of disorders, particularly cardiovascular diseases (Kurowska *et al*., 2000) and some types of cancer (Vanamla *et al*., 2006). Citrus fruits are important because of their nutritional and antioxidant properties. Beside ascorbic acid, citrus also contains flavonone glycosides, such as naringin which is the most important phenols in the water soluble fraction (Gil-Izquierdo *et al*., 2001). Citrus flavonoid properties have been found to include anticancer, antiviral, antiinflammatory activites, effect on capillary fragility, and an ability to inhibit human platelet aggregation (Benavete-Garcia *et al*., 1997).

One of the most important citrus fruits in Thailand is a pummelo (*Citrus grandis* (L.) Osbeck). Among pummelo cultivars grown in Thailand, the pummelo cv. “Thong Dee” has the highest yield (a half of total pummelo production). It is also widely consumed in Thailand. The main production areas include Chiang Rai (CR), Nakhon Pathom (NP), Nakhon Nayok (NY), Prachin Buri (PB), and Nokhon Si Thammarat (NST) provinces (Department of Agricultural Extension Thailand, 2008). “Thong Dee” cultivar is of the Thai group of pummelos. The fruit is very large and broadly obovoid to oblate, with a slightly depressed apex. The smooth light yellow rind is medium-thin and tightly adherent. The flesh is tinged pink and the flavor is good when grown under appropriate climatic

conditions. The pulp is juicy and easily separable from the membrane walls (Hodgson, 1967).

In recent years, the pummelo has received much attention because of its nutritional and antioxidant properties, especially flavonoids in Asia i.e. Thailand, China, Taiwan, and Japan (Wattanasiritham *et al*., 2005; Xu *et al*., 2008; Wang *et al*., 2007 and Nagata *et al*., 2006). In previous study, Wattanasiritham *et al*. (2005) reported that the naringin content of Thai pummelo was 26-58 mg/100g which varied on cultivar and cultivation area. Furthermore, the naringin content of "Thong Dee" cultivar from Nakhon Pathom province was 26.11 mg/100g. Generally, the quality and bioactive compounds of fruits and vegetables depend on environmental factors, production areas, and cultural practices (Vicente *et al*., 2009). However, there has been no detailed research on bioactive compounds and antioxidant capacity of pummelo flesh cv. "Thong Dee" obtained from all cultivar regions in Thailand. Thus, the main objective of this study was to evaluate chemical properties, bioactive compounds and antioxidant capacities of the pummelos cv. "Thong Dee" with local grade (80% maturity) in Thailand.

MATERIALS AND METHODS

Sample collection

Pummelos cv. "Thong Dee" at an optimum maturity (80%) were harvested from 5 major cultivation areas in Thailand during September 2008. The collected provinces were Chiang Rai (CR); the northern part, Nakhon Pathom (NP) and Nakhon Nayok (NY); the middle part, Prachin Buri (PB); the eastern part, and Nokhon Si Thammarat (NST); the southern part. The pummelos were harvested from four orchards in each province and transported to the laboratory within 3 days after harvesting. Fruits were peeled and flesh samples were frozen at -20°C until analysis.

Reagents and flavonoid standards

6-hydroxy-2, 5, 7, 8-tetramethyl-2-carboxylic acid (Trolox), 2,2-diphenyl-1-picrylhydrazyl radical (DPPH), ascorbic acid (AA) and Folin-Ciocalteu phenol reagent were purchased from Sigma-Aldrich (St. Louis, MO, USA). Naringin (naringenine-7-rhamnosidoglucoside, NAR) and hesperidin (hesperetin-7-rutinoside, HES) were purchased from ACROS (Geel, Belgium). Neohesperidin (hesperitin 7-neohesperidoside, NEH), kaempferol (3,5,7,4´-tetrahydroxyflavone, KAP), rutin trihydrate (RUT), apigenin (5,7,4´-trihydroxyflavone, APG) and quercetin dihydrate (3,5,7,3´,4´-pentahydroxyflavone dehydrate, QUE) were purchased from Sigma-Aldrich (Missouri, USA). HPLC grade dimethyl formamide (DMF) and acetonitrile (ACN) were purchased from Fluka. HPLC grade methanol and TFA (trifluoroacetic acid), were supplied by Carlo Erba (Rodano, Italy). All other chemicals used were analytical grade.

Sample preparation

The juice sac (15 g) from each orchard was extracted and homogenized with 60 ml of distilled water for 5 min. The mixture was centrifuged (5,000 g) at 4°C for 15 min. The supernatants were diluted with distilled water at 10, 1 and 5 fold for total phenolic compounds analysis, DPPH-assay and FRAP-assay, respectively.

Determination of quality parameters

The pummelo flesh was determined with color measurement spectrophotometer (CIE LAB/color Quest XE, USA). L*, a*, b* CIE Chromaticity values were recorded by three replicates in each fruit. The flesh was squeezed by hand and the juice was filtered to remove pulp and seed. The

clarify juice was measured the total soluble solids (TSS) with a hand refractometer (Atago, Japan). Titratable acidity (TA) was characterized by titration of pummelo juice with 0.1 M sodium hydroxide and expressed as citric acid (%w/w).

Determination of vitamin C and total phenolic compounds

Ascorbic acid was determined by visual titration, using 2, 6-dichlorophenolindophenol (Rapisarda, 1996) and reported as mg ascorbic acid per 100 ml juices. The total phenolic compound was measured using Folin-Ciocalteu's reagent (Singleton and Rossi, 1965). The result was reported as milligram gallic acid equivalent (GAE) per 100 g flesh.

Determination of flavonoids

Flavonoids in fresh pulp samples were analyzed by the method of Mouly *et al*. (1998), with some modifications. The juice sac (10 g) from each orchard was homogenized (8,500 g for 1.5 min) with 20 ml of DMF and centrifuged at 8,500 g for 15min. The supernatant was filtered through syringe filter (0.45 µm, PTFE) and then injected into the high-performance liquid chromatography (HPLC) system by an auto-sampler. The flavonoids of HPLC analyses were carried out on an Alliance 2965 separations module (Waters) linked simultaneously to a photodiode array detector (PDA) 2996 (Waters). Separation of flavonoid compounds was performed using a stainless-steel column (250 x 4.6mm I.D.) packed with C18 Altima, 5 µm (Alltech, USA), equipped with a pre-column (7.5 x 4.6mm I.D.) A binary solvent system of ACN and water with 4% acetic acid was operated to start at 0% and end at 70% ACN concentration for a 70 min period. The flavonoid peaks were detected at 280 nm and were identified by matching spectra and retention times with commercial standards.

Determination of antioxidant capacities

The antioxidant capacities were evaluated by DPPH radical scavenging activity (Yen and Duh, 1994) and ferric reducing power activity (Yen and Chen, 1995). The DPPH-assay was expressed as micromole equivalents of Trolox (TE) per 100 grams of pummelo (fresh weight basis). The FRAP-assay was reported as micromole equivalents of ascorbic acid per 100 grams of sample (fresh weight basis).

Statistical analysis

The data were subjected to statistical analysis using the SAS® system for window (version 8.1). The average data of four replicates were presented with standard errors of means. Significant differences between production areas were tested by the general liner model (GLM). The means of pummelo samples were compared by Duncan Multiple Range Test (DMRT) at the 5% level of significance.

RESULTS AND DISCUSSION

The pummelos cv. "Thong Dee" were harvested at 80% maturity for the domestic market from Chiang Rai (CR), Nakhon Pathom (NP), Nakhon Nayok (NY), Prachin Buri (PB), and Nokhon Si Thammarat (NST) provinces. The quality parameters including TA, TSS, TSS/TA ratio, color values and some chemical compositions are shown in Table 1. The TA and TSS varied slightly among provinces ranging from 0.44-0.68% and 9.20-11.55%, respectively. The TSS/TA ratios varied significantly which the highest value was found in NP and the lowest value was found in CR province. The samples from NST province obviously showed the highest vitamin C content (74.63

mg/100ml) whereas the samples from CR showed the significantly greatest value (94.93 mgGAE/100g fresh weight) of the total phenolic content than those from NP, NY, PB and NST provinces.

The antioxidant capacities of local grade pummelos were evaluated using DPPH-radical scavenging assay (DPPH-assay) and ferric reducing antioxidant power assay (FRAP-assay). The ranges were from 164.23-257.02 µmolTrolox/100g fresh weight and 209.78-278.99 µmol ascorbic acid/100g fresh weight from DPPH-assay and FRAP-assay, respectively (Table 2). The sample collected from NP province which had the lowest DPPH-assay (164.23 µmolTrolox/100g fresh weight). The antioxidant capacity (FRAP- assay) of all sample were not significantly differences.

Table 1. Some physical and chemical compositions of the local grade pummelo cv. "Thong Dee".

Analysis	Chiang Rai	Nakhon Pathom	Nakhon Nayok	Prachin Buri	Nokhon Si Thammarat
Titratable acidity (%)	0.68±0.09 a	0.44±0.02c	0.53±0.04b	0.50±0.0.03bc	0.51±0.02bc
TSS (%)	9.20±0.28 c	11.55±0.34a	10.10±0.90b	10.67±0.65ab	10.55±0.52b
TSS:TA ratio	16.62±1.86 d	26.12±1.38a	18.87±1.23c	21.29±1.15b	20.55±1.01bc
L*	42.90±2.24a	21.94±1.29d	36.70±0.76b	33.92±1.49c	38.03±1.17b
a*	0.75±1.26c	7.15±0.47a	2.74±1.31b	1.54±0.50bc	1.84 ± 0.76bc
b*	11.34±1.98c	33.84±3.98a	10.77±2.96c	18.11±3.42b	19.08 ± 1.26b
Vitamin C (mg/100 ml)	53.43±6.50b	32.94±1.73c	49.50±4.23b	50.77±6.02b	74.63 ± 2.20a
Total phenolic compounds (mgGAE/100g)	94.93±6.48a	54.87±12.62b	62.03±12.30b	51.93±17.07b	65.62 ± 5.90b

[1] Different letters in the same row for DMRT test indicate significant differences ($p \leq 0.05$)
[2] Mean ± SE obtain from analysis of four replicates (orchards)

Table 2. Total antioxidant capacity of the local grade pummelo cv. 'Thong Dee" [1,2]

Analysis	Chiang Rai	Nakhon Pathom	Nakhon Nayok	Prachin Buri	Nokhon Si Thammarat
DPPH-assay[3]	257.02 ±19.84 a	164.23 ±12.41 b	213.42 ±21.99 ab	214.70 ±26.37 ab	250.91 ±22.08 a
FRAP-assay[4]	235.58±19.69	209.78±24.78	268.78±40.02	243.45±41.34	278.99±14.95

[1] Different letters in the same row for DMRT test indicate significant differences ($p \leq 0.05$)
[2] Mean ± SE obtain from analysis of four replicates (orchards)
[3] Total antioxidant capacity (DPPH) expressed as µmol of Trolox (TE) per 100 gram of fresh weight
[4] Total antioxidant capacity (FRAP) expressed as µmol of Ascorbic acid (AA) per 100 gram of fresh weight

Seven flavonoid compounds mainly found in pummelo flesh cv. "Thong Dee" were determined. Standards and typical chromatograms obtained from pummelo flesh are shown in Fig. 1a and b. Six flavonoids including hesperidin, neohesperidin, kaempferol, rutin, apigenin and quercetin were not detectable. Only naringin was found and showed the predominant content. The retention time (32.9 min) of naringin peak and spectra (λ max 233, 283, 328 nm) in all samples were similar to naringin standard. Interestingly, there were unknown peaks which cannot be identified. It might be

other flavonoids and/or bioactive compounds in pummelo flesh cv. “Thong Dee”. In this study, the highest naringin content was found in pummelo from NST (71.90 mg/100g) and the naringin contents in pummelo flesh cv. “Thong Dee” collected from other areas (CR, NP, NY and PB provinces) ranged from 25.37-38.77 mg/100g (Table 3).

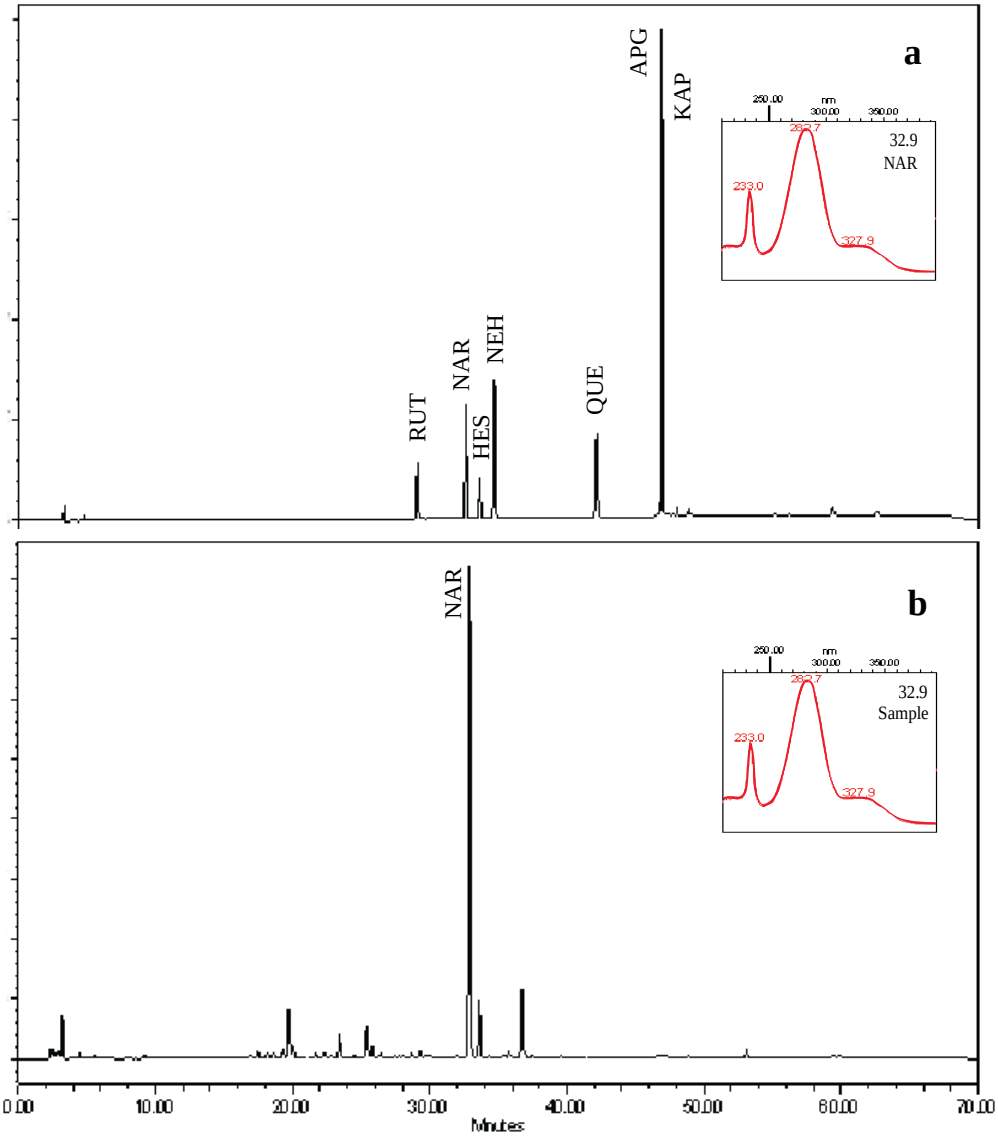

Fig. 1. HPLC chromatograms of flavonoid standards (a), RUT (20.6µg/ml), NAR (15.2µg/ml), HES(19.4µg/ml), NEH (15.2µg/ml), QUE (15.6µg/ml), APG (17.8µg/ml) and KAP (16.9µg/ml) and typical local grade pummelo flesh cv. “Thong Dee” (b).

Table 3 Naringin content (mg/100g) of the local grade pummelo cv. 'Thong Dee" [1, 2]

Analysis	Chiang Rai	Nakhon Pathom	Nakhon Nayok	Prachin Buri	Nokhon Si Thammarat
Naringin	32.36±11.52b	32.20 ±5.36b	38.77 ±12.37b	25.37 ±7.43b	71.90 ±10.90a

[1] Different letters in the same row for DMRT test indicate significant differences ($p \leq 0.05$)
[2] Mean ± SE obtain from analysis of four replicates (orchards)

The flavonoid content in grapefruit from China, was found to be approximately 118.83 mg total flavonoids/100g. Naringin are the main component (62.43 mg/100g) followed by small amounts of neohesperidin, narirutin and hesperidin, respectively (Xu *et al*., 2009). In Thailand, it has been reported that the major flavonoid found in pummelo cv. "Thong Dee" flesh was naringin (26.11 mg/100g) but no maturity detail was indicated (Wattanasiritham *et al*., 2005). This result could confirm our work that only naringin found in pummelo cv. "Thong Dee" flesh and the naringin content was slightly higher than those previously reported in pummelo but lower than grapefruit from China, except the pummelo cultivated in Nokhon Si Thammarat province. This indicates that there was a variation in naringin content in the local grade pummelo cv. "Thong Dee" grown in local cultivation areas. Some factors such as environment, production areas, cultivations, and cultural practices might cause the divergence. Therefore, pummelo cv. "Thong Dee" from Nokhon Si Thammarat province may be considered as an excellent source of phytochemicals with have potential health benefits.

CONCLUSION

In this study, bioactive compounds and antioxidant capacities in pummelo cv. "Thong Dee" from five major cultivation areas, namely Chiang Rai, Nakhon Pathom **,** Nakhon Nayok**,** Prachin Buri**,** and Nokhon Si Thammarat provinces, in Thailand were examined. Variations in chemical content were observed. Pummelos from Nokhon Si Thammarat and Chiang Rai provinces had the highest vitamin C and total phenolic compound content, respectively. Naringin is the most abundant flavonoid found in pummelo flesh, especially pummelo from Nokhon Si Thammarat province. However, pummelo from Nakhon Pathom province had the lowest vitamin C and total phenolic compound content, and DPPH antioxidant capacity.

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HOT WATER TREATMENT OF CUTTING-CANE INFECTED WITH *SUGARCANE STREAK MOSAIC VIRUS* (SCSMV)

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ABSTRACT

The thermal inactivation point (TIP) of SCSMV was determined by heating the infected plant sap for 10 min at 50ºC, 55ºC, 60ºC, and 65ºC. The sap was inoculated mechanically on indicator plant *Dactylactonium aegypticum.* The virus was detected by a reverse transcription polymerase chain reaction (RT-PCR) using specific primer to amplify a part of the coat protein (CP) gene. The SCSMV was detected on plants inoculated with 50ºC and 55ºC heat-treated sap, and was not detected in plants inoculated with sap heat-treated at higher temperature. This TIP was used as a guideline to treat the infected cutting-canes by hot water treatment (HWT) to evaluate its effectiveness in eliminating SCSMV. The temperature ranged from 52ºC to 55ºC and heat treatments were 10, 20, and 30 min submersion time. The results showed that elevating temperature and submersion time affected the viability and severity significantly. At an upper temperature of 53ºC with longer than 20 min submersion time, plant death was observed. Although the virus was not completely eliminated from the cutting-canes, HWT at 53ºC for 10 min was able to reduce the disease severity and maintain the plant's viability. The impact of HWT before planting will reduce the virus titer in plants and disease severity at the critical time of 3-4 months after planting of sugarcane thus minimizing the effect of virus infection in sugarcane.

Key words : cutting cane, TIP, virus elimination, severity

INTRODUCTION

During the period from 1995-2001, sugar production in Indonesia decreased from 2.1 million ton to 1.72 million tons and national production decreased every year until 2006 when only 2.3 million tons were produced (Dewan Gula Indonesia; Kompas 2007). This was below the national consumption. To cover the deficit, government imported sugar amounting to 200.000 tons. Since 2002, the Indonesian government proclaimed an acceleration program to increase sugar production with the main goal to achieve sugar self-sufficiency for direct consumption in 2009 and for total sugar consumption in 2014 (Departemen Perindustrian, 2009). Some constraints to sugar production include problems in plant pest and diseases which may become a serious threat to sugar production (ISRI, 2008).

Recently, an outbreak of streak mosaic disease on sugarcane occurred in many plantations in Java Island. Based on our previous studies, the cause of the streak mosaic disease is *Sugarcane streak mosaic virus* (SCSMV), a *Potyvirida*e member (Damayanti and Putra, 2010). There was no report of SCSMV in Indonesia previously; it is considered an exotic virus. The emergence of a new virus disease might be a consequence of the introduction of cutting canes from other countries and a

sufficient detection method was not available. The SCSMV was first time reported in Pakistan and India (Hall *et. al*., 1998; Hema *et. al*., 1999). In India, its incidence is up to 100% and can infect sugarcane together with *Sugarcane mosaic virus* (SCMV) (Hema *et al*., 2003; Chatenet *et al*., 2005). In Indonesia, it was estimated that SCSMV is distributed in more than 50% of sugarcane plantations in Java (ISRI, 2010), with incidence up to 62% (Damayanti and Putra, 2010). The effect of SCSMV infection on sugarcane var. PS 864 could reduce the sugar yield up to 22% with incidence up to 50% (Asnawi, 2009).

Basic studies related with a new pathogen such its identity, its bio-ecological characters including its transmission modes, vector, host range and bio-molecular characters need to be conducted to get useful information as a basic consideration to decide on an appropriate management strategy of the disease. Various control methods can be chosen such as culture practices, utilization of chemicals, biological control, physical therapy, utilization of plant extract which act as antiviral substances and genetic resistance. Among those methods, control attempts which are environmentally safe and sustainable are preferred over synthetic chemical use. To improve the effectiveness of controlling pathogens, an integration of some control methods will generally be effective in reducing the impact of the infection (Schumann and D'Arcy, 2007).

For a long time, hot water treatment (HWT) has been utilized to get disease-free plant propagation materials. By using plant tissue culture and chemotherapy in combination with HWT, the effectiveness of eliminating almost all of the pathogens is increased (Mink *et al.*, 1998). Kim *et al*., (2003) reported that HWT at 75°C for 72 hr and at 85°C for 24 h were able to inactivate *Cucumber green mottle mosaic virus* (CGMMV) on cucumber seeds. Further, 51% and 50% of garlic cloves were virus free of *Garlic yellow streak virus* (GYSV) when plantlets subjected to hot air treatment in a growth chamber at 36°C for 30 and 40 days, respectively and almost all plantlets were virus free when the treatment was more than 60 days (Conci and Nome, 1991). The elimination of plant viruses by HWT is usually based on its thermal inactivation point (TIP), however the TIP of SCSMV is still unknown up to the present. The TIP *in vitro* is higher than the plant thermal-death point (Nyland and Goheen, 1969). However, the optimization of either temperature or submersion time, can make HWT a useful therapy to eliminate viruses especially for perennial plants or vegetative propagation materials such as sugarcane and chrysanthemum.

Resistant varieties against SCSMV are not yet available and SCSMV free cane setts are hard to find in the fields at the present. Thus, this work sought to determine the TIP of SCSMV and use it as a guideline to evaluate the effectiveness of HWT on SCSMV infected cutting cane in an attempt to minimize the impact of the infection on sugarcane.

MATERIALS AND METHODS

Source of Inoculum

SCSMV infected cutting canes PS 864 variety were obtained from the Indonesia Sugar Research Institute (ISRI), Pasuruan, East Java. PS 864 is categorized as a susceptible variety which is cultivated widely in sugarcane plantations in Indonesia. The cutting canes (setts) were planted in plastic pots (Θ 50 cm) containing sterile soil and manure. The young leaves were used as a source of inocula.

Planting of *Dactylactonium aegypticum*

Grass seeds were planted in plastic pots (Θ 30 cm) containing sterile soil. Plants were maintained under screen house conditions until ready for further use. About 10-20 grasses/pot of 45

days old plants were inoculated with heat treated sap mechanically. All of the inoculated grasses were harvested and 0.1g of the composite samples of each treatment were used for RT-PCR detection.

Determination of Thermal Inactivation Point (TIP)

Infected sugarcane leaves were ground in phosphate buffer pH 7 (Merck, Germany) (1:5 w/v) to make plant sap. Plant sap was heat treated at 50°C, 55°C, 60°C, and 65°C for 10 min.

Mechanical Inoculation

Grass leaves were gently dusted with Carborundum 600 mesh (Nacalai Tesque, Japan) prior rub-inoculation. The infected plant sap (1:5 w/v) in phosphate buffer (pH 7.0) (Merck, Germany) was heat-treated for 10 min at each temperature and then used to inoculate the leaves. Plants were grown in a screen house under natural conditions for 4 weeks post rub-inoculation.

Nucleic Acid Extraction

Total RNA was extracted using RNeasy kit (Qiagen) according to manufacture's recommendation.

cDNA construction

Total RNA (3 ul) was used as a template for cDNA construction. To the eppendorf tube, 1 ul of 10 uM the 3'-primer $d(T)_{20}$, 0.5 ul of 10 mM dNTP and sterile water up to 7 ul were added. The premix was denatured for 5 min on 65°C, and chilled on ice. Then, 1 ul of 10 x RT buffer, 0.5 ul (20U) of RNAse Inhibitor (New England Biolabs, UK), 1 ul of 50 mM DTT and 0.5 ul (100U) of M-MuLV (New England Biolabs, UK) were added and the mixture was incubated for 1 hr at 42°C, and for 5 min at 95°C to inactivate the M-MuLV transcriptase.

RT-PCR

cDNA (1 ul) was added to a PCR cocktail (2.5 ul of 10x PCR buffer, 0.5 ul of 10 mM dNTP, forward and reverse primers (10 uM) 1 ul each, Taq polymerase 2.5 U (New England Biolabs, UK) and adjusted with sterile water up to 25 ul). The forward primer SCSMV-cpF (5'-GTGGGTTCAGTTCTCGGTTCGTAGC-3') and the reverse primer SCSMV-AP3' (5'-TTTTTTCCTCCTCACGGGGCAGGTTGATTG-3') (Hema *et al*., 2003) was used to amplify a 500 bp DNA fragment of partial coat protein gene (CP) and the 3' terminal of SCSMV. PCR condition was 35 cycles at 94°C for 30 sec, 47°C for 1 min, and 72°C for 2 min and a final extension on 72°C for 10 min.

DNA Visualisation

PCR products were separated by agarose gel electrophoresis using 1.2% gel agarose in Tris/Borate/EDTA (TBE) containing ethidium bromide (0.5 ug/ml) for 30 minutes on 70 Volt. Ladder 100 bp DNA (New England Biolabs, UK) was used as a marker. DNA visualisation was done under a UV illuminator and was documented by using a digital camera.

Hot water treatment (HWT) of sugarcane setts and its viability and severity

The thermal inactivation point of SCSMV was 55°C and the temperature was modified between 52-55°C. The sugarcane setts PS 864 variety was used to evaluate the effectiveness of HWT in reducing SCSMV in this variety. Setts were subjected to HWT at 52°C, 53°C, 54°C, and 55°C for

10, 20, and 30 min of each treatment. After HWT, setts were grown in sterile soil and maintained in the screen house under natural conditions. Parameter assessments were viability, disease incidence and severity at 2 months after planting.

Disease severity rating was performed with mock plants (healthy plants) with a standard made by ISRI. The first visible dewlap leaf (FVD) and spindle leaves of each plant were examined for mosaic symptoms at 2 months after planting by recording the percentage of leaf areas showing mosaic symptoms based on a score of 0-8 (Table 1).

Table 1. Scoring system of mosaic symptoms

Score	Approximately % of leaf area covered by mosaic symptoms*
0	0 %
1	0.1 – 5.0 %
2	5.1 – 10.0 %
3	10.1 – 20.0 %
4	20.1 – 30.0 %
5	30.1 – 40.0 %
6	40.1 – 50.0 %
7	50.1 – 75.0 %
8	75.1 – 100.0 %

*The first and second visible dewlap leaves and spindle leaves

Disease severity was counted using the following formula :

$$DS = \frac{\sum (n_i \cdot v_i)}{N \cdot Z} \times 100\%$$

where :

DS = Disease severity (%)
n = number leaves with a certain score
v = score
N = number leaves observed
Z = the highest score

Data Analysis

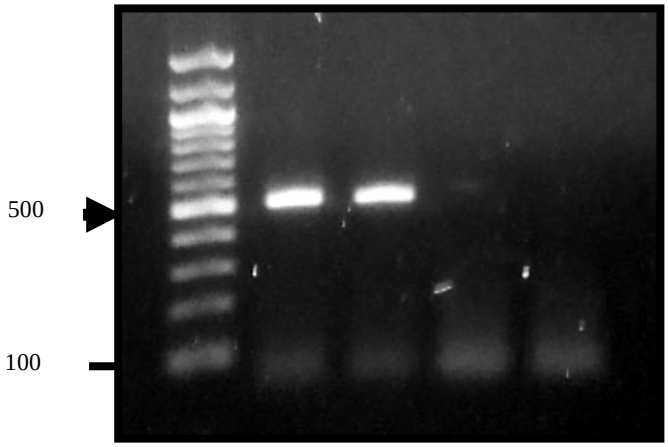
The experimental design used in the experiments was randomized complete design with 10 cutting canes per treatment and three replicates. Data was analyzed with analysis of variance (ANOVA) using SAS software version 6.13 (SAS Institute, Gary, NC, USA) and was followed by Duncan's Multiple Range Test (DMRT) ($\alpha = 0.05$).

RESULTS AND DISCUSSION

Determination of TIP

Until 4 weeks post inoculation (wpi) the inoculated *D. aegypticum* showed no obvious symptoms as well as control plants. However, after 4 weeks, the tested plants became dry and finally induced plant death (data not shown).

The total RNA from infected plants was extracted and detected by RT-PCR using primer specific to partial SCSMV CP gene. RT-PCR successfully amplified a 500 bp DNA fragment from inoculated samples of 50°C and 55ºC treatments. However, the virus was undetectable from inoculated samples of 60ºC and 65ºC treatments (Figure 1). It was suggested that the virus was still infectious at 50ºC to 55ºC treatments. This result indicated that the SCSMV's TIP was between 55-60ºC.



L 100 50ºC 55ºC 60ºC 65ºC

Fig. 1. Gel electrophoresis of SCSMV DNA PCR product (arrowhead). Total RNA was extracted from *D. aegypticum* inoculated with heat treated sap at 50-65ºC. Ladder DNA 100 bp (NEB) on the left

Application of HWT on infected cutting cane

The thermal inactivation point was used as a guideline to evaluate the effectiveness of HWT from 55-60ºC with submersion times of 10, 20, 30, 60 and 120 min in eliminating the SCSMV from infected cutting canes. HWT for up to 30 min at 55ºC caused more than 60% of cane setts did not grow, while HWT at 60ºC for up to 10 min submersion time caused the buds of all tested setts to die. All tested cutting canes treated by either HWT at 55ºC longer than 30 min or on 60ºC longer than 10 min submersion time could not withstand (data not shown). Further, the HWT was optimized by using lower temperatures from 52°C-55ºC and shorter submersion times of 10, 20, and 30 min (Table 2).

Effect on viability

The cane setts were obtained from SCSMV infected plants. The HWT at 52ºC for 10 and 20 min had no effect on the incidence or viability, while 30 min submersion time caused viability of cane setts to decrease up to 10%. At 53ºC for 10 min submersion time, all tested cane setts still had 100% viability, while 10 min longer submersion time decreased viability by up to 30%. A similar trend was observed for other treatments from 54°C-55ºC in comparison with the cane setts control (Table 2). It is suggested that the elevation of temperature and submersion time causes cane setts to lose their viability.

Effect on incubation period

The first time appearance of symptom of all setts which were subjected by HWT tends to longer than control plants. It was revealed that increasing temperature and submersion time affect to

incubation period. There was 2-9 days delay time the first symptom by HWT in compare to those of control plants although there were not significant differences (Table 2).

Effect on disease severity

Severity of all plants tested showed significantly lower than control plants (Table 2). The HWT on 52ºC for 10 min showed severity significantly higher than other treatments, while among other treatments were not significantly different. By elevated temperature and submersion time reduced the severity significantly in compared to those of control plants.

HWT can effectively eliminate pathogens from bulbs, and sereh disease from sugarcane setts (Mink *et al* 1998). Long hot water treatment (LHWT) at 50ºC for 2 hr completely eliminated several causal agents of sugarcane diseases such as ratoon stunting disease (*Leifsonia xyli* subsp. *xyli*) (Irawan *et al*., 1985; Mirzawan and Samoedi, 1995), leaf scald (*Xanthomonas albilineans*), and smut (*Ustilago scitaminea*) in sugarcane setts (Putra, 1997). In addition, LHWT not only effectively controlled ratoon stunting, but also could improve the quality of planting materials (Putra *et al*., 2009) and could increase sugar yield on several sugarcane varieties (Suwarno and Legowo, 1990). Further, short hot water treatment (SHWT) at 52ºC for 30 min can eliminate the causal agent of sereh disease (Handojo, 1982) but is unable to eliminate *L. xyli* from cane setts (Irawan *et al*., 1985). In addition, these treatments did not effectively control mosaic disease.

Table 2. Effect of hot water treatment on setts viability, incubation period and disease severity.

Temperature -Time (ºC – min)	Viability (%)	Incubation Period (days)	Disease Severity (%)
52-10	100 ± 0.00a*	16.0 ± 2.1a*	19.13 ± 5.73a*
52-20	100 ± 0.00a	16.0 ± 2.0a	15.93 ± 3.16b
52-30	90 ± 0.32ab	17.0 ± 5.7a	16.12 ± 5.80bc
53-10	100 ± 0.00a	17.0 ± 1.8a	16.00 ± 4.94bcd
53-20	70 ± 0.48abc	17.0 ± 8.4a	15.80 ± 8.31bc
53-30	70 ± 0.48abc	19.0 ± 9.2a	15.60 ± 8.42cde
54-10	70 ± 0.48abc	21.0 ± 10.1a	13.30 ± 6.80cde
54-20	60 ± 0.52abc	21.0 ± 11.0a	12.72 ± 6.70de
54-30	40 ± 0.52c	21.0 ± 10.9a	12.40 ± 6.46e
55-10	60 ± 0.52abc	23.0 ± 11.9a	11.60 ± 7.15e
55-20	50 ± 0.53bc	23.0 ± 12.2a	9.70 ± 5.60e
55-30	40 ± 0.52c	23.0 ± 11.8a	9.90 ± 5.30e
Control	100 ± 0.00a	14.0 ± 1.4a	60.00 ± 6.96f

*Number in columns followed by the same letter are not significantly different (α = 0.05)

In this study, HWT did not completely eliminate the SCSMV as effectively as it eliminated fungi and bacteria. However, a previous report by Benda (1971) showed that serial heat treatment including pre-treatment 52ºC for 20 min in the first day followed by 57.3ºC for 20 min in the second day and 57ºC for 20 min in the third day, can cure the SCMV infected cutting canes. While in case of garlic cloves, hot air treatment at 36ºC for 30 and 40 days resulted 50% and 51% cloves free GYSV and plantlet free virus for treatment more than 60 days (Conci and Nome, 1991). The biological character of virus, its distribution in infected tissues, type of plant tissues, temperature and submersion

time might affect the effectiveness of HWT. Therefore, in the case of SCSMV additional trials to optimize the appropriate temperature and submersion time need to be conducted.

Heat affects viral replication and virus movement. It has been reported that treated plant in sustained temperature of 37ºC or above would completely inhibit multiplication of many viruses (Kassanis 1957 *in* Hadidi *et al*., 1998). Heat can also cause inactivation of the virus in the early phase resulting in earlier reduction in SCMV titer (Balamuralikrishnan *et al.*, 2003). These might explain why HWT causes the incubation period to extend and reduces disease severity than control. Since the antisera against SCSMV is not yet available commercially, the effect of HWT on the virus titer could not be quantified. Further, based on the intensity of the DNA band of each treatment could not be differentiated by RT-PCR (data not shown).

Sugarcane are maintained and propagated by using setts which lead to high virus infestation over time. Hence the SCSMV titer needs to be reduced and subsequently eliminated. Although none of the treatments produced virus free plants, treatment at 53ºC for 10 min might be the best treatment to reduce the severity drastically and delay the appearance of phenotype symptoms without obvious effect on the viability. It is suggested that reduction of disease severity might be related to reduction of the virus titer as previously reported on SCMV (Balamuralikrishnan *et al*., 2003). Further, HWT at 55ºC with submersion time between 20 to 30 min might the best treatment to get the source of meristem tip culture with lowest severity. El-Nasr *et al*. (1989) reported that SCMV could eliminated by HWT at 55ºC and 57ºC followed by meristem tip culture, while serial HWT was effective in the elimination of the virus (Benda *et al.*, 1989). The early reduction in virus titer could be utilized to obtain more virus free plants in meristem tip culture. The SCSMV infection affected the production of tiller numbers (Asnawi, 2009) during the tillering period at 3-4 months after planting. This period is also a critical time for sugarcane to respond to the pathogen infection. Thus, HWT before planting would suppress the effect of SCSMV infection during the critical time. The maximum suppression of virus might lead to suppression of disease severity and extension of the incubation period which would eventually allow plants to overcome the infection.

The application of HWT in large scale plantations might be time consuming and expensive. However, HWT is worth considering to mitigate the impact of the virus at the plantation scale, especially during the tillering period. Further, HWT in combination with micro-propagation using meristem tip culture, might lead to complete virus elimination to preserve more virus-free plants. To improve the effectiveness of HWT, the present researches related with utilization of beneficial microbes such as PGPR, endophytic and decomposer bacteria to improve plant health and increase systemic resistance against SCSMV infection are on-going.

CONCLUSION

The thermal inactivation point of SCSMV is between 55ºC to 60ºC, and it is higher than the plant thermal death point for sugarcane. All heat treatments did not completely eliminate SCSMV, however HWT at 53ºC for 10 min drastically reduced disease severity while maintaining 100% plant viability. The earlier suppression of virus before planting by HWT would minimize the effect of SCSMV infection during the tillering period.

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AN ANALYSIS OF THE INVESTMENT CLIMATE IN AGRICULTURE IN HANOI PROVINCE, VIETNAM

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ABSTRACT

Hanoi province, Vietnam has much potential for agricultural development with its large consumer market for agricultural products, soil and water resources, natural climate, physical and social infrastructure. It is also one of provinces that has attracted a large number of investors. However, there are few agriculture investment projects in Hanoi in recent years. This paper presents the results of the structure interview of 200 managers of agricultural firms, co-operatives and farms in Hanoi province in 2008-2009. Even if these enterprises are pleased with their business performance and profitability, the investment climate could have negative effects obstructing investment incentives in agriculture. The study revealed eight key factors determining the investment climate in agriculture in Hanoi province, which include: land issue, provincial policies for agriculture, capital, physical infrastructure, administrative procedures, market, technology and labor issue. Land issues and provincial agricultural policies are the most important constraints; the second group are capital, physical infrastructure, governmental administration; and the third are market, technology and labor issues.

Key words: business performance and profitability, agricultural firm, cooperative, farm

INTRODUCTION

The importance of the rural and agricultural investment climate has only recently been realized. In the 1960s and 1970s, governments in many countries believed that they should play a direct role in input supply, production, trade, transport, and distribution. The long legacy of state-controlled and managed markets left the institutions and policy frameworks for liberalized and private-sector-led markets underdeveloped and private-sector capacities relatively low in many countries (World Bank, 2007). Like the Vietnamese government, the authority of Hanoi found that agricultural development plays a significant role in the economic development. However, under the pressure of rapid urbanization and other factors, agriculture in Hanoi has been facing many challenges. Besides, Hanoi attracted many domestic as well as foreign investment projects, but agricultural investment projects are few. In 2000, Hanoi called for 373 foreign investment projects but only two were in agriculture. In 2007, of the 1,118 projects implemented, there were only four projects involving agricultural production (GSO, 2008).

This study aimed to evaluate the investment climate and conditions for attracting investment in agriculture in Hanoi province, based on the analysis of effectiveness and efficiency of agricultural businesses in the period of 2000-2008 and assessment of the eight components of investment climate in agriculture in Hanoi. It will then suggest some policy recommendation for attracting investment in agriculture in Hanoi.

METHODOLOGY

The primary data came from a survey of production and business units in the field of three types: agricultural firms, agricultural cooperatives, farms, and some basic relevant management agencies in Hanoi in 2008-2009. In addition, some secondary data were collected from the General Statistic Office (GSO). The fields of agriculture are classified as cultivation, animal husbandry, aquaculture, business of agro products and mixed type. A sample of managers of 200 units randomly selected among agricultural units in the studied site were interviewed using standard questionnaires, and orientation interviews of 60 civil servants in the local government offices were also conducted.

The conceptual framework

The World Bank (2004) shows that although the term investment climate is used broadly, it is taken to mean the policy, regulatory, institutional and governance environment that supports (or fail to support) entrepreneurship and efficient markets. The report emphasizes that a good investment climate encourages higher productivity by providing opportunities and incentives for firms to develop, adapt and adopt better ways of doing things – not just innovations of the kind that might merit a patent but also better ways to organize a production process, distribute goods, and respond to consumers. The study developed the conceptual framework presented in Figure 1. The investment climate in agriculture is generated by eight components including management capacity of local government, Hanoi's agricultural policies, public infrastructure, markets for agricultural products, science and technology, land, finance and labor force.

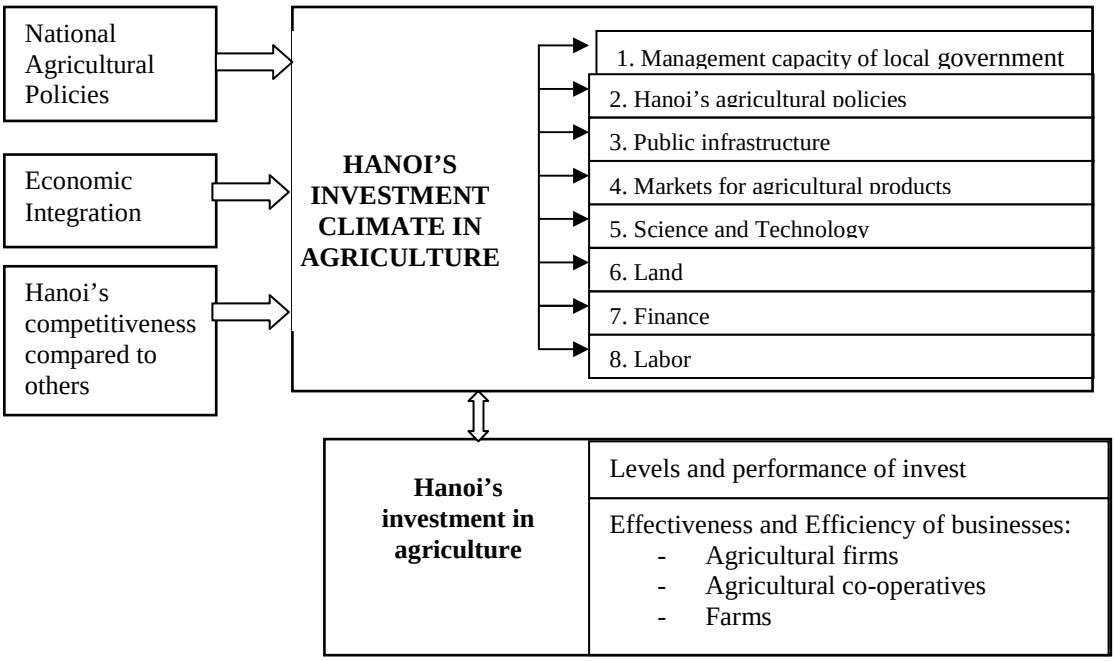


Fig. 1. Conceptual framework for analysis of investment climate in agriculture in Hanoi

A positive trend of these components, such as: a good management capacity of local government with a clear mechanism; stable agricultural policies; an adequacies system of public infrastructure; a large markets for agricultural products; the development in science and technology; and a good

mechanism for land hiring and finance will lead to an increase in efficiency of investment as well as improve attractiveness of investment climate in agriculture in Hanoi. On the other hand, the effectiveness and efficiency of investment will decrease, thus leading to a reduction in attractiveness of agricultural investment climate.

FACTORS AFFECTING THE INVESTMENT CLIMATE IN AGRICULTURE IN HANOI PROVINCE

There are two other factor groups affecting the investment climate in agriculture in Hanoi. The external factors include: national agricultural polices, degree of economic integration, and Hanoi's competitiveness compared to the other provinces. If national agricultural policies are in favor of agriculture development, Vietnam can integrate in the large world market. With the high capacity of competitiveness in Hanoi, investors will then be stimulated to invest more in agriculture of Hanoi. The second group includes internal factors referring to effectiveness and efficiency of agricultural firms, agricultural co-operatives and farms in Hanoi. Effectiveness of agricultural units measures the results of doing business in a specific period; efficiency measures the relative relationship between results and costs of doing business in a period, normally in a year. Some basic indicators were productivity of labor, of land, profit per labor, and profit per capital and so on. A high business performance and profitability of agricultural units will be a base for promoting and improving the investment climate in agriculture.

External factors

Economic integration of Vietnam in the world market also creates a good condition for improving the investment climate in Hanoi. Vietnam has joined ASEAN, WTO and other international organizations which allow Hanoi to attract and select more, high capacity investors. This in turn helps to develop agriculture in Hanoi towards high productivity, quality, food safety and ecological environment. On the other hand, it requires highly competitive products.

In comparison with other provinces, Hanoi seems to have higher competitiveness. Hanoi is a center of political, economic and cultural, as well as one of the largest cities in Vietnam. It has many favorable conditions for economic development in general and agricultural development in particular. It possesses both conveniently natural factors such as alluvium, water resource, and weather climate, and socioeconomic supporting factors like developed infrastructure systems, expanded market for goods and agricultural products. It is the location of many research centers, universities, and institutes which is a foundation for economic development. Moreover, the authority of Hanoi has established a long-term development strategy for agriculture in order to exploit effectively the inherent advantages. Hanoi is also one of provinces of the whole country which has attracted a larger number of investors. This also promotes the attractiveness of the investment climate in agriculture in Hanoi.

National agricultural policies also play an important role and influence the investment climate in agriculture of the country in general and Hanoi in particular. The government aims to focus on industrialization, modernize agricultural and rural development; increase investment in building infrastructure; establish logical structure of agricultural production, and apply science and technology achievement in agriculture. They have strived to improve the policies, create a good investment climate in agriculture through renovating administrative procedures, enhancing clearance, expanding markets, investing and developing human resources, social environment, and infrastructure. This will motivate the investment climate in agriculture of Hanoi.

The impact of these factors on the investment climate in agriculture are as follows:

Hanoi has gained many achievements in the development process. Gross domestic products (GDP) increased at an average growth rate of 35.98% during the period 2000-2007. Even the contribution of the agricultural sector to GDP decreased over time, GDP of agricultural sector in Hanoi rose at the average rate of 10.85 in the same period (GSO, 2003; 2008). The investment for the infrastructure in general as well as in agricultural sector increases over time with high average growth rate. However, the ratio of agricultural investment was very limited, accounting for only 8.4% in 2000, decreasing to 1% in 2006 and then increasing to 3.5% in 2007. On average, in that period, the amount of agricultural investment increased by 19.69%, which is lower than the average growth rate of total investment, in general, at 48.50% (GSO, 2003; 2008). This means that the role of agriculture in Hanoi is not considered properly.

The number of foreign investment projects in Hanoi increased over time, but the numbers in the agricultural sector still accounts for a very small proportion. In 2000, there were only 2 over 373 projects in agricultural sector, accounting for only 0.54%. In 2007, there were only 4 agricultural projects over a total of 1.118 projects in general, which was only 0.36%.

The registered and implemented capital of foreigners in the agricultural sector accounted for a very small proportion in total capital in Hanoi. The registered capital in the agricultural sector was only 2.3 million USD in 2000 and 4 million USD in 2007, which is very much lower than 7,340 million USD in 2000 and 10,257 million USD of total registered capital. The implemented capital in the agricultural sector in 2000 and 2007 were 2 million and 3 million USD while total implemented capital in general were 2,577 million and 5,138 million USD, respectively. This implies that the attraction in agriculture investment in Hanoi is very low (GSO, 2003; 2008).

Public capital invested in agricultural sector in Hanoi tended to reduce over time. In 1999, public capital invested in rural areas of Hanoi was 113.8 billion Vietnamdong (VND). The numbers in 2000 and in 2002 were 93.5 and 79.7 billion VND (HPC, 2004) wherein investment in the infrastructure system in rural areas such as irrigation, dikes and rural transportation system, dominated the largest proportion (more than 80%). Direct investment in production accounted for only 5% of total investment. The investment for developing seeds and newborn husbandry which applies technology is negligible. In general, public capital invested reduced in all fields over time.

Internal Factors

The internal factors refer to effectiveness and efficiency of agricultural firms, agricultural co-operatives and farms in Hanoi as indicators.

There was a big difference in the scale of investment capital among the different kinds of units assessed. On average, the total capital of an agricultural firm at the time of the survey was 16,358 million VND. It was 30.77 times higher than of an agricultural cooperative (531.5 million) and 16.65 times of a farm (982.6 million). The amount of expanded capital in firms and farms doubled, while those in the cooperative decreased. The business strategy of firms seemed concentrated on distributing agricultural products with an estimated capital of 12 billion VND while cooperatives and farms are in favor of providing inputs service for agricultural production. Only firms consider expanding the distribution of forestry products and producing inputs for agricultural production while farms only intend to raise animal and aquaculture (Table 1).

In 2008, agricultural firms invested 16.36 billion in agriculture, including 10.92 billion for expanding business. Investment was mainly in agro-products with a total of 12.12 billion or 75% of total investment. There were only 1.13 billion for cultivation (7%) while none in husbandry because of the bird-flu issue. Investment in cooperatives was a total of 531.5 billion wherein 161.8 billion was expanded investment. Investment focused on 157 billion for cultivation and 374.1 billion for

agricultural services. Farms invested 982.6 billion in which 668.8 billion was for expanding production in 2008. The allocation of this investment was for cultivation (62 billion), agricultural service (664.7 billion), agro- products (36.2 billion), husbandry and aquaculture (33.2 billion), and mixed activities (138.2 billion).

Table 1: Private capital invested per unit, 2008 -2009.

Indicator	Firm		Cooperative		Farm	
	Mil. VND	%	Mil. VND	%	Mil. VND	%
Total Capital	**16,357.9**	**100.0**	**531.5**	**100.0**	**982.6**	**100.0**
Primary Capital	5,443.3	33.3	369.7	69.6	313.8	31.9
Capital expanded	10,914.6	66.7	161.8	30.4	668.8	68.1
Classified by Business Strategy						
Total capital	**16,357.9**	**100.0**	**531.5**	**100.0**	**982.6**	**100.0**
In which:						
Cropping	1,131.6	6.9	157.4	29.6	62.7	6.4
Inputs for agricultural production	1,003.6	6.1	0.0	0.0	0.0	0.0
Services for agricultural production	927.9	5.7	374.1	70.4	664.7	67.6
Distribution of agricultural products	12,124.8	74.1	0.0	0.0	36.2	3.7
Animal and aquaculture production	0.0	0.0	0.0	0.0	33.3	3.4
Distribution of forestry products	1,170.0	7.2	0.0	0.0	0.0	0.0
Multiple purposes	0.0	0.0	0.0	0.0	138.2	14.1

Source: Generated from the survey 2008-2009

In comparison with the firms and cooperatives, profit per capital in farms was much higher at an average ratio of 30.1%. Most especially, cropping and seedling production farms reached the highest ratio (31.6%). Firms which did business in agro products, agricultural services and provided materials achieved a level of 20%, and those which produced inputs for the livestock gained 18.6%. Agricultural cooperatives got a ratio of 23.1%, much higher than 14.1% of the services cooperatives. These results show that the investing efficiency in agriculture in Hanoi is quite good (Table 2).

Firms that provided agro service had the highest profit on cost ratio (0.3); followed by those which did business on forest products which reached 0.287. Firms that produced inputs for livestock attained a very low ratio (0.008). The survey results also implied that investment in husbandry, aquaculture, and mixed farms promised a quite high efficiency (0.395).

Farms were likely to have the shortest time of return of 4.5 years, and it differed among various kinds of farms. The shortest time was 3.8 years for mixed farms and the longest was 4.9 years for cropping farms. The time for return of firms and cooperatives were 10.4 and 4.7 years, respectively. The longest time of return was 18.5 years mainly because of growing perennial trees. Time for return in agricultural cooperatives was 4.2 years, longer than the cooperative that provided agricultural service (3.1 years).

Although the average number of labor in agricultural units increased over time, most units had small and very small labor size. Approximately, 70% of firms had less than 50 laborers. Only 15% firms had more than 100 laborers. The average number of the labor force in firms increased from 75 at the time of registration to 100 people at present; 100% of cooperatives and farms had less than 50 regularly working laborers. The corresponding figures in the farms were 7 and 10 people. The labor force in cooperatives was almost stable at 12 people. At the high seasonal production, the

demand for labor increased, most of the units hired temporary workers to meet the requirements of production.

The professional qualification of workers in the investigated units was low. In general, 100% office laborers in the farms and 71.4% those in the cooperatives had not been trained. Unskilled supervised workers dominated 100% in the farms, 80% in cooperatives and 12% in firms. The trained workers in the firms were mainly technical workers (68.7%) and engineers (19.3%). About 20% of laborers in the cooperatives were trained just for operating electricity and the water system.

Table 2. Efficiency of capital invested in agricultural sector (%).

Indicator	Firm	Cooperative	Farm
Profit per capital (%)	17.5	14.4	30.1
Classified by Business Strategy:			
Planting	12.7	23.1	31.6
Inputs for agricultural production	18.6	-	-
Services for agricultural production	20.4	14.1	28.5
Distribution of agricultural products	20.3	-	-
Animal and aquaculture production	-	-	30.7
Distribution of forestry products	10.5	-	-
Multiple purposes	-	-	18.2

Source: Generated from the survey 2008-2009

Profit per labor of firms was 18.5 million, farms 17.6 million and cooperatives 14.5 million (Table 3). Agro-products business ventures achieved the highest turnover and profits per labor (303.6 and 20.7 million) while those in forest products got lower (76.2 and 2.6 million). In cooperatives, turnover and profits per labor of cultivated and manufacturing plants were 167.2 million and 52.4 million, two times higher than ones, which were in agro products. Breeding and aquaculture farms had profit per labor of 21.1 million. The mixed farms which attracted more workers than any other type of farm (15 workers per farm) gained higher turnover and profit per capital (46.8 million and 15.5 million).

Table 3. Efficiency of land and labor in agriculture (million VND).

Indicator	Firm	Cooperative	Farm
Revenue per hectare of agricultural land	118.2	93.8	103.6
Revenue per agricultural laborer	147.8	102.1	122.4
Profit per hectare of agricultural land	37.4	14.1	25.4
Profit per agricultural laborer	18.5	14.5	17.6

Source: Generated from the survey 2008-2009

On average, the firms' land area was 10.29 hectares (ha), in which cultivated land occupied the highest proportion (50.34%) followed by ground water ponds (39.46%). Forested land accounted for a negligible rate. For cooperatives, the average area was 34.16 ha, and that of farms was 4.82 ha. Area for offices and factories accounted for a small portion, only 6.22%, 3.43% and 7.26% of the total area in firms, cooperatives and farms, respectively. Most of the land used for the purpose of

manufacturing and trading of firms and cooperative come from land allocation with the corresponding ratio of 50.44%, 66.63%,while in the farm rented land accounted for 93.36% (Table 4).

Table 4: Status of land in investigated units.

Items	Firm	Cooperative	Farm
Total area (ha)	10,29	34,16	4,82
Structure (%)	100,00	100,00	100,00
According to usage of land			
- Cultivation	50,34	78,51	45,02
- Forestry	3,98	0,00	0,00
- Ground water ponds	39,46	18,06	47,72
- Other usages	6,22	3,43	7,26
According to origin of land			
- Government allocated	50,44	66,63	6,64
- Rented land	49,56	33,37	93,36

Source: Generated from the survey 2008-2009

Firms gained the highest level of turnover (118.2 million) and profit (37.4 million) on a hectare of land. The lowest level belonged to cooperatives with the turnover of 93.8 million and profit of 14.1 million. The corresponding numbers for farms were 103.6 million and 25.4 million (Table 3). Notably, cultivated and seedling production farms achieved quite a high turnover and profit per ha of land, at 152.9 and 44.9 million, respectively. It was twice higher than of the breeding and aquaculture farms (72.4 and 17.2 million). Highly efficient farms produced mainly high value crops such as flowers, ornamental plants (Tu Liem), jasmine (Soc Son) and others.

The average growth rate of profit after tax in firms was high, at 24.9% but their ratio of profit-after-tax on capital reduced from 7% in 2003 to 3.4% in 2007. There was a distant difference among different kinds of firms. Profit after tax in cooperatives increased but its speed decreased. The average growth rate of profit after tax in farms was high, at 26.6%. Firms contributed the highest amount into state budget; average number was 34,000 VND per one million of investment capital. The cooperatives and farms contributed at a very low level with the corresponding numbers of 8,000 and 11,000VND, respectively. The investigated units seemed to reduce their ratio of contribution to the budget overtime.

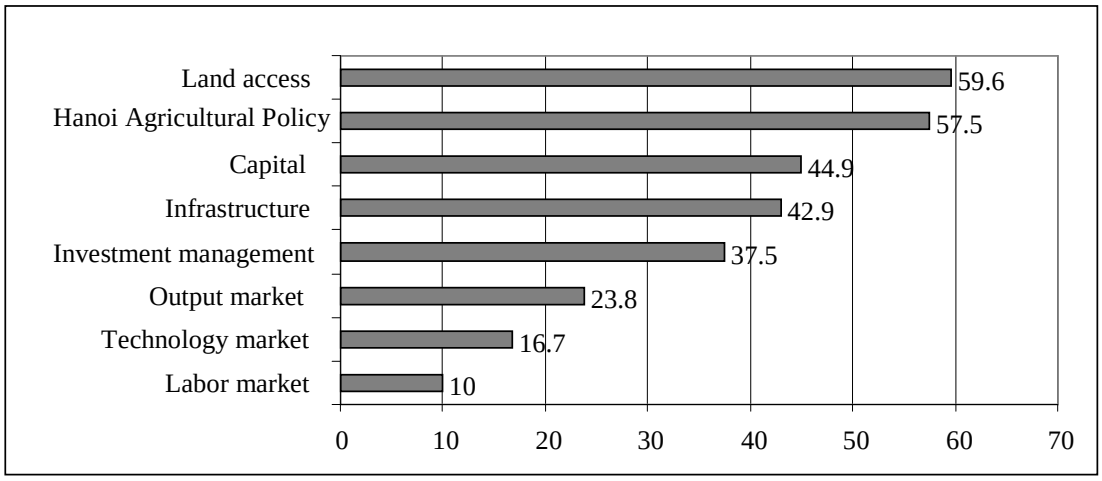
The number of jobs created based on investment capital had a tendency to decrease gradually. On the average, for every one billion investment in 2003, firms could create nine new jobs. In 2007, it reduced to seven. Farms created 29 jobs per one billion of investment. The capacity for creating jobs in cooperatives was the highest. These could create 153 jobs per one billion investments in 2007, much higher than firms and farms. However, in terms of absolute numbers, firms created the highest numbers of jobs. The contribution to build infrastructure and improve the natural environment of the firms was at lowest of 16,000 VND per a million of investment (2007), lower than for farms (38,000 VND) and cooperatives (102.000 VND).

In general, investment in agriculture can generate benefits in terms of financial, socio-economic aspects. Most of the investors interviewed said that their financial profit is not so high but it is stable and they do not need a big amount of capital. This implies business performance and profitability are not discouraging investors in agriculture. So, which factors have constrained

investment in agriculture? In order to find the answer for this question, we would like to look at the investment climate in agriculture.

THE INVESTMENT CLIMATE IN AGRICULTURE IN HANOI

The most obstructing factor for attracting investment in agriculture was land issues. Nearly 60% of the investigated units reflected that land issues limited their investment opportunities. Agricultural policies ranked the second, followed by capital, infrastructure, and management capacity of the local government. The least obstacle factors were markets, technology and labor (Figure 2).



Source: Generated from the survey 2008-2009

Fig. 2. Constraints in the investment climate for agriculture

Land issues

Land plays a significant role in the investment process in the agricultural units. Survey results showed that 20.6% of firms, 19.9% of cooperatives and 32% of farms considered land as a decisive factor in the production process. More than half of them indicated that land is basic for conducting business and production. However, investigated units expressed that the process of land leasing involved several inadequacies and difficulties. Only 77.6% of surveyed units answered questions about land hire and 48.2% experienced difficulties in renting. The reasons given were difficulty in access to land (12.3%), transformation of agricultural land for other purposes that leads to scarcity of land in some local provinces (12.1%). Other reasons are high fees of land rented and inconsistent procedures for renting land.

The main problems for land rental were documents approved by civil servants (41.3% comments), manners of local civil servants (26.6%), and status of embezzlement causing harassment (21.5%). The cooperatives and farms faced fewer difficulties in accessing land than the firms did. Land rental terms seemed too short compared to expectation of the units. On average, time of leasing for firms was 13 years; for cooperatives, 9.5 years; and for farms it was 12.5 years. Meanwhile, their expectations were 45, 50 and 40 years, respectively. In addition, it was difficult to access the information for renting land (47.4% comments). This is due to the scarcity of land and inefficient agricultural land planning.

Agricultural policies in Hanoi

The investigated units indicated that agricultural policies in Hanoi were neither stable nor adequate (60.3% comments). This led to a reduction in investment efficiency as well as diminished attractiveness of the investment climate in agriculture in Hanoi. There are two existing systems of land prices in Vietnam nowadays. State government regulates the formal system while the other operates under the informal market. Differences between the two systems are quite large that leads to the distorted price in the market. The market price in the urban and suburban areas is much higher than the profitability from land use. The price provided by the provincial People's Committee reached only 50% to 70% of market price. In addition, there is a lack of coherence, inconsistency between the overall socio-economic development planning and the duration of land allocation.

The Master Plan, which lasts for 10 years, is going to be considered for amendment in 5 years (Article 25 of Land Law), while the duration of land allocation for investment projects of firms is normally 50 years. Thus, many units had to move to other places due to changes in planning. This caused damage and risk because of deficiency compensation, and time wasted to build and stabilize production. In order to reduce risk, investors often choose short-term investment projects which in turn leads to inefficient land use.

The policy of value-added-tax is not suitable for agribusiness conditions. Inputs for the production of agricultural units come mainly from individual households which have no legal status. Therefore, these units often have to accept high tax of 3.1% yield value because they do not have billings to prove the origin of goods for reduction or completely free of value added tax. Policies to control volume and quality of agro products are not effective.

Farmers tend to cultivate intensively to gain high yield in a short time. They use chemicals unscientifically to stimulate their trees and animals. Thus, chemical residues often remain in the products. This imposes negative effects on the input of agricultural units and reduces their competitiveness against imported products. Moreover, agricultural units often sign contracts to support seed, pesticides, equipment, technology, and purchase farmers' products. Nevertheless, farmers usually break the contract and sell their produce to other traders. These units face many difficulties in collecting inputs and have to buy inputs from traders at higher prices. This phenomenon occurs commonly but there is no financial institution for handling it.

Capital

The units also emphasized the important role of capital in agricultural production because it helped them to stabilize the production (28.5%), widen their investment structure (19.8%), create opportunities and maintain business (5%), and equip facilities (1.6%). However, it was difficult for them to access credit systems for investment (49.1% comments). The main reasons were due to too complex administrative procedures (15.5%), lack of collateral (14.5%), lack of information and relationships (7.7%). It was also difficult to gain access to informal credit (33.6%), either due to insufficient collateral (5%), high interest loans (9.4%), lack of information (5%), shortage of cash (5%) and some other reasons.

Infrastructure

Infrastructure is gradually becoming an important factor before investors decide to invest in agriculture (43.8%). Consequently, transportation was considered the worst (31% bad comments), followed by wastewater treatment system (26%), planning of land issues and clearance (20%). The best comments were on education and training systems, information system, and security systems (Table 5).

Table 5. Ranking of infrastructure facilities (%).

Ranking	Very poor	Poor	Acceptable	Good	Very good	No answer
Transportation	6.9	24.1	38.8	23.3	2.6	4.3
Inventory facilities	1.7	12.1	36.2	17.2	0.0	32.8
Electricity	4.3	11.2	33.6	39.7	2.6	8.6
Irrigation	6.9	12.1	37.1	30.2	1.7	12
Liquid waste treatment	7.8	18.1	30.2	14.7	0.9	28.3
Information	0.9	2.6	33.6	53.4	6.9	2.6
Security	0.9	2.6	29.3	59.5	2.6	5.1
Planning	5.2	14.7	42.2	19.0	1.7	17.2
Education and training	0.9	0.9	46.6	26.7	0.9	24
Business support services	2.6	11.2	37.1	24.1	0.9	24.1

Source: Generated from the survey 2008

Management capacity of local government

The administrative procedures imposed many restrictions in the process of investing in agriculture. Land rental procedures were cumbersome and time-consuming (20.6% of comments), loan processing was slow (22.4%), and business licensing got troublesome (24.2%). Other interviewees reflected that income tax for firms at ratio of 25% was high and they thought it should be 20%. Interviewees also complained that many investment projects did not disburse due to slow implementation or time consumed to explore the market and select trading categories. Clearance for doing business was slow and cumbersome. Administrative procedures were complex. Procedures for clearance and settlement for land disputes were difficult. There were 26.6% comments which complained of high negative charge, vague administrative procedures and difficult to understand, especially the multi-stage procedures (14.5%), which led to time-consuming administrative procedures.

Another constraint came from civil servants' behavior. Authority in the People's Committees at the district level caused the most annoyance (13.7% comments), followed by staff of banks (7.6%), tax offices (5%) and customs offices (5.1%). This situation resulted from the numerous stage, unspecific procedures and negative charge. Other reasons were wrong appointments, multi appointments leading to confusion and lengthy procedures.

Output market

Most investigated units undertook a market research before investment (84.5%). It seemed very easy to purchase inputs for production (86.6% comments). Hanoi is a wholesale market for agro products in north Vietnam. It has a large supply, ventilated market mechanism and fast information system. The consumption of agricultural products is also easy because of a large, broad market and diverse demand. However, they complained that the competitiveness of agricultural products was low, and demand for products was unstable. About 23.8% of investigated units commented that output market is still a factor that constrained them to invest in agriculture in Hanoi.

Science and Technology

Hanoi is the heart of scientific research in Vietnam. Science and technology becomes more and more important in agricultural production nowadays (68% comments). Producers receive much support from scientific agencies. Their achievements bring success to many firms (49.9%) but less in the cooperatives and farms. Linkages between the scientific research centers with agricultural units were still weak (29.3%). Some units felt that technology has limited them when investing in agriculture.

Labor

Local labor resources have become more and more an important factor in attracting investments in agriculture (53.4% responses). Recruitment of unskilled worker seemed quite easy (49.8% responses). Nevertheless, some units complained of high wage level (3.4%) and labor in some case prevented them from investing in agriculture. Unskilled workers seem to dominate their labor forces, account for the largest share and meet their requirements. The ratio of unsatisfied workers was quite small (4.2%). The labor force was stable. On the average, 79.3% labor worked stably during the recruitment. This is really a stimulating factor in attracting investment in agriculture in Hanoi.

In addition, over half of the units said that the recruitment of highly skilled labor or experts was easy. It was due to available labor supply (33.5%). Hanoi is a good climate for attracting professional workers, as there are many nearby universities and colleges. The ratio of investigated units that recruited temporary labor is quite high, at 62%. Average numbers of temporary workers in firms were 146, in a cooperative were 49 and in a farm were 103. The least and the most numbers of temporary workers were 3 and 2100; 2 and 300; and 1 and 2400 workers, respectively. Corresponding workload of these workers were 37.1%, 57.3% and 46.7%, respectively. They indicated that hiring temporary labor could reduce their costs and exploit their labor forces. This is a typical characteristic for agriculture in Hanoi.

POLICY RECOMMENDATIONS

In order to develop the agricultural sector and make the best use of internal elements in the investment climate in agriculture, the first and most important thing that the Vietnamese government and Hanoi authorities should do is to improve the policies of land and capital**.** Good policies for reasonable land use and an investment plan based on the overall planning will stabilize agricultural production. In addition, Hanoi should set up a perfect and unique pricing framework for land usage, and upgrade incentive mechanisms and clearance. The local government should strengthen the capacity of management, simplify procedures for land allocation, land hiring, and have financial institutions with sanction to handle arising problems. This will motivate investors to invest more in agriculture. The national and local governments should also have a favorable credit system for agriculture such as the priority policy of interest rates for agricultural units. It is also necessary to increase speed and efficiency of procedures settlement, enhance capital for medium and long term and expand forms of loans. This will encourage the investors to participate more in the agricultural sector.

The second thing that Hanoi should do is to reform administrative procedures in the direction of ventilation, reduce the focal acquisition records and simplify records. Transparency and thoroughly consistent information, clear and standard instruction documents make it easy for investors to approach the Hanoi market. The civil servants need to change their manners. The capacity for management and monitoring should be improved more effectively. Besides, priority should be given to advanced technology in agriculture. High technology centers and agricultural firms should be built to perform and transfer new technology to others. It would be better to approach and apply the

efficient methods of management. It is also important to plan, build and upgrade rural and wholesale markets and create favorable conditions to exchange agro-products, encourage and support preliminary processing and storage of agro-products in the intermediaries markets at Gia Lam, Thanh Tri, Dong Anh and Tu Liem. The inspection system should be strengthened to detect counterfeiting, poor quality and unknown origin products. High quality input products should be encouraged and supported for higher value products. Economic markets and prices information need to be disseminated widely. This will contribute to improve the attraction of the agricultural sector in Hanoi.

Thirdly, linkage and coordination among departments and organizations should be strengthened. Value chain from research to producers and consumers should be set up for better agricultural production. Hanoi needs a good regime for scientists, experts, intellectuals and laborers working in agriculture. Training and transfer of scientific techniques to farmers should be performed. There should be preferred policies to encourage and support the training organizations and qualified high-tech agricultural laborers. Hanoi needs to strengthen and improve the quality of investment promotion to accelerate the potential and climate of investment in agriculture. Tripartite dialogue mechanism should be implemented regularly in order to detect and solve the problems and obstacles in the investment climate. This will support investors thus attracting more investment in agriculture in Hanoi.

To take the advantage of its location, Hanoi should strengthen incentives and support for investors in the agricultural sector. Hanoi needs to reduce income tax of agriculture units which are located in unfavorable areas (poor nutrition, soil, difficult transportation) producing high quality seeds or seedlings. Building warehouses, centers of agricultural trade and developing market information systems will create a condition for market development. Promoting export markets for agricultural products, supporting vocational training and research, application and transfer of new technologies need to be carried out. It is also significant to encourage agricultural insurance and support external risks such as storms, floods, droughts, epidemics and price fluctuation.

In addition, there is a need to improve rural infrastructure and apply science and technology achievement on agriculture. Although infrastructure system in agricultural and rural areas in Hanoi is more developed than other provinces in Vietnam, it was still inferior. We should increase investment on roads, irrigation and electricity systems. It is suitable to attract private sectors to bid and build infrastructure. Strong inspection mechanisms and financial sanctions to ensure unpolluted water and well-organized treatment of wastewater need to be implemented. The state budget should mobilize investment for canals, dikes system and regular dredging.

CONCLUSION

T.H.Hung et al (2006) showed that the investment capital can contribute transformation for structure of rural and agricultural economy, product diversification, improving value of agricultural products and technology as well as job creation and changing socio-economic status in rural areas.

Investment in agriculture in general, and in Hanoi in particular can generate benefits in terms of both financial and socio-economic aspects. Even if Hanoi has gained many achievements in the development process and attracted many investment projects in recent years, the investment capital in agriculture in comparison with total GDP is still very low, and its growth rate is unstable. Our research results show that effectiveness and efficiency of agricultural business units is not low. Most interviewed investors said that their financial profit is not so high but it is stable and they do not need a big amount of capital. The main constraint for investment in agriculture in Hanoi are the eight components generating the investment climate: ability and behavior of local government administration, Hanoi's agricultural policies, local public infrastructure, markets for agricultural products, science and technology, land, finance and labor force. Of these, land access, ability and

behavior of local government administration and province's agriculture are main constraints for the investment climate in agriculture.

In order to develop the agricultural sector, make the best use of internal elements and to take the advantages of location, Hanoi should improve policies of land and capital; innovate local administrative procedures; strengthen incentives and support for investors in agricultural sector; improve rural infrastructure and apply science and technology.

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STATUS AND STRATEGIC DIRECTIONS OF THE LAMBANOG WINE PROCESSING INDUSTRY IN LILIW, LAGUNA, PHILIPPINES

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ABSTRACT

The status of the lambanog processing industry in the Municipality of Liliw, Laguna was examined to cover an analysis of the structure and competitive forces affecting the industry, the problems besetting the industry, and identified strategic directions to attain growth and competitiveness. Descriptive analysis was used to present and analyze the current situation and business performance of the lambanog enterprises. Both the lambanog processors and distributors were used as respondents. The study shows that all of the firms are family-owned and operated and are categorized under micro-scale enterprises. Production capacity ranges from eleven to thirty-six gallons per week. Seventy percent of their produce goes to different barangays within the town while the rest are distributed in nearby towns in Laguna and Rizal provinces. Operating profit showed an average of thirty-two percent. Porter's five forces of competition revealed that entry and exit barriers as well as bargaining power of buyers are high, suppliers have low bargaining power, threat of substitution is high, and competition is rather low. In order to remain competitive, the lambanog wine processors should consider the following strategic directions: cost focus, market niching, market and product development, and strategic alliances among government and other private institutions.

Key words: beverage, strategy, competitors, coconut vodka, industry analysis

INTRODUCTION

Lambanog wine, also called coconut vodka, is an alcoholic beverage produced in the Philippines. It is a very popular alcoholic drink among men and women in the rural areas of the Southern Tagalog provinces, where it is widely produced. It is widely enjoyed by the locals and festive occasions are almost incomplete without it (www.sanpablounlimited.com). It is free from artificial chemicals because it is made purely from coconut sap. Lambanog processing starts with the pruning of the coconut flowers to let the sap drip from the blossoms. The sap is then collected and cooked using the fermentation process, producing coconut "tuba". The tuba is distilled, cooled, and filtered to produce the coconut wine. It may be added with fruit flavors such as berries, raisins, calamansi, mango, and even gum flavor to offer a variety of taste.

Lambanog wine is produced in the Southern Tagalog region particularly in the provinces of Quezon, Laguna, and Batangas. The Quezon province produces most of the lambanog wine because of abundance in coconut plantations in the area. In the province of Laguna, the Municipality of Liliw located in the eastern part, is considered as the major lambanog producer and distributor. Lambanog wine production has been in existence in Liliw since the time of the Spanish colonization. Processors take advantage of the abundance of coconut trees in the area. Lambanog wine production gives employment to many residents in Liliw. The market consists of townsfolk as well as nearby towns.

However, the industry has experienced setbacks a few years ago due to infestation of coconuts, shortage of raw materials, and competition from other substitute products (e.g. beer, gin, vodka). Still, the lambanog wine supply is not sufficient to meet its demand. The most pressing problem is the lack of consistent supply of tuba due to unfavorable weather conditions (Donato, 1989). Other common problems include loss of workers resulting to injuries, poor technology, lack of government support, high cost of maintaining karitan, high cost of acquiring production equipment, and stiff competition from the big distilleries of alcoholic beverages. Currently, the industry is being revived but it needs to determine its current status, the problems besetting the industry, and what directions should it take to become more competitive.

The study aims to present the situation of the lambanog wine processing industry in Liliw, Laguna, the problems experienced by the industry, and to determine the strategic directions for the industry. This includes identifying the profile of lambanog wine processors, the structure and competitive forces affecting the performance of the industry, and the investment opportunities and entry points in the lambanog wine processing business. The study could help both the local government and private sector to determine what they can do to develop and sustain the industry in the area.

METHODOLOGY AND ANALYTICAL FRAMEWORK

Descriptive analysis was used in the conduct of the study. This type of research was used to present the current situation and business performance of the lambanog enterprises in the area. The status, problems, and strategic directions of the players as well as the environmental forces affecting the whole industry were illustrated using the same design.

The lambanog wine processors and distributors in Liliw, Laguna were the respondents for this study. The scope of the interview covered production, personnel, marketing and financial aspect. Referral approach was used to locate the lambanog wine processors since there is no list of distillers in the area. A respondent was asked to identify other respondents who, in turn, would identify another until all the needed respondents were located; though, not all processors identified were interviewed due to their distant location. Questionnaires were used to acquire basic information from the producers such as status, problems, and prospects of the enterprises. Observation in the distilleries and farms visited was also done. Interviews with the key informants in government agencies and institutions that are linked to the lambanog industry were also done. Other primary data such as industry figures, government programs and policies, and pertinent statistics from government agencies and institutions relating to lambanog industry were also gathered. Frequency analysis and use of descriptive statistical tools like mean, minimum, maximum and standard deviation were used to analyze the data.

Porter's Five Forces Model of Competition was used to evaluate the competitive status and conduct of the firms. Firms were grouped strategically and compared based on their business structure, assets and practices. The rivalry among competing firms was assessed while other competitive forces in the market were considered.

These forces included the following: (1) the rivalry among the existing firms; (2) potential entry of new competitors; (3) competitive pressures from substitute products; (4) supplier bargaining power; and (5) the buyer's bargaining power.

Figure 1 presents Porter's Five Forces of Competition Model.

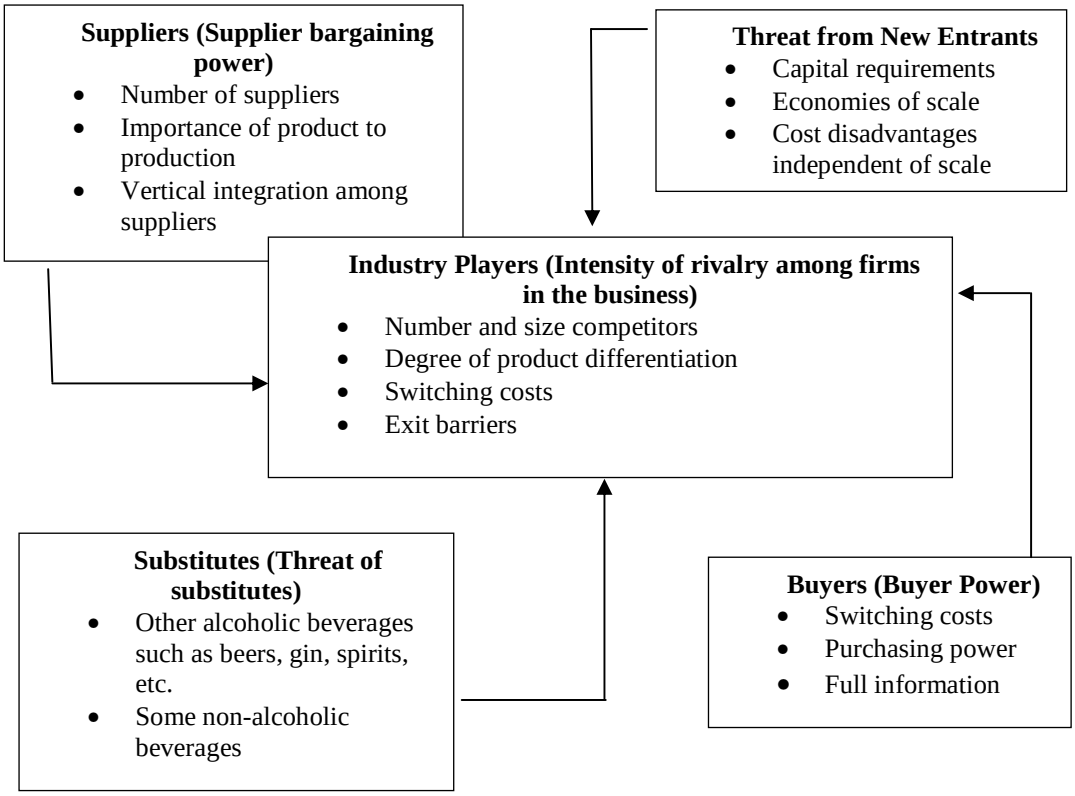

Fig. 1. Porter's Five Forces of Competition Model

In addition, SWOT analysis was done to determine the most appropriate strategies for the lambanog wine processing industry. Those strategies that suit the capability of the firms and the condition of the business environment were considered in order to improve the lambanog processing industry in Liliw, Laguna

RESULTS AND DISCUSSION

Description of the Industry

In the Philippines, Quezon province is the major producer of lambanog wine because of the abundance of coconut plantations in the area. According to Villaflor (2005), there are 14 registered lambanog wine processors based on a list provided by the Department of Trade and Industry (DTI). Most of them are cottage small scale enterprises with 4 to 25 employees. Some of the distillers get their supply of raw materials from their own coconut farms while others rent out. The production capacity of these distilleries ranged from 25 gallons to as much as 350 gallons of lambanog weekly. The three main distilleries in the country are also located in the Quezon province - the Mallari Distillery, the Buncayo Distillery, and the Capistrano Distillery (Vito, 2004).

While Quezon remains the leading distiller, lambanog production has been existing in Liliw, Laguna as early as the Spanish colonization. Processors are located in farms which are relatively far from town proper. Their products are sold in the locality and also transported in other places using working animals like horses, in most cases. Production has been hampered by coconut infestation in

year 2002. However, it is slowly recovering as new players started to venture in lambanog wine production. Some of the processors have acquired bigger facilities and replaced old equipments to increase the level of production while others have started producing flavored lambanog and sell to places outside of the town.

Currently, the level of production in Liliw, Laguna is not sufficient to meet its demand. Based on interviewed firms, they were not able to produce optimal amount of lambanog due to lack of supply especially during the rainy season. Not all the coconut trees are tapped because some of them are fruit bearing trees and not suited for lambanog production. Some of the coconut farm owners sell their produce to copra makers and retailers of coconut juice and meat.

Profile of Industry Players

The study covered seven lambanog processors in Liliw. All of them are categorized under micro-scale enterprises with four employees or less. Three processors are operating in Brgy. Ibabang Taykin, one each in Brgy. Bungkol, Brgy. Palayan, Brgy. Baanan, and Brgy. Palina. Five (71%) distillers have been operating their business for over 23 years while the remaining two (29%) have existed for six years and below. Distillery operators age 40 years old and above and are all married. All firms are family-operated businesses. Four of the seven entrepreneurs are under sole proprietorship while the rest are under partnership. In the partnership set-up, the capitalist partner finances all the expenses in the farm and distillery while the industrial partner operates the entire business.

Table 1 summarizes the profile of lambanog processors in Liliw, Laguna.

Table 1. Profile of lambanog processors in Liliw, Laguna.

Parameter	Mean	Standard Deviation	Minimum	Maximum
Age of entrepreneur (years)	51.57	6.05	40	60
Number of family members	4.85	1.35	3	7
Length of business existence	21.07	12.30	1.5	32
Number of hired workers	2	1.35	1	4

Source: Field interviews (2007)

Aside from lambanog processing, lambanog distribution has also been a source of livelihood for the residents in Liliw. There are about 15 distributors located in the area, including both registered and non-registered enterprises. Seven distributors were interviewed in this study. The interviewed firms have been in the lambanog distribution for at least 12 years except for the two new players. Five (71%) of them are both into wholesaling and retailing while the other two (29%) are into retailing only. All the distributors operate as sole proprietors. Lambanog wine is the major product they sell but they also have other sources of income such as variety stores and piggeries. Some of them are also employed in private and government institutions. Table 2 summarizes some important characteristics of the distributors.

Table 2. Profile of lambanog distributors in Liliw, Laguna.

Parameter	Mean	Standard deviation	Minimum	Maximum
Age of the entrepreneurs (years)	56	13.61	44	78
Length of existence (years)	25	23.45	1	59
Annual income (Php)	62,400	46,517	12,000	120,000
Average weekly sales (gallons)	63	57.28	3	150
Cost of registration (i.e. Mayor's permit/Brgy. permit., in Php/year)	1,800	1,701	200	4,500

Source: Field interviews (2007)

Raw Materials and Production Capacity

The use of coconuts as the basic raw material in lambanog production makes the product unique among alcoholic beverages. Coconut trees that are tapped do not bear nuts. Majority of the processors rent a coconut farm where they get the raw material needed for the production. One owns a plantation while another sourced his raw material from a farm owned by his relative. Most of the farms are situated near the residence of the processor. The distilleries are also found in the farms for easy transport of tuba.

Seventy one percent (71%) of the interviewed firms produced at least 22 gallons of lambanog weekly. The other two produced less than the said amount of lambanog. Based on their average production capacity, firms 6 and 7 (Table 3) produced the highest amount of lambanog weekly. Each of them has a production capacity of 36 gallons a week. The least production of lambanog was only 11 gallons per week. Table 3 shows the available weekly production of all the interviewed lambanog processors in Liliw, Laguna.

Table 3. Production capacity of lambanog processors in Liliw, Laguna.

Variable	Mean	Standard Deviation	Minimum	Maximum
Average frequency of distillation per week	2.14	0.69	1	3
Average volume of lambanog distilled per distillation (in gallons)	12.28	0.75	11	13
Production capacity per week (in gallons)	26.28	8.28	12	36

Source: Field interviews (2007)

Lambanog production exhibited seasonality within a year. The production level varied depending on the type of weather they experienced for a period. The highest production of tuba was during the months of February to May. From August to December the yield is low. In very dry season the production of tuba is also reduced. Some of them get supply of tuba from other farms to

fill the needed amount of tuba in order to make lambanog. During the rainy season, there is no or little tuba produced especially when there is typhoon in the area. The *karitan* assembly used by the tapper in collecting sap and move from one tree to another is damaged during this season. This forces the processors to stop the operation temporarily and resumes when the *karitan* is fixed. Rebuilding the *karitan* costs a farmer an average of five thousand pesos. Aside from the climate, labor was also affecting the volume of their production. If one of their workers failed to come and perform his job, the operation was impeded and would resume only after the owner has found somebody who will replace the absent worker. The condition of equipment used in processing lambanog also affected the volume of production. However, market demand did not influence the level of production of a firm. If the processor received a large order of lambanog but the supply was not enough, they would source lambanog wine from other processor to fill the order. This typically happens during holidays and festivals when the demand for lambanog is high.

Market

Direct selling is the most common way to distribute the product. The processors use their own residences as the main point of distribution. Buyers go directly to their houses to purchase lambanog wine. Some have signage in front of their houses to attract more customers. Their products are distributed through different channels such as wholesalers, retailers, local consumers, and consumers from other towns and provinces. Approximately 70% of the firms' products are sold within their respective barangays and within the town. The remaining thirty percent are sold in nearby areas which include Rizal, Nagcarlan, Majayjay, Sta.Cruz, Pila, Calamba, and San Pablo City in Laguna, and Antipolo and Tanay in Rizal Province. Lambanog wine produced in Liliw has also reached Metro Manila. Four of the seven firms sell their products on cash basis. The other three processors are accepting 50% down payment or full credit which has to be paid one to two days after purchasing the product. An estimate of 70% of total sales is paid in cash while remaining 30% is through credit. According to the firms, there are no plans to introduce the products to other places because they are satisfied with their present markets. In some instances, they had to buy lambanog wine from other distilleries because they are not able to fill the customer's order due to limited capacity. Some of them had transported their products to other provinces but they had to stop because of high costs and difficulty in collecting receivables.

All firms produce pure lambanog wine, however, two of them make flavored ones. Some of the flavored variants include coffee flavored wine, tea flavored wine, lambanog soaked with apple peeling, and prune-soaked lambanog. Flavored lambanog is made by request. Firms do not use any brand name for their products. The same sizes are sold by the processors. All the packaging materials used are provided by the customers. Purchased lambanog wine is transferred in the containers brought by the buyers. Some firms lend their regular customers with containers especially if they purchase in large quantities. One container or stauffer holds about six gallons of lambanog. The packaging material used is a big plastic container called the stauffer. One gallon and one half gallon lambanog use smaller plastic containers with handle. Some firms used glass containers.

The price for one stauffer of pure lambanog ranges from Php780- Php900 while the price for one gallon lambanog ranges from Php130 to Php150. Retail prices are as follows: twelve ounces of lambanog is sold at the range of Php12- Php17. Flavored lambanog costs higher than pure lambanog. It is sold for Php190- Php200 per gallon of any flavor.

Financial Outlay

Personal savings was the major source of capital among the lambanog wine processors in Liliw, Laguna. All firms did not rely on financing from financial institutions such as banks. Most of the capital was invested on equipment and construction of distillery. All processors used copper

boiler, metal coil, and condenser for processing lambanog wine; however, one uses alcohol meter to measure the alcohol contents of their products. Most of the expenses on the facilities of some firms were shared by the household's facilities since the distilleries were located near their residences. Majority (71%) of the firms do not use electricity since they operate during daytime. Materials used in the farms were bamboos, rope and wire. Seventy one percent spend their personal savings on maintaining coconut farms while the other two firms were funded by their partners. Five (71%) out of the seven firms do not use any vehicle to deliver their products. Instead, they bring the processed lambanog wine in their houses for distribution.

The estimated income statements of the seven lambanog processors were summarized in Table 4. Given a total production capacity of 8,400 gallons during the year, firms were able to generate total annual sales of Php1,182,240. The firm with the largest capacity (1,920 gallons) has the largest operating profit of Php100,725, which indicates that the firm earned more through the full utilization of its production capacity. Operating margin of each firm ranges from Php24,000 to Php 100,000. Operating profit margin averaged at 32% with 20.6% as the lowest profit margin and 42.95 %.as the highest. This could be attributed to lower cost of production such as labor costs and farm expenses thus increasing the profit margin.

Table 4. Financial performance of lambanog processors in Liliw, Laguna

Firm	Capacity (gallons/year)	Sales (php)	Operating profit (php)	Operating profit margin (%)
1	1,248	187,200	52,200	27.88
2	576	80,640	24,000	29.76
3	624	81,120	33,000	40.68
4	1,056	147,840	63,500	42.95
5	1,248	174,720	36,000	20.60
6	1,728	241,920	60,000	24.80
7	1,920	268,800	100,725	40.35
TOTAL*/ Ave**	**8,400***	**1,182,240***	**52,775****	**32****

Source: Field Interviews (2007) * Total (Capacity and Sales) and ** Average (Operating profit and Operating profit margin).

Export Potential of the Lambanog Wine

The Center for International Trade Expositions and Missions (CITEM), the export promotion arm of the Department of Trade and Industry, has identified lambanog wine as a potential export product under the Brand Development Program. The program aims to standardize the lambanog wine processing, provide alternative applications of lambanog to processors, and trademark it to make it more competitive in the global market. It was launched on the export market in 2001. CITEM has in fact helped three major distilleries in Quezon province by giving technical and marketing assistance. These distilleries have already begun to release flavored lambanog wine to increase its appeal on younger consumers. The Mallari Distillery, one of the three major producers in the country, has been the most active in promoting the product thru trade fairs. The tourism industry

also plays a role in the exposure of the lambanog wine to foreigners who visit the country. Lambanog wine exports go to Japan, Taiwan and Algeria (Porter 2005). In 2001 the total value of exports amounted to $2,720; in 2002, $1,764; and in 2003, $31,739. While the data showed that exports have increased, trade data tracking is very limited and the list is still too small to be reflected in most export/import statistics. However, if the demand for lambanog wine continues to grow, there is a good opportunity for the lambanog wine processors in Liliw, Laguna to tap the export market.

Global Outlook for the Wine Processing Industry

Wine industry has seen an increasing in terms of wine production. According to a market research report published by Synergyst, the worldwide wine industry has become increasingly internationalized and sophisticated. The market has become fragmented, international, and information-intensive. Global wine production increased to about 25,066 million liters. Red wine is still the leader in the world wine market with sales rising to 12% between 1998 and 2003. France and Italy are considered as the leading wine producers with 25% market share. Global consumption on the other hand has become more diverse and fragmented. In recent years, Europe has experienced a considerable decline in market share. UK accounted for 8.9% of the share in wine consumption in 2003 , France with 11%. The United States accounted for about 19.4%. China, in particular has entered a high-speed growth rate in wine production. In 2008, Chinese wine production amounted to 698,000 kiloliters, a 5% increase from the previous year. It also enjoys the highest wine consumption growth rate in the world. In India, the wine industry is also growing rapidly as more and more Indians are adopting a new lifestyle with a growing trend for drinking wine. India has currently about 60 wineries with an estimated investment of about $60 million. In Australia, wine production was 1,171 million liters and the total wine companies have increased to 2,420 in 2009. With the increasing trend in global wine production and consumption, there is an opportunity for the Philippines to become an international player in the wine industry given a good market positioning strategy.

Analysis of the Lambanog Wine Processing Industry

Industry Structure and Competitive Forces

The lambanog wine processors in Liliw, Laguna compete both in the local and national arena with its rivals in the liquor industry. Locally, they compete with the neighboring towns of Nagcarlan and Magdalena in Laguna which also produce lambanog wine. Other competitors are those in the Quezon province where there are big lambanog distilleries. On the national level, lambanog wine competes with other liquors such as brandy, whisky, gin, and rum, which are readily available in retail stores.

The product produced by the players is weakly differentiated since all of them offer pure lambanog wine in the same packaging and sizes. The only difference is in the alcohol content. Price is based on firm's personal decision with consideration on the competitors' price. The market is composed of the distributors, retailers and direct consumers. The products are usually distributed in the neighboring towns in Laguna and some parts in Quezon. The industry structure is analyzed using Porter's five forces of competition.

Entry and Exit Barriers

The industry has moderate to relatively high capital requirement starting at Php170,000. This includes farm rent and maintenance, and the raw materials and equipment for distillery. The wine processing itself requires special skill because the procedure is very critical to produce quality lambanog wine. The raw material, that is the coconut, requires a large outlay of capital as either the processor would rent or own coconut plantation where coconut can be obtained directly. These

factors make barriers to enter the lambanog wine processing business high. Barriers to exit are also relatively high due to specialized equipment for distillery. This can only be sold to another industry participant since there is no alternative use of the equipment.

Key Buyers

Buyers have relatively low switching cost. Distributors could easily shift to other processors in the area and even in neighboring towns that produce lambanog wine. If a supplier cannot fill the orders, distributors could easily find another supplier in the area. Consumers also can shift from one supplier to another. These make it difficult for processors to increase the price of lambanog wine which affects the profitability of the business.

Key Suppliers

Since majority of the processors do not own their own coconut plantation, raw material is sourced by renting coconut farms. Rental fees depend on the total number of coconut trees planted, both tapped and untapped trees. Rental fees are relatively low ranging from Php1,500 to Php9,000. Farm rent seldom increases though efficiency of the farm depends on the amount of sap collected from the trees. Equipment and other tools used in distillation are relatively easy to source so this does not pose much problem to the processors. Thus, the bargaining power of suppliers is low.

Competitors and their Strategies

There is no direct competition among the processors in Liliw because each has relatively its own set of valued customers from neighboring towns and in the locality. On some occasions, these processors source their lambanog wine from other processors when demand for the product is high.

The main competitors come from the provinces of Batangas and Quezon, and some distillers from the nearby towns of Magdalena and Nagcarlan. Those coming from other provinces are sold at a much cheaper price than the wine produced in Liliw. Since there is no product differentiation in terms of quality and packaging, price is often the only factor that causes rivalry in the area.

Substitutes

The threat of substitution is relatively high because of other alternative alcoholic beverages available in almost all retail stores. Substitute products include beer, gin, brandy, vodka, and whisky. These products come in different sizes and varieties, and prices are either cheaper or at par with the average price of lambanog wine. Price and availability are considered as the main drivers for substitution.

Problems of the Industry

Problems encountered by the lambanog wine processors revolve around the functional areas, namely: marketing, production, finance and personnel. Competition between substitutes such as those commercially available alcoholic beverages is the only marketing problem identified by three (43%) firms. They do not see each other as competitors because demand for lambanog wine is more than they can supply. In production, the lack of supply of tuba during rainy season has been the major problem of all the processors. When it rains, water mixes with toddy which results to lower tuba production. The quality of tuba is also affected when it is mixed with water and therefore the quality of lambanog wine also suffers. Two processors (29%) mentioned defective equipment as another problem. In the financial aspect, lack of capital (29%) and collection of credit (14%) were specified. Majority (57%) of the processors identified absenteeism among their regular workers as their

personnel problem. This delays the production and sometimes affects the quality of tuba when coconuts were not tapped for a single day. Two firms (29%) also mentioned workplace injuries as one of their problems. Table 5 summarizes the major problems identified by lambanog processors in Liliw.

Table 5. Major problems of the lambanog processors*

Functional Area and Problems	Number of times cited	% of Total Respondents
Marketing		
Competition between substitutes	3	43
Production		
Lack of raw material supply	7	100
Defective equipment	2	29
Finance		
Lack of capital	2	29
Difficulty in credit collection	1	14
Personnel		
Absenteeism	4	57
Injuries in the workplace	2	29

Source: Field interviews (2007)
*Respondents may have multiple answers

SWOT Analysis

The strengths, weaknesses, opportunities, and threats pertaining to the industry were analyzed and presented using the SWOT Matrix table. The internal environment represents the strengths and weaknesses of the industry in the locality while the external environment identifies the opportunities and threats – the forces that have potential impact to the industry's success.

Strengths

Among the strengths include a relatively high quality of wine in terms of alcohol content, long and solid experience in lambanog wine processing, skilled labor in terms of tuba collection and distillation process, a low bargaining power of suppliers in terms of coconut farm which also contributes to the low production costs.

Weaknesses

The industry suffers lack of tuba during rainy season which makes wine production relatively unstable during this period. Other weaknesses that stem from wine operations are the use of traditional distillation process which may affect the overall quality of the wine and absenteeism among workers. There is also a lack of entrepreneurial mindset among the owners of the enterprises, limited marketing and promotional activities, poor credit collection that contributes to the insufficiency of capital to acquire new and better equipment. Buyers have low switching costs as they can easily choose other alcoholic beverages over lambanog wine. The product is also undifferentiated in terms of taste, color, alcohol content, quality, and even packaging. In general, the lambanog wine processing industry lacks direction and needs to have a clear focus on where it is going to make it competitive.

Opportunities

Prospects for the lambanog wine industry is good as it has been identified by CITEM as an export potential and it enjoys support from the government. There is also a trend towards organically processed foods and beverages as more people have become health as well as environment conscious. There is also an unmet demand in nearby towns and provinces.

Threats

As alcoholic beverage is considered a luxury, a slowdown in economy affects the lambanog wine industry. In addition, competition from other wine and alcohol products is relatively high and buyers can easily switch from one product to another.

Table 6. SWOT Matrix for the Liliw Lambanog Wine Processing Industry

External Environment / Internal Environment	OPPORTUNITIES 1) Unmet demand within the locality and nearby towns and provinces 2) Trend towards organically processed foods and beverages 3) Identified by CITEM as an export potential product /availability of government support	THREATS 1) Competition from substitutes (e.g. other alcoholic beverages) is relatively high 2) Economic slowdown
STRENGTHS 1) Relatively high quality of wine in terms of alcohol content 2) Low production costs 3) Relatively experienced in lambanog wine processing 4) Low bargaining power of suppliers in terms of coconut farms 5) Skilled labor (in terms of collecting tuba and distillation)	<u>S-O Strategies</u> Market niching (e.g. OTOP) Cost Focus (low price relative to Quezon lambanog) Product Development (expand product lines such as adding flavored lambanog products)	<u>S-T Strategies</u> Cost Focus (low price relative to Quezon Lambanog) Market penetration (low price combined with extensive distribution)
WEAKNESSES 1) Lack of supply of tuba during rainy season 2) Undifferentiated product 3) Insufficient capital for equipment acquisition 4) Traditional/crude distillation process 5) Poor credit collection 6) Lack of direction for the industry as a whole 7) Absenteeism among workers/lack of incentives 8) Limited promotional and marketing activities 9) Lack of entrepreneurial mindset 10) Low switching costs among buyers	<u>W-O Strategies</u> Establish sourcing/supply chain alliances (supply agreement between coconut farms and lambanog processors) Establish strategic alliances (e.g. industry associations, entrepreneurship training, marketing alliances, technology support services, joint ventures)	<u>W-T Strategies</u> Establish strategic alliances (e.g. industry associations, entrepreneurship training, marketing alliances, technology support services, joint ventures)

STRATEGIC DIRECTIONS FOR THE LAMBANOG WINE PROCESSING INDUSTRY

Based on the analysis above, the wine processing industry in Liliw, Laguna should consider the following strategies in order to remain competitive and sustain its growth:

Market niching

This strategy will prove to be beneficial to the industry by establishing a common brand (e.g. "Liliw Lambanog") for all the industry players. They could apply for the One Town One Product (OTOP) Program of the Department of Trade and Industry (DTI). This will distinguish their product from other lambanog wines available in nearby towns as well as gain a competitive position vis-à-vis the Quezon lambanog.

Cost Focus

Since there is little product differentiation and the scope of business activity is relatively narrow, the industry would benefit from the cost focus strategy by pursuing a lower-cost advantage in its current market segment. As with market niching strategy, they could establish a common brand that their customers could identify as low cost but with almost the same quality as compared to Quezon lambanog.

Product Development

The processors may also look into the development of flavored lambanog wines to increase its share in the existing markets. However, along with this strategy, they may need to develop new competencies such as enhance their technical and entrepreneurial skills, improve their business processes, and possibly acquire new tools and equipment.

Market Penetration

This can be achieved through a combination of competitive pricing and extensive distribution strategies. They could use the low-cost advantage and direct selling approaches to secure dominance in the existing markets. Increase in usage by existing customers may also be done through loyalty schemes such as giving discounts to bulk orders, free lambanog wine or free delivery for orders up to a certain quantity, or even giving free "pulutan" or finger food during fiesta or special occasions.

Strategic alliances

The Lambanog processors in Liliw, Laguna may take advantage of economies of scale through alliances. They may form an association that would provide its members joint benefits such as financial assistance through loans, training and seminars for effective management of their businesses, and marketing assistance. This will also facilitate a more efficient operation thorough sharing of resources. Pooled resources can be used to finance large investments such as facilities upgrade and coconut plantation expansion. Entering and executing contract agreements on supply and distribution are easier since the collective production of processors will allow bigger volume. Lambanog processing is a value adding activity for coconut farmers; hence, they may be encouraged to venture into wine processing or at least supply processors with good quality sap. A mutually beneficial agreement between coconut farmers and lambanog processors may help minimize raw materials shortage.

According to one of the interviewed distributor, there was a proposal to make a cooperative of the lambanog wine processors in Liliw. But it was not implemented because most of the processors were not willing to join the cooperative. In order to encourage the processors, they must be properly informed about the benefits they can derive from joining a cooperative or association. Example of which are loan programs provided for the members of the association. In times of typhoons when the *karitan* assembly is damaged, the owners of distilleries may apply for a loan to be spent in repairing the assembly. In times of low production or sales, the organization may offer alternative sources of income. The association may also help the processors gain new markets by joining national or international trade fairs or exhibits. The assistance of the local government is also vital. The local government can provide linkages through various government agencies as well as non-government organizations (NGOs) in providing financial, technical, and marketing assistance. The processors should register the cooperative in order to avail privileges. Example of which are lower prices for inputs needed in the farm (e.g. fertilizers, pesticides, and other materials used in the *karitan*) through government assistance like in the case of Quezon (i.e. technical and marketing assistance under BDP). Producers must also register their businesses with the local government or BIR not only to conform to their responsibility as entrepreneurs but also to gain assistance and information about the business and the industry as a whole.

CONCLUSIONS AND POLICY IMPLICATIONS

Lambanog wine processing in Liliw, Laguna has long been established as an industry in the locality. It remains to be a primary source of income of residents. The product capitalizes on its indigenous raw material to remain novel and appealing. Though market prospects are good, production capacity is constrained by limited and unstable supply of raw materials. The produced lambanog wine has little differentiation among the processors both in terms of flavor and size. Majority of the produce were absorbed by the distributors within the town itself and the rest were sold in nearby towns. Based on Porter's analysis, entry and exit barriers are high, key buyers have low switching costs, bargaining power of suppliers is low, threat of substitution is high, and competition is considered to be relatively low with price as the main factor that cause such.

Policy initiatives should be geared towards providing assistance to the lambanog wine processors to be more competitive and sustain the industry's growth. Areas that need to be addressed include enhancing technical and entrepreneurial skills, improvement of the business process, access to financing, and acquisition of new tools and equipment. On the part of the wine processors, they should form strategic alliances with their suppliers to ensure continuous supply of raw materials and other inputs as well as with their distributors for a sure and stable market. The local government should take the initiative of establishing a common brand for the lambanog wine through the assistance of the Department of Trade and Industry under the One Town One Product (OTOP) Program. This will strengthen the current market and possibly develop new ones. It could also forge linkages with other government agencies and non-government organizations that can provide the technical, market, and financial assistance. On the national level, coconut is a high-valued commodity by the government and value-adding activities through the production of coconut-based products such as lambanog wine is one way to enhance the usefulness and value of coconut. The government therefore has to prioritize which coconut-based products it should support to maximize the impact of its limited budget.

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FOOD CONSUMPTION PATTERNS AND HOUSEHOLD FOOD SECURITY IN CALABARZON

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ABSTRACT

A study was conducted to determine the household food security in CALABARZON using calorie intakes of the selected households. Secondary data 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 covering 251 households in CALABARZON were subjected to descriptive (using simple frequencies, percentages, mean and totals and pie and bar charts) and multiple regression analyses as well as Chi-square tests.

The average annual per capita income in CALABARZON was estimated at PhP36,212 while the average food expenditure was PhP37.9 per person per day. The average food consumption was 923 grams per person per day and 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 kcals but the poor had an average of 1,572 and the non-poor households had 1,953 kcals per day. It was further revealed that 60% of the households in CALABARZON were food insecure. Of the poor households, 74% were food insecure while for the non-poor families only 57% were food insecure.

Key words: calorie intake, nutritional status, poverty incidence

INTRODUCTION

The Food and Agriculture Organization (FAO) defines food security as existing when *"all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."* Similarly, the United States Department of Agriculture (USDA) holds that *"food security for a household means access by all members at all times to enough food for an active, healthy life."* The World Bank has a more encompassing and simplified definition, *"the availability of food and affordability of food to all the citizens in a country, with the essential elements being the availability of food and the affordability to acquire it."* Studies operationalizing this definition have already been conducted. Melgar-Quinonez et. al. (2006) examined the relationship between household food insecurity and food expenditure using sample households taken from rural areas with small central urban district from Bolivia, Burkina Faso and the Philippines. Households which are food insecure, even at moderate levels, might have a very poor dietary quality (low intake of micro-nutrient-rich foods) and that severely food-insecure households might have limited access even to staple foods. Further, in Bolivia, the high price of imported fruits resulted in lower dietary variety among the households. The group concluded that there is significant negative correlation between household food insecurity and food intake, with food intake being considered as a function of affordability. In like manner, Ibrahim et al (2009) assessed the state of food security among urban households in the Federal Capital Territory of Nigeria using 120 randomly chosen respondents. Food insecurity is not only prevalent in the rural areas but in urban areas as well.

Policies that can lead to increased farm income should be prioritized by the Nigerian government since the high income level of the urban households was found to be the major contributor to their high food security status.

Considering the above, an individual's concern for food security is anchored on his/her ability to acquire or access food, be it free or at a given cost. However, from the point of view of nutrition, accessibility/availability and affordability need not be the only concern but should also cover food quality. Food availability is a major function of the producers and the distribution channel, accessibility and affordability are a function of the buying power of the consumers. The level of poverty or income of the consuming public therefore, plays a major role in ensuring food security of a population (Briones et al 1999). Buying power also affects the quality of food bought by consumers with the premise that the poor households or individuals can only afford low quality or less nutritious foods. This is the very reason why when food security is the main concern, the calorie adequacy of households must also be considered. The access to available and nutritious foods, is manifested in the number of people who are able to meet the Recommended Energy and Nutrient Intake (RENI) for Filipinos (FNRI 2005).

Several studies show that income is the determining factor of the nutritional status of the household. Food accessibility depends on the average per capita income such that regions with higher per capita incomes had higher food consumption (Bautista 2005; FNRI 2005). This paper therefore is an effort to determine the association between hunger (or food security) and poverty. The need to conduct the study in CALABARZON is imperative because the area has over one-third of the country's special economic zones and accounts for approximately 12 percent of the Philippine population (BAS 2007) implying that it is a good source of manpower and skills for the country's industrial sector. CALABARZON is composed of five provinces: CAvite, LAguna, BAtangas, Rizal and QueZON and is located southwest of Metro Manila.

Similar to other regions in the Philippines, hunger in CALABARZON is also prevalent. Table 1 reveals that in 1997 up to 2006, the percentage of both families and the total population who are considered poor are getting higher. In 1997, 20.62% of the people in the area were poor and such proportion rose to 22.34% in 2006. More recent estimates at the national level emphasize the unabated growth in the number of people who are getting hungry in many areas in the country.

The region was studied as it is one of the spillover areas of Metro Manila when it comes to population, especially the urban poor, mainly because the two areas are adjacent to each other. It is hoped that through the information on consumption pattern, income distribution and calorie intake of the selected households provided by this paper, more appropriate local policies which can improve the food security situation in the area can be implemented.

Table 1. Family and population poverty incidence (%), CALABARZON, 1997-2003.

Province	1997		2000		2003		2006	
	Family	Population	Family	Population	Family	Population	Family	Population
Cavite	8.0	11.0	10.2	13.0	8.6	12.5	7.8	11.2
Laguna	12.3	14.9	8.1	10.8	8.4	10.6	10.6	13.2
Batangas	22.1	25.6	20.7	25.8	24.5	30.4	25.6	30.7
Rizal	8.3	10.2	5.6	8.1	3.4	4.9	6.4	8.9
Quezon	36.5	41.4	32.9	39.3	32.8	39.8	38.4	47.7
Average	17.44	20.62	15.5	19.4	15.54	19.64	17.76	22.34

Source of basic data: National Statistics Coordination Board

Generally, the study aimed to assess the status of household food security in CALABARZON. Specifically, it sought to: (1) describe the selected households in CALABARZON; (2) determine the food consumption patterns of the selected households; (3) assess the calorie intakes of the selected households; and (4) determine the factors affecting food security in CALABARZON.

METHODOLOGY

The study used primary data generated by the 2003 Family Income and Expenditures Survey (FIES) of the National Statistics Office (NSO) and the 2003 Food Consumption Survey (FCS) of the Food and Nutrition Research Institute (FNRI), Nutrition Assessment and Monitoring Division. At the time of the study, only the 2003 data were available for public access. FIES and FCS respondents were cross-matched and a total of 251 matched households from CALABARZON were considered for the study. The FCS-generated household data included among others: calorie intake, household size, gender, age, educational attainment of the household head and food expenditures. On the other hand, the FIES data include household income, non-food expenditures like electricity, fuel, and water. Other data such as the poverty and food thresholds were gathered from the National Statistical Coordination Board (NSCB), Poverty, Labor, Human Development and Gender Statistics Division.

Of the 251 sample households, 110 were located in partially urban areas while 141 lived in urban areas. Barangays are considered urban if these have at least 1,000 inhabitants with at least six establishments providing either commercial, manufacturing, recreational and/or personal services and with at least three of the following: a town hall, church or chapel with religious service at least once a month; a public plaza, park or cemetery; a market place, or building, where trading activities are carried on at least once a week; and public building like a school, hospital, puericulture and health center or library. While the NSCB classified all poblaciones or central districts and all barrios that do not meet the requirements for urban classification in March 2008 as rural, it gave a classification of partially urban on those municipalities with both urban and rural barangays. From among the provinces in CALABARZON, the following were taken as samples: Rizal (64), Laguna (52), Cavite (47), Batangas (46), and Quezon (42).

Households were further classified into poor and non-poor based on Republic Act 8425 (Social Reform and Poverty Alleviation Act). The poor refers to individuals and families whose income fall below the poverty threshold officially set by the government.

Data were analyzed using simple frequencies, percentages, mean and totals and pie and bar charts. Food security was measured through estimate of calorie adequacy using the following formula:

$$\% \text{ Calorie Adequacy} = \frac{\text{Calorie intake of the household}}{\text{Recommended energy and nutrient intake}} \times 100$$

Both calorie intake of the households and the RENI were measured in kilocalories. RENI, defined as levels of intakes of energy and nutrients that on the basis of current scientific knowledge, are considered adequate for the maintenance of health and well-being of nearly all healthy persons in the population, was obtained from the FNRI and is previously known as "Recommended Dietary Allowances (RDA). Thus, a household with a calorie intake of less than 100% is considered food insecure.

Chi-square tests were performed to determine the dependence of food security on the given variables. Similarly, regression analysis was done to determine the factors affecting food security.

Limitations of the Study

Although the study has been quite comprehensive in terms of covering all the provinces in CALABARZON, it however was limited by the availability of more up-to-date data from the two national agencies of the country mandated to do such a detailed survey. The use of more recent data could have yielded more time-relevant research results and therefore more meaningful issues and recommendations.

While a lot of changes have already occurred between 2003 up to the present, both at the national and the international economic scenes, such changes have been in fact for the worse implying that the results of the study are still very much relevant, although it may have been under-estimated.

The annual per capita poverty threshold in CALABARZON rose from only P13,670 in 2003 to P17,171 in 2006, up by almost 26% within a period of only four years. Similarly, the country's per capita food threshold increased from only P8,339 in 2003 to P10,855 in 2006. This implies that more households could have been more food insecure than what the paper actually reported. If this is the case then the recommendations and policy implications of these results are also still very much relevant and worthy of public dissemination even at the international level.

RESULTS AND DISCUSSION

Household Characteristics

The mean age of the household head-respondents was 47 years with a range of 16 to 90 years. Urban household heads were relatively younger at 46 years old while those in partially urban areas were, on the average, 49 years old. The households were dominated by male (82%) but in terms of formal schooling 41% reached elementary level, 35% high school level and 22% college level. Those engaged in jobs related to industry and services dominated with 36% and 35%, respectively. Those who performed agriculture-related work comprised only 20% further emphasizing the urban and partially urban classification of the areas considered (Table 2).

The average household size was found to be 5 for both the partially urban and urban areas The average monthly income in CALABARZON was PhP36,212 but those in the former have lower average monthly income (PhP28,142) than those in the latter (PhP42,508). Those earning PhP15,000 and below were found to be 18% but those who received more than PhP45,000 accounted for 22%. As a consequence, non-poor households comprised 84% while the poor households were only 16% (Fig. 1).

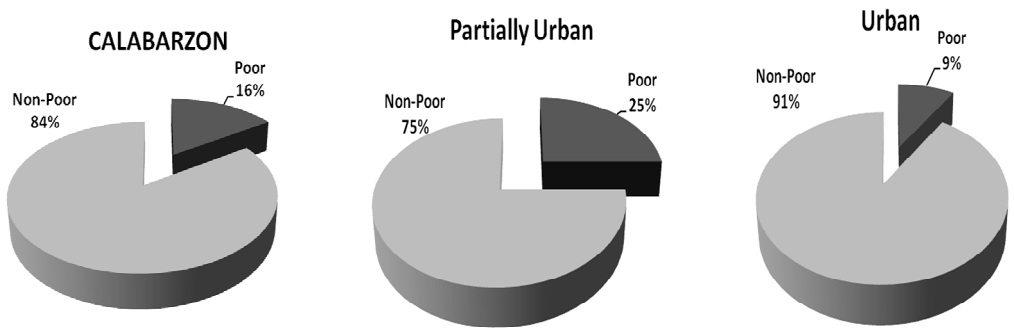

Fig. 1. Proportion of poor households by classification, CALABARZON, 2003

Table 2. Socio-economic characteristics of 251 household heads, CALABARZON, 2003*

Characteristic	Classification				CALABARZON	
	Partially Urban		Urban			
	Number	Percent	Number	Percent	Number	Percent
Age (Years)						
16-30	11	10	20	14	31	12
31-45	37	34	50	35	87	35
46-60	38	35	48	34	86	34
>60	24	22	23	16	47	19
Average	49		46		47	
Gender						
Female	15	14	30	21	45	18
Male	95	86	111	79	206	82
Educational Attainment						
No Schooling	2	2	2	1	4	2
Elementary	54	49	49	35	103	41
High School	43	39	46	33	89	35
College	11	10	44	31	55	22
Occupation						
No Occupation	6	5	16	11	22	9
Agriculture	41	37	8	6	49	20
Industry	41	37	50	35	91	36
Service	22	20	67	48	89	35
Household Size						
≤ 2	19	17	8	6	27	11
3	16	15	29	21	45	18
4	21	19	28	20	49	20
5	14	13	29	21	43	17
6	16	15	24	17	40	16
≥ 7	24	22	23	16	47	19
Average	5		5		5	
Income (PhP)						
≤ 15,000	32	29	13	9	45	18
15,001-30,000	42	38	48	34	90	36
30,001-45,000	20	18	41	29	61	24
≥45,001	16	15	39	28	55	22
Average	28,142		42,508		36,212	
Poverty Status						
Non-Poor	83	75	129	91	212	84
Poor	27	25	12	9	39	16

*Sources of Basic Data: Food and Nutrition Research Institute and National Statistics Office, Philippines

Food Consumption and Expenditure

The daily per capita food consumption in CALABARZON was 923 g with partially urban households having higher consumption rate at 983 g than their urban counterparts with only 876 g. The partially urban households had higher consumption of all food groups except for sugars and syrups, milk and milk products, and dried beans and nuts (Table 3).

Table 3. Mean daily per capita food consumption (in grams) and expenditure (in pesos) by major food groups, CALABARZON, 2003

Major Food Group	Food Consumption			Food Expenditure		
	Partially Urban	Urban	CALA BARZON	Partially Urban	Urban	CALA BARZON
Cereals and cereal products	448	401	421	10.61	11.84	11.30
Starchy roots and tubers	8	8	8	0.27	0.50	0.40
Sugars and syrups	43	76	61	1.27	2.23	1.81
Dried beans, nuts, and seeds	8	9	9	0.28	0.41	0.36
Green leafy vegetables	31	8	18	0.48	0.27	0.36
Fruits	138	112	124	3.37	3.08	3.21
Fish, meat, and poultry	219	199	208	13.81	15.30	14.65
Milk and milk products	9	10	10	1.81	1.85	1.83
Fats and oils	20	16	18	1.04	0.82	0.92
Miscellaneous	59	35	46	3.67	2.65	3.10
ALL GROUPS	983	876	923	36.60	38.96	37.93

Source: Food and Nutrition Research Institute

Furthermore, cereals and cereal products accounted for the largest share among the major food groups with 46%. Fish, meat and poultry products accounted for 23% share while fruit consumption was 13% share. Although miscellaneous consumption was noted to be higher than the more important food groups, it should be emphasized that condiments, vinegar, salt and spices and other items which are commonly used for meal preparations are lumped in this item (Figure 2).

The bulk of cereal consumption was accounted for by rice and since rice is a staple food, its demand has a greater tendency to increase as population continues to rise also. Similarly, demand for rice which is a good source of energy increases as the need for more energy of the working classes in CALABARZON increases. In the same way, the high demand for fish, meat, and poultry products was due to the higher energy requirements as more household members become more active at work. Moreover, there is a point that a person will require so much only of cereals particularly rice, and if that is already satisfied or met, the extra income can be spent for other food items like fish, meat and poultry products. Household preferences tend to favor fish and meat consumption due mainly to their higher calorie and protein contents which are likewise essential for a more energetic and healthful living. It is said that proteins are the building blocks of human growth and development hence the increasing demand for this food group by the working class. This is well supported by the fact the region has high production of meat and poultry products (BAS, 2008).

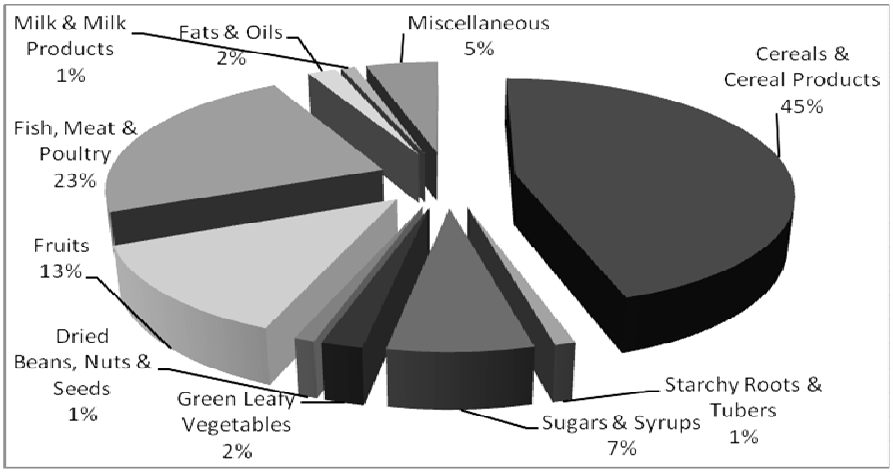

Fig. 2. Percentage share on mean daily per capita food consumption by major food groups, CALABARZON, 2003

On the other hand, the mean one-day per capita food expenditure of a household in CALABARZON amounted to PhP37.9 with the urban households (PhP38.96) having a higher food expenditure than the partially urban households (PhP36.60) (Table 4). As income increased, the per capita food consumption and expenditure also increased for both the partially urban and urban households implying that income is indeed directly proportional to food consumption and expenditure.

Table 4. Mean daily per capita food consumption (in grams) and expenditure (in pesos) by income group, CALABARZON, 2003.

Income Group	Food Consumption			Food Expenditure		
	Partially Urban	Urban	CALA BARZON	Partially Urban	Urban	CALA BARZON
≤ 15,000	755	608	712	25.97	23.27	25.1
15,001 – 30,000	975	765	863	33.93	31.62	32.7
30,001 – 45,000	1135	872	958	38.21	41.89	40.7
› 45,000	1271	1105	1154	62.89	50.14	53.9
ALL GROUPS	983	876	923	36.60	38.96	37.9

Source: Food and Nutrition Research Institute

Figure 3 on the other hand, shows that the share of cereal expenditure (30%) of the households in the region was only second to the expenditures on meat, fish and poultry (39%) and that the share of cereal and cereal products expenditures of the households in the urban area was higher than those in the partially urban areas. The differences in commodity prices might have influenced the food expenditures of the households on the different food items. For instance, the prices per kilogram of fish, meat and poultry products were higher than the price per kilogram of cereals and other food groups, thus the larger share in food expenditure for the former.

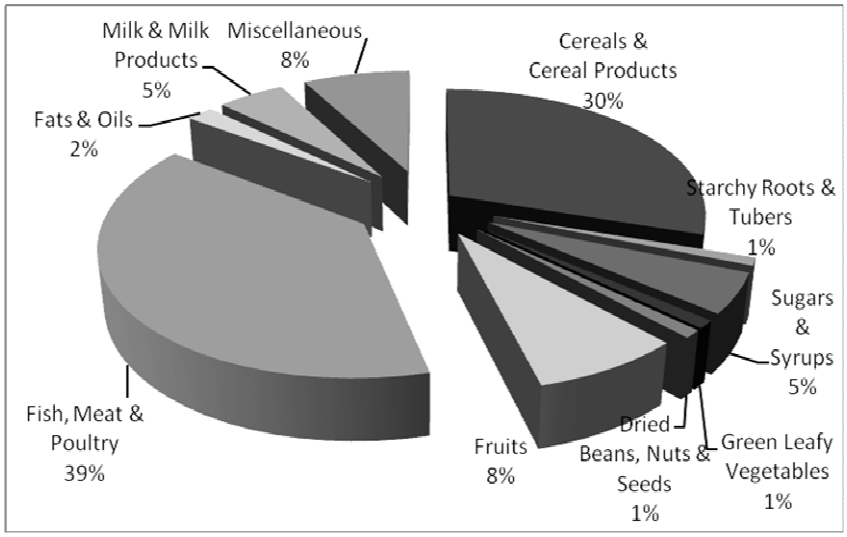

Fig. 3. Percentage share on mean daily per capita food expenditure by major food groups, CALABARZON, 2003

Considering poverty status, the per capita food consumption of non-poor households (962 g) was higher than that of the poor households (710 g) in the whole region and in both the partially urban and the urban areas (Table 5). Also, the non-poor households had a higher consumption of majority of the food groups except for the starchy roots and tubers. In contrast, the share of low calorie foods like cereals to the total food consumption was higher for poor households while the share of high calorie foods like meat and poultry products to the total food consumption was higher for the non-poor households (Figs. 4 and 5). Low calorie foods are generally cheaper than high calorie foods hence the poor households can better afford them.

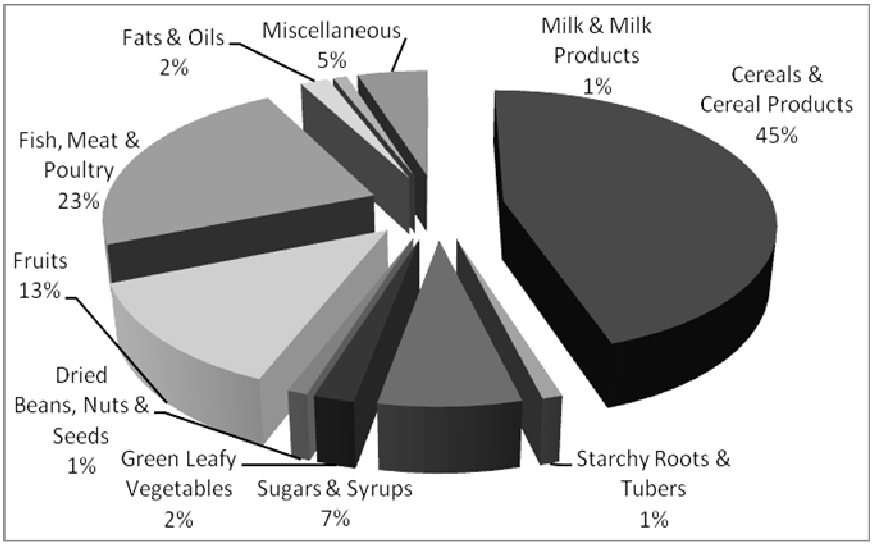

Fig. 4. Percentage share of mean daily per capita food consumption of major food groups, non-poor households, CALABARZON, 2003

Table 5. Per capita food consumption (in grams) of major groups by classification and poverty status, CALABARZON, 2003.

Major Food Group	Partially Urban		Urban		CALABARZON	
	Non-Poor	Poor	Non-Poor	Poor	Non-Poor	Poor
Cereals and cereal Products	459	412	410	305	429	379
Starchy roots and tubers	8	9	8	10	8	9
Sugars and syrups	51	19	79	39	68	25
Dried beans, nuts and seeds	9	9	10	3	10	5
Green leafy vegetables	36	18	8	9	19	16
Fruits	152	97	114	95	129	96
Fish, meat and poultry	244	141	205	136	220	140
Milk and milk Products	11	2	11	3	11	2
Fats and oils	22	14	17	9	19	12
Miscellaneous	69	30	37	17	50	26
ALL GROUPS	1060	747	899	625	962	710

In general, the mean daily per capita food consumption and expenditure in CALABARZON decreases as household size increases (Table 6). This is a result of the decreasing allocation of food for each member as the family size increases given the limited resources a household has. Comparative data however show that the same cannot be generalized for urban households as no general pattern is discernible using the collected data.

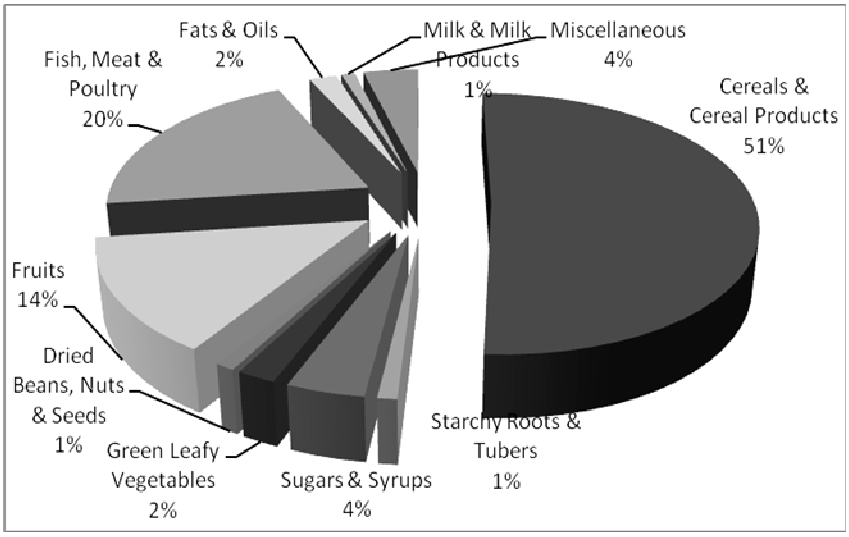

Fig. 5. Percentage share on mean daily per capita food consumption of major food groups, poor households, CALABARZON, 2003

Table 6. Mean daily per capita food consumption (in grams) and expenditure (in pesos) by household size, CALABARZON, 2003.

Household Size	FOOD CONSUMPTION			FOOD EXPENDITURE		
	Partially Urban	Urban	CALA-BARZON	Partially Urban	Urban	CALA-BARZON
≤ 2	1439	954	1295	51	40	48
3	1099	794	903	35	32	33
4	858	1014	947	40	45	43
5	837	847	844	33	38	36
6	914	949	935	31	47	41
≥7	785	744	765	30	33	31
ALL GROUPS	983	876	923	37	39	38

Source: Food and Nutrition Research Institute

Energy Intake and Household Food Security

The average per capita energy intake of a household in CALABARZON was 1,894 kcals while the RENI was 1,938 kcal (Table 7). Although the average daily per capita energy intake of households in the partially urban areas was higher (1,940 kcal) than those in the urban areas (1,858 kcal), the difference was found to be statistically insignificant. In contrast, the per capita energy intake of non-poor households was consistently higher than that of the poor households in both areas and the difference was found to be significant at 1% level of probability. This finding is well supported by the fact that the non-poor households had a higher consumption of high calorie foods (i.e. fish, meat and poultry products) than their poor counterparts (Table 4).

Table 7. Mean daily per capita energy intake (kcals), RENI (kcals), and food insecurity (%) by poverty status, CALABARZON, 2003.

Poverty Status	Partially Urban			Urban			CALABARZON		
	Energy Intake	RENI	Food Insecure	Energy Intake	RENI	Food Insecure	Energy Intake	RENI	Food Insecure
Non-Poor	1905	1937	59	2028	1967	56	1953	1949	57
Poor	1346	1884	67	1672	1875	92	1572	1878	74
AVERAGE	1940	1944	61	1858	1933	59	1894	1938	60

Source: Food and Nutrition Research Institute

In CALABARZON, 6 out of 10 families were found to be food insecure (Fig. 6). Although food insecurity seems higher in partially urban areas (61% as opposed to 59% for urban areas), the difference when tested was found to be statistically insignificant. On the other hand, the relationship between food insecurity and poverty status was found significant at 5% level of probability (Fig. 7). That is, poor households are more food insecure than non-poor households.

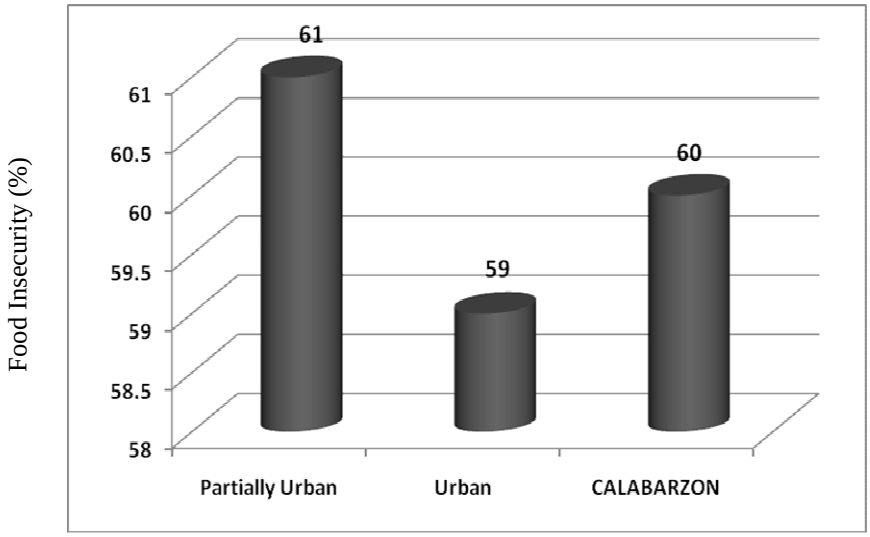

Fig. 6. Proportion of food insecure households by classification, CALABARZON, 2003

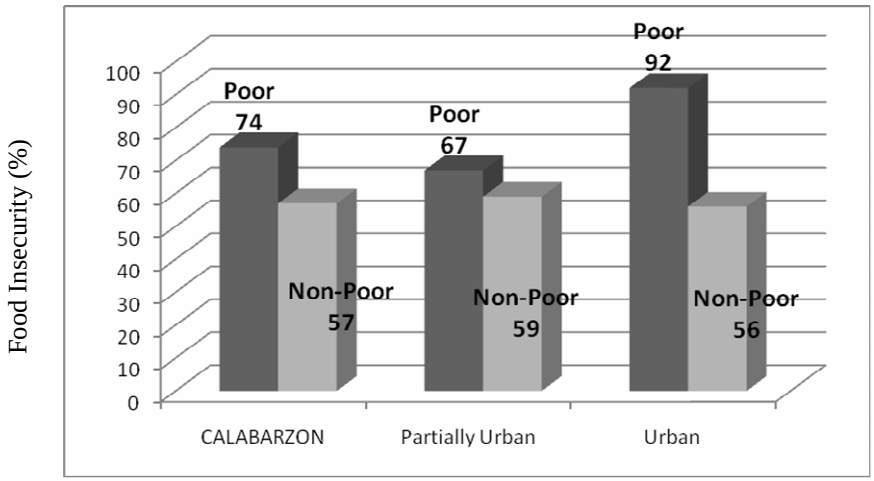

Fig. 7. Proportion of food insecure households by poverty status and classification, CALABARZON, 2003

Factors Affecting Household Food Security

Among the factors looked into, only per capita income was found to significantly affect food security at the household level (Table 8). This is to be expected because most of the food items consumed by the respondents were bought since urban and partially urban areas have less or no soil to plant vegetables and raise animals even for home consumption only. In this case, the buying power which is the per capita income is the main determining factor of how much food can be bought by the consuming household.

Results of the regression analysis revealed that except for fruits, all the major food groups included in the model were significant. Per capita income was confirmed to be a strong determinant along with the dummy for program participation (Table 9). These results are to be expected since the major food groups were almost all necessities. Fruits on the other hand, especially for the poor households can be considered a luxury. Program participation as used in the context of this paper

refers to the participation of household-respondents in government programs related to nutrition education and food production. The results imply that those who were able to participate in such programs had the greater tendency to increase their per capita energy intake.

Table 8. Results of chi-square tests of independence between food security and its determinant variables, CALABARZON, 2003

Variable	X^2 - Stat	Degrees of Freedom
Age of the household head	3.440^{ns}	3
Educational attainment of the household head	1.262^{ns}	3
Per capita income	17.266***	3
Household size	6.363^{ns}	5

Table 9. Regression results for per capita energy intake, CALABARZON, 2003

Variable	Coefficient	T-Ratio
Constant	1.194***	11.634
Per capita income	0.061***	2.876
Cereals and cereal products	0.597***	17.577
Starchy roots and tubers	0.028***	3.270
Sugars and syrups	0.027***	3.381
Fruits	0.006	0.756
Fish, meat and poultry	0.043***	3.600
Milk and milk products	0.020**	2.212
Fats and oils	0.047***	4.833
Miscellaneous	0.033***	3.279
Electricity expenditure	-0.0028	-0.391
Water expenditure	0.002	0.446
Education expenditure	-0.001	-0.342
Transportation expenditure	-0.0001	-0.005
Dummy for own food production	0.008	0.761
Dummy for program participation	0.067***	2.821
Dummy for classification	-0.015	-1.378

*** Significant at 1% level of probability
** Significant at 5% level of probability
* Significant at 10% level of probability

CONCLUSIONS

Income had a positive effect on household food consumption and expenditures, thus, resulting in higher percentage share of low calorie foods like cereal and cereal products to the total food consumption and lower energy intake of the poor households than the non-poor households. On the other hand, the percentage share of high calorie foods like fish, meat and poultry products to the total food consumption by the non-poor households was higher than the poor group.

Finally, the study revealed that 60% of the households in CALABARZON were food insecure and that poor households were more food insecure than the non-poor ones. Government programs related to nutrition education and food production are positive motivators to enhance food security.

POLICY IMPLICATIONS AND RECOMMENDATIONS

The food insecurity is a cause for concern considering that CALABARZON has several industrial and technology parks that employ more skilled and service workers than anywhere else in the country. There is a need for a more institutional approach to the food insecurity problem in the area. More forceful implementation of minimum wage laws among the company-locators is recommended since there are company-locators that are still offering lower than the mandated minimum wage. In addition, company-locators can be given more incentives by the concerned LGUs so that they will be encouraged to provide more non-wage benefits to the workers. Non-wage benefits could ease the burden in the employees' out-of-pocket expenses on other items and therefore leave them more money to buy the necessary food items. According to a key informant who is a manager of the Human Resource Department in one of the company-locators in the area, the workers refuse a raise in their salaries because this would exceed the minimum wage level. Salaries set above the minimum are subject to tax which lowers an employee's take home pay. Non-wage incentives/benefits are therefore preferred. Reduced tax burden for those who will give more non-wage benefits to their employees is only one of the many incentive schemes for the locators.

In order to cope, it is also recommended that the LGUs encourage the households both in the partially urban and in urban areas to find alternative sources of food (Cuevas, 2002). The Food Always in the Home (FAITH) Program of the Laguna Provincial Office is one program that can help ensure the availability of food within a household. FAITH advocates the planting of a variety of vegetables and raising of fowl and fish in the yard for the family's own consumption. Its supposedly self-sustaining way of feeding a family should reduce the food expenses of a household. It was reported by the FAITH monitoring group that a family can save PhP30 to PhP106 a week through the program. Apart from ensuring that the family has something to eat on the table, a more innovative family who is able to produce a surplus from home consumption, even in small amounts, can earn extra income.

Similarly in the urban areas, where soil or space for growing crops is limited, households can still produce crops through the use of Simple Nutrient Addition Program (SNAP) hydroponics (Armada and S&T Media Services, undated). This space saving technology, which is essentially soil-less containerized farming, is a good alternative for urban households with very little or no soil at all for gardening (Alaban 2008; Santos and Ocampo 2005). It can be done in apartments and townhouses where small terraces can be used for growing plants. The Institute of Plant Breeding of the University of the Philippines Los Baños has perfected this technology and is ready to share with interested parties.

Aside from finding alternative sources of food, the role of women not only in helping earn the much-needed money but also in ensuring good nutrition for the family must be given due attention and recognition. Good nutrition can be achieved through correct combination and preparation of cheap but healthy food items. The FNRI through the DSWD and also the LGU can play an important role in this endeavor by teaching the womenfolk how to prepare simple and yet delicious, nutritious and low-cost food for the family.

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EFFECTS OF WOOD VINEGAR AND FERMENTED LIQUID ORGANIC FERTILIZER ON SOYBEAN (SRISAMRONG 1) CULTIVATED UNDER DROUGHT CONDITIONS

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ABSTRACT

The efficiency of wood vinegar added to fermented liquid organic fertilizer to increase yields and reduce pest infestation was evaluated on a new variety of soybean (Srisamrong1) in Tumbol Rong Chang, Amphoe Muang, Phichit province during the drought season (December 2008 to March 2009). The fermented liquid organic fertilizer from herbs and wood vinegar was evaluated in 6 treatments: 1) water as control; 2) wood vinegar; 3) derris + neem seed + turmeric + molasses; 4) turmeric + tobacco + turmeric + molasses; 5) citronella grass + neem seed + turmeric + molasses; 6) citronella grass + tobacco + turmeric + molasses. Beginning at 15 days after planting, the 6 treatments were applied as foliage application at 7 days intervals for a total of 8 applications. The yields had significantly different response to the application of wood vinegar and fermented liquid organic fertilizer. Particularly, Treatment 3 and 5 showed highest and lowest efficiency in average yields with 1300 and 906.25 kg/ha (208 and 145 kg./rai) respectively. There was no significant difference among treatments on yield components such as average height, pod/plant, and 100 seeds weight. However the number of seeds/plant was significantly different in Treatment 6 which showed the highest significant efficacy to increase soil organic matter. Treatment 2 (wood vinegar) showed the highest significant efficacy with insect damage scores of 1.75 compared to an average damage score of 3.29 for the other treatments.

Key words: derris, neem seed, turmeric, molasses, citronella grass, tobacco

INTRODUCTION

Soybean, *Glycine max* (L.) Merrill is one of the most important economic plants in Thailand. The Office of Agricultural Economics, Ministry of Agriculture and Cooperatives (2006) reported that Thailand has an annual soybean production of 0.21 million tons, representing 12 percent of demand. It is well known that soybean exerts unique properties, such as excellent nutrition value, health benefits and the ability to be used in many industrial products. The important problem in soybean cultivation in Thailand is low productivity. One major cause is the outbreak of insect pests which could lead to the more applications of chemical pesticides and result in chemical residues in the environment. Therefore, using fermented liquid organic fertilizer from herbs such as derris, neem turmeric, citronella grass, tobacco and wood vinegar to substitute chemical insecticides is an alternative way of pest control to avoid the use of undesirable chemicals. It is an environmentally friendly method for soybean cultivation.

Liquid organic fertilizer is the product from bio-fermentation of vegetables, fruits, and animal wastes fermented with sugar and useful microbes. These microbes help to break down the nutrients which are valuable in terms of plant nutrients. When the nutrients are metabolized or degraded by bacteria or microorganisms, the substances are liberated, such as proteins, amino acids,

organic acids, accelerating growth hormones, vitamins, enzymes which are useful for highly efficient plant growth (Apai and Thongdeethae, 2001).

Wood vinegar is a mixture of organic compounds which is suitable for the organic farming concept. It is a byproduct from charcoal production, a condensate from the combustion of fresh wood burning in airless condition namely, Iwate kiln. Raw wood vinegar has more than 200 chemicals, such as acetic acid, formaldehyde, ethyl-valerate, methanol and tar compound. It has been used as a traditional remedy by the Japanese for over 400 years (Mu *et al*., 2003). In addition it can be used as prebiotics (Watarai 2005). It was also found to have termicidal activity (Yatagai *et al*., 2002), antifungal property against fungi that cause wood decay such as *Trametes versicolor* and *Tyromyces palustris* (Nakai *et al*., 2005) and anti plant pathogenic microorganisms such as *Phytophthora capsici*, *Fusarium oxysporium*, *Ralstonai solanacearum*, and *Pythium splendens* (Hwang *et al.*, 2005). Moreover, it was also found to have antibacterial properties against dermatitis bacteria (Rakmai *et al.*, 2009). In Thailand, wood vinegar has been used in a variety of processes, such as industrial, livestock, household and agriculture products. Wood vinegar improves soil quality, eliminates pests, and accelerates or inhibits plant growth (Apai and Thongdeethae, 2001).

Therefore, the application of wood vinegar to fermented bio-fertilizer from herbs for soybean production is one organic agriculture method for reducing use of chemical pesticides and fertilizers. This study sought to evaluate the efficiency of the fermented liquid organic fertilizers of varying formulae using herbs and wood vinegar on a new variety of soybean (Srisamrong1).

MATERIALS AND METHODS

The experiments were conducted in farmer' fields in Tumbol Rong Chang, Amphoe Muang, Phichit province during the drought season (December 2008 to March 2009). The data was collected from a harvested area of 1x4 meters in experimental plots (2x5 meters) from a total of 36 plots. Soybeans (Srisamrong1) were planted by sprinkling in rows of 50cm distance. Beginning at 15 days after planting, the 6 treatments of fermented liquid organic fertilizer including water control were applied as foliage application at 7 days intervals for a total of 8 applications (60 days old). The ratio of 5:3:1:5 (kg:kg:kg:ml) was applied on Treatments 3 to 6 and were fermented in wood vinegar, 50 cc/20 liters of water including 12 g of microbial activator (LDD7). All of the treatments were diluted with water in the ratio of 1:200 before spraying.

The experiment was in RCBD (randomized complete block design) with 3 replications and 6 treatments as follows:

1. Water (control)
2. Wood vinegar
3. FLO* formula 1 (derris + neem seed + turmeric +molasses)
4. FLO* formula 2 (turmeric + tobacco + turmeric + molasses)
5. FLO* formula 3 (citronella grass + neem seed + turmeric + molasses)
6. FLO* formula 4 (citronella grass + tobacco + turmeric + molasses)

* FLO= Fermented Liquid Organic Fertilizer

The soil nutrient levels prior to planting and after harvest were analyzed. The yield components of 10 soybean plants, chosen randomly were recorded in terms of height (cm), limb, node length, seed number, pod number, 100 seeds weight (g) and yield (kg/rai). The rating score of insect pest infestation on soybean was measured using the following criteria.

Score 1 = leaves area were infested (damaged leaves) <25%
2 = leaves area were infested (damaged leaves) between 26 to 50%
3 = leaves area were infested (damaged leaves) between 51 to 75%
4 = leaves area were infested (damaged leaves) between 76 -100%

The data was analyzed for ANOVA in Randomized Complete Block Design (RCBD) and by Duncan's multiple range test (DMRT) by Sirichai's statistics program.

RESULTS

Effect of wood vinegar and fermented liquid organic fertilizer treatments

Yields of soybean (Srisamrong1) in response to the application of wood vinegar and fermented liquid organic fertilizer were significantly different (Table 1). Treatment 3 and 5 showed the highest and lowest yields compared to the other treatments with 208 and 145 kg./rai (1300 and 906 kg/hectare), respectively. Although there were no significant effects for all treatments on the yield components (height, and 100 seeds weight and pod/plant), significant differences where noted on the number of seeds/plant. In particular, treatment 6 (formula 4: citronella grass + tobacco + turmeric + molasses) showed the significantly highest number of seeds/plant , 33.60 (Table 2).

Table 1. Effects of wood vinegar and fermented liquid organic fertilizer on average yield (kg/rai) of soybean (Srisamrong1) during the drought season in Phichit (December 2008 -March 2009).

Treatments	Yield (kg/rai)
1. Control (water)	185.33 ± 21.71^{ab}
2. Wood vinegar	174.67 ± 1.85^{ab}
3. FLO formula 1	208.00 ± 2.19^{a}
4 FLO formula 2	193.33 ± 2.87^{ab}
5. FLO formula 3	145.33 ± 2.16^{b}
6. FLO formula 4	176.00 ± 2.33^{ab}
F-test	*
CV (%)	15.65

* = significant difference at level of confidence 95 % by DMRT method (LSD .05 = 51.37)
Mean in a column followed by the same letter are not significantly different at the level by DMRT.

Table 2. Effects of wood vinegar and fermented liquid organic fertilizer on height, node and pod on soybean (Srisamrong1) during the drought season in Phichit (December 2008 -March 2009).

Treatments	Yield components				
	Height (cm)	Node/plant	Pod/plant	No. of seeds/plant	100 seeds weight (g)
1. Control (water)	32.90 ± 1.17	7.13 ± 0.35^{a}	15.47 ± 4.85	27.23 ± 7.50^{ab}	13.77 ± 0.62
2. Wood vinegar	32.83 ± 4.38	6.97 ± 0.15^{a}	14.43 ± 4.33	26.27 ± 9.01^{ab}	14.53 ± 0.56
3. FLO (formula 1)	32.07 ± 1.35	7.06 ± 0.40^{a}	14.40 ± 1.85	28.03 ± 4.20^{ab}	14.29 ± 0.73
4 FLO (formula 2)	31.20 ± 1.01	6.63 ± 0.49^{ab}	14.50 ± 1.83	26.97 ± 1.62^{ab}	14.70 ± 0.67
5. FLO (formula 3)	28.27 ± 2.15	6.37 ± 0.32^{b}	14.50 ± 3.25	23.27 ± 7.75^{b}	13.96 ± 0.37
6. FLO (formula 4)	30.40 ± 2.00	6.90 ± 0.52^{a}	18.97 ± 6.34	33.60 ± 9.85^{a}	14.76 ± 0.35
F-test	ns	*	ns	*	ns
CV (%)	7.48	3.95	18.33	22.14	4.36

ns = non significant difference
* = significant difference at level of confidence 95 % by DMRT method (LSD .05 = 0.49)
Means in a column followed by the same letter are not significantly different at the level by DMRT.

Pest infestation evaluation

The results of the score evaluation rate on disease and insect pest infestations are shown in Table 3. Wood vinegar showed the highest efficiency on insect pest control resulting in a highly significant difference in the insect damage score of 1.75 compared to an average damage score of 3.29 - 4 for the other treatments (Table 3).

Table 3. Insect pest infestation in treated soybean.

Treatments	Scores of insect pest infestation on soybean
1. Control (water)	3.75 [a]
2. Wood vinegar	1.75 [b]
3. FLO (formula1)	3.50 [a]
4 FLO (formula 2)	4.00 [a]
5. FLO (formula 3)	3.50 [a]
6. FLO (formula 4)	3.25 [a]
F-test	*
CV (%)	22.81

* = significant difference at level of confidence 99 % and 95 % by DMRT method
Means in a column followed by the same letter are not significantly different at the level by DMRT.

Soil Analysis

The physical and chemical properties of the soil were determine prior to planting and after harvest in all treatments (Table 4).

Table 4. Nutrient levels in soil before planting and after harvest (December 2008 - March 2009).

Soil Samples	Nutrient content in treated soil samples (ppm)						
	pH	% OM	N	P	K	Ca	Mg
Pre harvest	6.15	1.29	0.24	94.25	132	-	-
Guard row							
In plots	6.33	1.24	0.30	130.15	180	-	-
Post harvest							
Guard row	6.47	1.76	-	156.85	84	5098.4	335.1
In plots							
1. Control (water)	6.46	1.09	-	71.45	186	5098.4	304.3
2. Wood vinegar	6.42	1.55	-	37.4	138	5381	315.9
3. FLO (formula 1)	6.42	1.64	-	49.8	138	5143.9	233.2
4. FLO (formula 2)	6.5	1.69	-	81.78	144	5361	315.9
5. FLO (formula 3)	6.45	1.08	-	18.05	84	5221.2	342.1
6. FLO (formula 4)	6.61	2.24	-	92.48	300	5102	305.1

The soil was clay in the guard row and silty clay in the treated plots. The soils had an average pH of 6.4 which is moderately acidic. The highest organic matter (% OM), 2.24, was found

in the plots sprayed with Treatment 6 (citronella grass + tobacco + turmeric + molasses). Therefore, the highest level of major nutrients (P and K) occurred in Treatment 6 with 92.48 and 300, respectively. The lowest % OM occurred in the plot sprayed with citronella grass + neem seed + turmeric + molasses and control (water). There was no difference among treatments in the minor nutrients (Ca and Mg), but the lowest levels were found in Treatment 3: (derris + neem seed + turmeric + molasses).

Fermented liquid bio-fertilizer analysis

The nutrient values of wood vinegar and FLO= Fermented Liquid Organic Fertilizer treatments are shown in Table 5. The lowest of pH (2.74) and EC (Electrical Conductivity) (17.19) were found in Treatment 2 (wood vinegar). The major nutrients (NPK) and minor nutrients (Ca and Mg) in wood vinegar treatment were very low when compared with all of the other treatments.

Table 5. Nutrient content and chemical properties of wood vinegar and fermented liquid organic fertilizer.

Treatments	Nutrient content (%)						
	pH	EC (ms/cm)	N	P	K	Ca	Mg
1.Wood vinegar	2.74	17.19	0.03	0	0	0	0.003
2.FLO (formula 1)	4.28	26.70	0.14	0.010	0.97	0.25	0.13
3.FLO (formula 2)	4.99	28.30	0.16	0.014	0.75	0.30	0.05
4.FLO (formula 3)	4.20	23.30	0.14	0.089	0.79	0.11	0.09
5.FLO (formula 4)	4.24	25.30	0.16	0.027	0.85	0.14	0.10

Weather data

The weather data throughout the drought season showed that average rainfall between December 2008 and March 2009 was only 2.68 mm. Meantime, the averages of maximum and minimum temperature were in the range of 22.9ºC in January to 29.0ºC in March 2009. The average percent relative humidity was 72.14 % (Table 6).

Table 6. Weather data during the drought season (December 2008 - March 2009).

Weather data	Monthly data (2008-2009)				
	December	January	February	March	Average
Rain (ml.)	0.6	0.0	0.0	10.1	2.68
Temperature (°C)(max.)	29.4	29.7	33.8	36.5	32.35
(min.)	17.3	16.1	21.0	23.4	19.45
Average	23.35	22.9	27.4	29.0	25.66
Relative Humidity (%)	77.35	68.5	69.5	73.22	72.14

cited : Weather station, Phichit

DISCUSSION

Yield response of soybean to wood vinegar and fermented liquid organic fertilizers in different formulations were studied in the drought season at Phichit. Although Treatments 3 and 4

showed highest efficiency soybean yield, the highest efficiency in terms of number of seeds/plant, pods/plant and weight of 100 seeds (g) occurred in Treatment 6 when compared with the other treatments. The organic fertilizer formulation of citronella grass + tobacco + turmeric + molasses (5:3:1:5) showed the highest organic matter (%OM). The formulation seems to be appropriate in increasing soil fertility. Similarly, the result of the rainy season experiment at Phitsanulok indicated that the highest % OM occurred on soils which were treated with the same formation (Pangnakorn *et al*., 2009). However, Treatment 2 (wood vinegar) tended to be the highly efficient as an insect repellent when compared with the other treatments which were fermented from various kinds of herbs. Although in 2004, Chotitayangkul *et al*. reported that application of wood vinegar on soybean (KKU 5E) did not increase significantly the height, dry weight and yield components, they observed high efficiency in germination of soybean seeds treated with wood vinegar in the ratio of 1:300. Similarly, in 2007, Chotitayangkul *et al*. (2007) indicated that application of wood vinegar at the ratio of 1:300 did not significantly increase yield and yield component of peanut but gave the highest pods/plant, yield and shelling percentage of peanut.

In additional, Pangnakorn *et al*., (2007) reported that the application of wood vinegar in 0.1% and 0.2%, had high efficiency for controlling insect pests in Chinese kale. In addition, the application of only extracted substances had lower effect on yield components than mixing with bio-fertilizer and yeast (Mekki and Ahmed, 2005). Moreover, in testing some herb extracts for controlling Kiefer lime leaf miner it was demonstrated that derris gave higher efficiency in controlling leaf miner than the other treatments including ocimum (Uraisakul and Piadang, 2007). However, this study was conducted in experimental plots where soybean had never been planted.

The major insect pests of soybean found in the experimental plots were soybean pod bug (*Riptortus linearis* Fabricius), soybean looper (*Pseudoplusia includens*), and pod sucking bug (*Nezara viridula*). But the white fly (*Bemisia tabaci*) (Gennadius) which is the major problem of soybean variety Srisamrong 1 was not found in this study. It can be presumed that, wood vinegar has the potential to be used as a biopesticide for repelling soybean insect pests. Wood vinegar is a good resource for organic production in agriculture (Mu *et al*.,2003). Therefore, the application of wood vinegar with fermented liquid bio-fertilizer from herbs for soybean cultivation is one organic agriculture method, which can avoid chemical uses of pesticides and fertilizers, leading to safe food production .

CONCLUSION

In general, the addition of fermented liquid bio-fertilizer on crop plant is an effective method for increasing growth and yields of soybean. In particular, wood vinegar showed a potential for high efficiency in repelling insects and showed the highest significant efficacy of reducing pest infestation in soybean as well.

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SOCIAL DYNAMICS OF THE BUTTERFLY INDUSTRY IN MARINDUQUE, PHILIPPINES

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ABSTRACT

This paper argues that the continuing reproduction of butterfly industry in Marinduque is the creation of a multitude of actors who combine or rearrange social relations, material artifacts, natural resources and other living things to constitute or sustain the industry. Using focused group discussions, personal interviews, survey and personal observations in Marinduque, Philippines where the butterfly industry is flourishing, the study found out that the living actors made use of their human, social, natural, financial and physical capital to carry out their various roles within the industry. They innovated and adapted the captive breeding technology for butterfly not only to protect and manage their natural resources but to ensure the sustainability of their butterfly products. They did these through the domestication of butterflies and planting of host plants. They arranged and re-arranged inter-and intrahousehold relations to enable them to combine their capabilities, skills and knowledge in raising, nurturing and trading butterfly products. They put order to this newly created social activity by developing norms founded on social ties and obligations. As a consequence, the industry developed the rules of the game which guided its participants on how to compete and cooperate with each other.

Key words: cooperation, competition, conflict

INTRODUCTION

Economic and environmental crises are among the challenges that the world faces today. People around the world face the complex issues of global warming, climate change, biodiversity loss, poverty, and economic and political downfalls. Thus, everyone is in search of long-term, ecologically- and economically-sound livelihoods and technology-based enterprises to address these challenges. In his article, "Small is Beautiful", Schumacher argues that an appropriate technology is one that is readily understood by the people who are using it, is environmentally non-destructive, incorporates locally-available raw materials, is economically and environmentally-sustainable, and is not dehumanizing or degrading to the people who use it (http://www.butterflyfarm.co.cr/en/why-butterfly-farming.html).

A number of people-oriented and environmentally-sound livelihood enterprises have already proliferated, among which include the butterfly farming industry. Based on reports, (http://www.butterflyfarm.co.cr/en/why-butterfly-farming.html), butterfly farming, when properly

undertaken, could be an alternative and progressive endeavor with respect to impact on the immediate surroundings to which people and other living organisms depend. In contrast to traditional farming methods in tropical countries which require the clear cutting of natural habitats, butterfly farming is dependent upon the native vegetation.

In Papua New Guinea, butterfly farming is proving a business to which villagers quickly adapt. Butterflies do not require the equipment or financing of a conventional farm. Insect farming allows people to participate in the cash economy without causing disruptive changes in traditional village life. The villagers can work long and hard if they wish or they can put it only enough time to produce a little cash for necessities, leaving plenty for raising crops and other village activities (http://www.agripinoy.et/butterfly-farming-1.html).

Butterfly farming has also begun to proliferate in the Philippines, particularly in the province of Marinduque. Marinduque, one of the island provinces in the Mindoro, Marinduque, Romblon and Palawan (MIMAROPA) regions, is an agricultural province. Generally, the people are engaged in coconut and rice production, fishing, handicrafts making, and butterfly farming. Marinduque is in fact names as the Butterfly Capital of the Philippines, contributing 85% of the country's butterly and pupa exports. More than three-fourths of the butterfly breeders in the Philippines are based in this province (http://www.inquirer.net/specialfeatures/theenvironmentreport).

The butterfly industry in Marinduque started in the 1960s. At that time, butterflies were collected from the wild and traded as deadstock. Later, when the people learned the technology of captive breeding, they began raising butterflies in their backyards and traded them as livestock and deadstock. Since then, the lives of people engaged in this industry had significantly changed. It became a major source of income of households in the towns of Boac, Buenavista and Gasan and a major revenue contributor to the municipality and provincial governments. Its benefits did not end there.

The industry helped develop a consciousness among people about the significance of protecting and conserving their environment to sustain the supply of wild butterflies and host plants. The butterfly industry has also supported the local and international tourism industry through exports of live butterflies

The beginning of the butterfly industry in Marinduque

Based on personal accounts of the respondents/informants, the idea of building an industry out of butterflies was introduced by Dr. Claro Santiago to the people of Marinduque in the 1960s, in particular Castro Mirafuente and Romeo Lumawig. Lumawig, the only one who entered the business, started exporting deadstock butterflies which were collected live from the wild, then killed and packed inside triangular papers. The demand was high, which made Lumawig employ butterfly catchers. Among these catchers were the Layrons of Barangay Cawit, Boac who entered all forested and interior portions of the province.

In the 1970s, a group of scientists and butterfly enthusiasts led by a Japanese entomologist, Yasuzuki Nishiyama, visited Marinduque and hired Edgar Borja of Boac and Venuz Francisco of Buenavista to collect butterflies for them. Their collection sorties extended far beyond Marinduque into the provinces of Palawan, Mindoro and Quezon. Nishiyama introduced the captive breeding technology to Borja during their stay in Palawan. This technology consisted of putting egg-laying butterflies in small circular hanging cages. The cages were brought to butterfly highways, which are places visited frequently by butterflies**.** Other butterflies, especially the male ones, were attracted to the cages and were then caught by people who patiently waited for them.

The spread of captive breeding technology

When Borja returned to Marinduque, he started teaching others how to catch as many butterflies as possible. He first introduced the technology in Barangay Bagtingon, Buenavista and in Barangay Cawit, Boac. On the other hand, the Layrons made some innovations as they found the technology too laborious. They observed and followed the flying butterflies to the sites of egg-laying. Then they began constructing big cages made up of used mosquito nets where they deposited the collected eggs and caught butterflies. Leaves of host plants and sugar solutions were put inside the cages. The Layrons let the butterflies fly around and lay eggs without being disturbed. The Layrons started also collecting host plants from the forest and planted them near their houses.

They became successful with the captive breeding technology, enabling them to produce and market pupae**.** They were the first group of people able to breed and supply the province's exporter, Nelson Maiquez, the son-in-law of Romeo Lumawig. They exported pupae and papered butterflies to the United Kingdom and later became known in other countries with tropical houses. The demand for pupae for export increased and led the Layrons to teach the technology to their relatives and friends so as to cope with export needs.

The spread of technology, access to local and international markets, and emergence of support from LGUs, GOs, NGOs and private sector.

The people within the area started observing and imitating the captive breeding technique and put up their own breeding cages. The technology became popular not only in Cawit but also in neighboring barangays and towns. Concomitant to this development was the growing interest of other groups in the butterfly industry. The Department of Science and Technology (DOST) assisted some individuals who went into encapsulation and electroplating of butterflies. The media's attention was also captured. Television and radio reporters wrote about the industry. Some butterfly farms were featured on national television and even used as locations of selected shows. Private individuals visited butterfly farmers' residences. Some Manila universities sent their students to Marinduque to conduct research about the butterfly industry. The Philippine Society of Butterfly Enthusiast (PSBE) was also created.

METHODOLOGY

The social dynamics and interactions in butterfly farming in Marinduque were gathered using the case study method. The study involved 36 respondents who were classified as pure breeders, breeder-collectors and breeder-traders. Three forms of social interactions, namely: cooperation, conflict and competition that exist in the butterfly industry in Marinduque were gauged in this study.

RESULTS AND DISCUSSION

Socioeconomic information about the respondents

As shown in Tables 1 and 2, the industry consists of three groups of people who have organized their respective households to raise, process and trade butterfly products for local and international markets. These are the pure-breeders, breeder-collectors and breeder-traders. The respondents were mostly in their late 40s and with educational attainment ranging from elementary to collegiate levels. They have been involved in the industry for more than 16 years. While they have other sources of income, most respondents derived bulk of their income from the butterfly industry.

Table 1. Demographic characteristics of the respondents and their households.

CHARACTERISTICS	PURE BREEDERS[1]		BREEDER-COLLECTORS		BREEDER-TRADERS	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**
MAIN RESPONDENTS						
Age						
• Mean	48.5		50.4		50.15	
• Range	35-57		36-55		38-65	
Educational attainment						
• Elementary	8	40	1	17	1	10
• High school	9	45	3	50	4	40
• Vocational course	1	5			1	10
• College undergraduate	1	5	1	17	1	10
• College graduate	1	5	1	17	3	30
TOTAL	**20**	**100**	**6**	**100**	**10**	**100**
Years of involvement						
Mean	17.15		13		16.6	
Range	8-30		9-21		8-30	
SPOUSES						
Age						
• Mean	46.2		44.5		49	
• Range	35-65		35-55		36-62	
Educational attainment						
• Elementary	7	39	3	50	1	11
• High school	9	50	1	17	2	22
• Vocational course	1	5.5			1	11
• College undergraduate	1	5.5	2	33		
• College graduate					5	56
TOTAL	**18**	**100**	**6**	**100**	**9**	**100**
HOUSEHOLD SIZE						
• Mean	7		8		4	
• Range	3-12		3-8		3-7	

[1] The number of spouses of pure-breeders does not equal 20 because two respondents were widowed, while one from the breeder-trader group is single.

Table 2. Sources of and approximate income of raisers from butterfly-associated activities and other sources.

VARIABLE	Pure Breeders		Breeder-Collectors		Breeder -Traders	
	Freq of mention (n=20)	%	Freq of mention (n=6)	%	Freq of mention (n=10)	%
Approximate monthly income derived from butterfly farming (in peso)						
16,000-19,999						
10,000-15,999	4	20	4	67	2	20
5,000-9,999	14	70	2	33	5	50
Below 5,000	2	10			3	30
Total	20	100	6	100	10	100
Mean income	8324.50		11,166.17		12,349.5	
Range	4,500-15,000		5,000-12,000		5,000-17,000	
Other sources of income						
Coconut	15	75	4	67	1	10
Animal raising	15	75	6	100	-	-
Rice farming	6	30	1	17	2	20
Petty trading	6	30	2	33	5	50
Handicraft	3	15	2	33	-	-
Fishing	1	5	-	-	-	-
Driving	1	5	-	-	1	10
Construction	-		1	17	-	-
Approximate monthly income derived from other sources (in peso)						
10,000-15,999	-	-	-		5	50
5,000-9,999	5	25	4	67	2	20
Below 5000	15	75	2	33	3	30
Total	20	100	6	100	10	100
Mean income	5437		6583		9424	
Range	4,500-7,000		4,500-7,000		4,500-10,000	

SOCIAL DYNAMICS WITHIN HOUSEHOLDS OF PURE-BREEDERS, BREEDER COLLECTORS AND BREEDER-TRADERS

The butterfly industry is a household-based activity that involves planting host plants, constructing cages, catching butterflies from the wild, mixing and feeding sugar solutions, picking butterfly eggs, collecting and changing larval food plants, cleaning cabinet cages, collecting pupae inside the cages, controlling pupae quality, hanging pupae to hatch, marketing pupae and live butterflies and processing dead butterflies (Table 3). A single member of the household could actually perform all the tasks, but this was not done as household members viewed it as a family enterprise, and each member has a role to play. They had to help one another not only to sustain the industry but to lighten the burden of every co-owner. These perceptions were consistent with the

ideology associated with family enterprise as eloquently put up by the respondents "*We need to help one another to sustain our business. Things get done easily if we help other*".

As to role distribution within households, the study found out that roles requiring manual expenditure of energy were generally allocated to male members. Examples were planting of host plants, construction of cages, catching of butterflies, and collection of larval host plants from the wild. This was observed for all categories of participants in the industry. As one husband/father respondent said, *"Together with my son, I usually perform the difficult tasks of planting host plants, constructing butterfly cages, catching butterflies from the wild, and collecting larval food plants from the forest"*.

Women, on the other hand, were mainly responsible in nurturing and controlling the quality of butterflies, pupae and larvae. They cleaned the cages, collected eggs and pupae, and mixed and fed sugar solutions to the butterflies. They also marketed their products either as livestock or as deadstock.

As expected, the children, depending on their age, assisted their parents in whatever possible way. This expectation was rationalized along the idiom of "I am a co-owner of the enterprise". Hence, whatever benefits their households would get from the business would eventually redound to them. They caught butterflies from the wild, and collected and planted host plants. One of the children stated, *"We help our parents, especially if there is a high demand for the products. We have realized, that after all, we are the one who would benefit from all of these initiatives."* These expectations from children, however, were relaxed especially during school days. As shown in Table 3, children's participation in butterfly raising was not as high as those of the other household members. As one respondent narrated, "*We do not oblige our children to help in the activities, especially if they have school assignments. But if they don't have classes, they volunteer to work*".

While there seems to be a general rule as to who should perform a particular task in the enterprise, a deeper analysis of household task allocation revealed that it was something that household members negotiated on a daily basis. For example, when male members of the households were not available, other members were asked to take over. This was significant in households where men had to leave the house to attend to other jobs to augment their income particularly during periods of low demand for butterfly products. There were those involved in coconut farming, vegetable raising, as well as raising animals, while some were engaged in commercial activities like sari-sari stores, construction, and others requiring them to relinquish their major activities to other household members (Table 3). In such circumstances, other members readily took over. This was highlighted by one male respondent who said that: *"I usually delegate the tasks to my children. I have to be engaged in other jobs especially when the demand for butterflies is low"*.

While the unitary character of households in role allocation and task performance was apparent, there were some instances when this norm was violated, thereby exposing the instability of a butterfly household-based enterprise. Concrete examples of this were: (1) when children failed to do their assigned tasks, and (2) when a member of the household misallocated the proceeds of the enterprise, thus affecting the reproducibility of the business. In such situations, (1) irritations occurred among household members to the point that parents got angry with their children; (2) husband and wife fought with each other and (3) the enterprise failed to expand**.** Some respondents said "*Sometimes it is really frustrating especially when the children lie. When we forget to feed the larvae, for example, we will already incur losses, but the children do not understand this*". Another respondent said, *"It's really maddening because, instead of using the money for household necessities, it is just lost in gambling*". Finally, one respondent claimed ,"*I confront my husband if he gambles especially if he loses. I won't mind it too much if he wins. There are times when the butterfly business is really on its downfall"*.

Table 3. Division of labor among household members of pure-breeders, breeder-collectors and breeder-traders.

ACTIVITIES	PURE-BREEDERS			BREEDER-COLLECTORS			BREEDER-TRADERS		
	Men % (n=19)	Women % (n=19)	Children % (n=46)	Men % (n=6)	Women % (n=6)	Children % (n=10)	Men % (n=10)	Women % (n=9)	Children % (n=13)
Planting of host plants	100	62	61	100	67	52	90	56	38
Construction of cages	100	32	32	100	22	25	90	22	44
Catching of wild butterflies	100	40	65	100	22	56	30	0	38
Mixing and feeding of sugar solutions	32	95	28	11	100	33	50	80	23
Picking of butterfly eggs	26	95	43	50	100	35	40	100	38
Collection of larval food plants	100	74	54	100	76	42	90	56	54
Cleaning the cabinet cages and replacing larval food plants	89	100	33	83	100	25	50	100	38
Collecting pupae from the cages	26	100	38	67	100	21	50	100	31
Quality control of pupae	42	89	13	83	100	17	60	100	23
Marketing of pupae	36	95	33	50	100	29	30	100	23
Hanging pupae to hatch	53	79	22	100	83	31	20	44	46
Marketing of live butterflies	26	95	17	67	100	35	10	100	46
Processing of deadstocks	26	42	9	33	83	13	30	78	38
Marketing of deadstocks	21	53	9	33	83	13	30	89	23

SOCIAL DYNAMICS AMONG HOUSEHOLDS WITHIN RESPONDENT-CATEGORIES

Pure-breeders The pure-breeder households were connected to one another in several ways. They both cooperated and competed with one another when carrying out their respective roles within the industry. Depending on their contexts, they shared their host plants with other pure-breeders, taught others how to improve further their captive breeding techniques or helped each other in marketing their products. On the other hand, they also competed by trying to outdo one another in production as well as in marketing their products. In many instances, they made use of their social capital to assure themselves of market outlets.

Sharing of host and food plants. Interestingly, sharing of host and food plants occurred only during the so-called "lean months" or when the demand for butterfly products was low. During that period, some pure-breeders cut down or withdraw from production automatically. Those who had unused supply of host and food plants readily shared them with other pure-breeder households who remained in production. They rationalized that this mode of behavior was helping not only those who remained in production but the industry as well.

Sharing of captive breeding technology. Captive breeding technology was shared by the pure-breeders especially to those who just entered the business. They did this for no reason at all except for the happiness derived from the act.

Marketing assistance. Some who had difficulty marketing their butterflies were assisted by other pure-breeders. This was especially true when there was an oversupply of butterflies or when there were new entrants to the industry. Assistance came in the form of or a combination of the following: (1) providing the list/names of possible buyers; (2) personal introduction to prospective buyers or (3) direct marketing of their products. Reasons for assisting one another were for others to earn and to ensure the industry's sustainability. A pure-breeder said, "*When there is an oversupply of butterflies, it becomes very hard for us to sell them. There are breeders who know other buyers so they assist us in marketing our products. They even sell our products themselves***".** Another respondent added, "*We need to help other breeders because they also need money, which is why they raise butterflies in the first place. Besides, if we do it alone, there is a possibility of losing our costumers if we provide only a partial of their requirements*".

Competition in selling butterfly products. All pure-breeders wanted to dispose of their stocks and earn income from it. However, some found difficulty in disposing their products. They perceived that other pure-breeders were talking ill of their products.

Competition in marketing. Buyers and other suppliers were considered as limited resources that pure-breeders were trying to get hold of. Because pure-breeders were increasing in number, buyers could choose among the suppliers. Hence, the pure-breeders employed several strategies to attract buyers. These included reducing the prices of their stocks, producing healthy butterflies, and maintaining good relationships with buyers. Selling of stocks at a lower price usually happened when there was an oversupply of pupae. A respondent narrated: "*There are times when there is oversupply of pupae. Buyers naturally flock towards the pure-breeders offering the lowest price. Sometimes, pure-breeders are really compelled to sell at low prices"*.

Pure-breeders also maintain good quality of their products. The larvae are given extra care and attention to produce healthy and higher value pupae. Some breeders make sure that the packaging is good to be able to protect the pupae from damages. *"Buyers prefer big and live pupae because they are aware that these characteristics would mean good quality pupae, which commands higher prices. If we know that our products are not competitive enough, we do not show them to the buyers because*

these will just be rejected anyway. If there are buyers who still buy these products, we usually sell them at lower prices ", as claimed by some respondents.

Maintenance of good relationships with buyers. One way of competing with other pure-breeders was by maintaining good relationships with the buyers**.** Pure-breeders considered good human relation as an asset to survive and thrive in the industry. They would do everything to ensure that breeder-collectors and breeder-traders buy from them. Providing special service to the breeder-collectors and breeder-traders was a necessity. This is validated by a respondent who said that *"You need to develop good rapport with the buyers. You have to impress upon them that you are honest and trustworthy. To be able to please the buyers, there are instances that I deliver the pupae myself".*

Competition for scarce resources (host plants). Host plants were a very important resource among butterfly pure-breeders. But because of the increasing number of pure-breeders, host plants had become scarce. This was not a problem to pure-breeders who had their own plantations; but only to those who collected host plants from the wild. According to the latter they had to exert extra effort to locate the source. *"You should be resourceful in locating host plants where they abound. There are times when you think you are ahead of the others, only to find out that they have also discovered your sources and have helped themselves to find the plants there".* A respondent said *"Here in our place, a number of breeders engaged in butterfly breeding, especially during the peak season of breeding it is the right time to breed the butterflies, many are into it. But the scarcity of food plants in their surroundings. This is because breeders just get their food plants from the mountains. So, if they all start the breeding at the same time, competition for host plants from the mountains become stiff".*

Those who did not own plantations needed to guard their sources in the mountains against trespassers. One respondent added that "*scarcity of host plants compelled some breeders to steal the host plants of other breeders. Therefore, the farmers need to guard and look after their plants. Others, however, have resorted to cultivating their own host plants".*

Conflict due to loss of and damage to resources. Conflict can bring some ordinarily isolated individuals into an active role. Attempt of some pure-breeders to protect their property and resources from possible offenders make them to be more vigilant and cautious in other words, pure-breeders become extra protective of their source of livelihood. Host plants are very important to butterfly farmers. They serve as breeding places and food for the larvae. Thus, butterfly farmers protect them from being encroached upon by unauthorized people. However, trespassing on breeding areas still happens. As such, pure-breeders develop resentment toward the offenders. "*Who would want to see your farm being unfairly taken advantage by others?*", said one breeder, and to which an offender answered, "*Sometimes we cannot help getting food plants from the others especially if we do not have enough larvae."*

Sometimes, encroachers are not satisfied by just getting what they need. They actually get more than what is needed. *"I confronted the offender and even thought of bringing the matter to the village council. I could not imagine that what I have worked for so hard, would just be destroyed by the others who are, in fact, benefitting from it",* said by the pure-breeder.

One farmer related: *"It is because of envy, especially if they see that you are earning a lot. What they do is to destroy and/or steal what you have*".

Not only the host plants are stolen, but also nets of the cages and the contents. "*Usually, the children steal the pupae. They sell the pupae, and used the money to cover their school expenses. Unfortunately, these children sometimes destroy the cages also".*

Breeder-collectors

Cooperation among breeder-collectors was typically observed in marketing. It was the common practice for breeder-traders to assign supply quota to breeder-collectors. Some breeder-collectors met the quotas at once, but others found it difficult to do so for lack of pure-breeders to supply their needs. Breeder-collectors who met their targets helped other breeder-collectors by providing the latter with the names of pure-breeders who could fill in the shortage. This is being done when the demand for butterfly products is high, but the supply is very limited.

On the other hand, when there is too much supply of butterfly products and the demand is low, the breeder-collectors cooperated with one another by letting only a few of them to do the collection. In addition, some breeder-collectors sold their products to the other breeder-collectors using the same selling price for pure-breeders .

Offering high prices to pure-breeders. Breeder-collectors usually competed with each other for pure-breeders who could supply the stock, and for buyers to whom the stocks were sold. They offered pure-breeders higher prices than what others normally paid.

> *"Competition among breeder-collectors is stiff. They ask pure-breeders how much other breeder-collectors pay for their products. If they can, they offer a higher price just so the pure-breeders will sell to them. Pure-breeders, consequently sell their products to the highest bidders, leaving only a little or none at all to the other collectors."*

Giving cash advances to pure-breeders. Breeder-collectors provided pure-breeders with advance payment in return for their products to be collected later. Unfortunately, some breeder-collectors enticed pure-breeders to renege on previous commitments by offering money higher than the cash advances.

Maintaining good relationships with pure-breeders and breeder-traders. Breeder-collectors also competed with each other in developing and maintaining links with the breeder-traders in the locality, to ensure that, the breeder-traders would buy from them whenever they had available stocks. As one breeder-collector narrated: *"You need to have contacts with many traders, because in times of oversupply, you need not depend on one trader only"*

Breeder-trader Households

Cooperation among breeder-traders was usually expressed in marketing and providing butterfly products.

Marketing and providing butterfly products. Foreign and local buyers were the usual clients of breeder-traders. Sourcing the clients depended on how resourceful the breeder-traders were. They usually sought clients by attending festivals and trade fairs, and through internet surfing. Breeder-traders expressed support for one other by providing stocks to those who needed them most. One breeder-trader shared that *"When my supply is not enough, I would call my colleagues. If they have stocks and do not need them immediately, they would willingly share their stock. When my turn comes, I also do the same."*

Conflict among breeder-traders in marketing. Conflict among breeder-traders usually happened if one breeder-trader continued buying and selling butterfly products without complying with government regulations. As one respondent mentioned: "What will happen to us who operate the business with permits if we compete with those who operate illegally?"

Competition between and among breeder-traders was observed in maintaining the suppliers (pure-breeders and breeder-traders). Breeder-traders had their own strategy to maintain their relationship with pure-breeders and breeder-collectors. They offered good prices for the latter's products or supplied them with needed inputs.

SOCIAL DYNAMICS ACROSS CATEGORIES

Between pure-breeder and breeder-collector households

Pure-breeders and breeder-collectors usually cooperated with each other in marketing and in providing technical and financial assistance, and other resources like ready-to-lay butterflies and pupae.

Marketing. Pure-breeders and breeder-collectors who had established good relationships with each other were expected to support one another. The former sold butterfly products to the latter and the latter was expected to buy the farmer's products. This expectation, however, put the pure-breeders at a disadvantage vis-à-vis the latter especially in cases when the price given was lower than what other breeder-collectors offered. However, because of the ideology of "sense of gratitude", pure-breeders were obliged to remain in relationship with breeder-collectors. This was put explicitly by one respondent: "*It is ungrateful to sell your products to the other breeder-collectors even if they offer a much higher price. Sometimes, I just ask my breeder-collector to increase the price. Who knows, we may need their help in the future. If you do not earn their trust, they might not help you anymore.*"

Breeder-collectors, on the other hand, were expected to perform their share of the negotiation (once a transaction with the pure-breeders is done). One respondent mentioned that "*Once you have already contracted them to buy their products, you must keep your word, otherwise they may not accommodate you in the future.*"

Whenever possible, breeder-collectors personally visited the pure-breeders to collect their harvest. Such kind of arrangement was advantageous for the pure-breeders, ensuring their products were disposed. Similarly, it was favorable to the breeder-collectors because they were assured of regular supply.

> *"It is already an assured market when breeder-collectors would come and pick up our products. Although we do not get paid immediately in cash, at least we have something to look forward to. What is important is we have disposed our products."*

Providing financial assistance. One form of support that the breeder-collectors provided to pure-breeders was through advance payment. However, pure-breeders were obliged to commit their products to the breeder-collectors in return for the advanced money. One of the pure-breeder narrated,

> *"If they see that you have lots of larvae, they would offer cash, actually credit disguised as advanced payment, with an agreement that they would collect the larvae when these are ready. Of course, I would always want to grab this opportunity, especially if I do not have enough financial resources to spend for the immediate needs of my family".*

Breeder-collectors and pure-breeders also found time to discuss problems concerning the business. This enabled them to come up with recommendations to address the problems. The above findings imply that cooperation will not only improve the relationship with one another, but help them both solve whatever problems will occur in attaining their goals.

Making other resources available. Pure-breeders who raised only common species of butterflies were provided by breeder-collectors with alternative species which could command higher prices in the market. In accepting the species, pure-breeders were again committed to their breeder-collectors.

> *"As a collector, I prefer those which command higher prices in the market. When breeders raise common butterflies which are cheaper, I voluntarily provide them with the pupae or ready-to-lay butterflies with much better market price"*

Pure-breeders and breeder-collectors competed with each other in marketing their products. Once the pure-breeders learned to sell their products to the breeder-traders, they closed the breeder-collectors' opportunity to source products directly from them. Pure-breeders directly sold their products to the breeder-traders, and at low prices to ensure that the latter would buy them. They also made sure that their products were of good quality, thus earning the breeder-traders' trust.

Between breeder-collector and breeder-trader households

Cooperation between and among breeder-collectors and breeder-traders was frequently observed during marketing of butterfly products.

Marketing and financial assistance. For breeder-collectors to get stocks from pure-breeders, the breeder-traders advanced money to the breeder-collectors. This was favorable to the latter because they could immediately purchase stocks, deliver these to the breeder-traders, then collect the payment. Breeder-collectors were also informed as how much the breeder-traders would pay for the stocks. In this way, they could determine how much stock to procure from the pure-breeders.

> *"Traders would give us money to purchase the stocks. They tell us in advance what kind of pupae they prefer to buy"*

Breeder-traders were free to choose their breeder-collectors. Because of this, breeder-collectors would try to convince the former to keep a relationship with them by selling their stocks at lower prices. As one breeder trader said: *"The breeder-collectors sell their stocks at a lower price especially when there is an oversupply of stocks. Certainly, I buy from them, especially when their products are of good quality"*

A breeder-collector confirmed this:

> *"Because of many breeder-collectors trying to sell their stocks, we need to devise a strategy to persuade the breeder-collectors to buy from us. One strategy is reducing the price of our goods"*

Between pure-breeder and breeder-trader households

Cooperation between and among pure-breeders and breeder-traders was usually observed in marketing and in making available other resources like ready-to-lay butterflies or pupae to be used as mother stock.

Marketing. While the breeder-traders could harvest from their own farms, they still needed additional stocks to fill the quota requirement of their local and foreign clients. They sourced from their pure-breeder partners. Likewise, breeder-traders were able to help the pure-breeders by buying the latter's stocks at prices higher than what the breeder-collectors offered. Such relationships benefited the pure-breeders and their families.

"Sometimes there were traders who buy directly from us especially when they urgently need stocks. Products which breeder-collectors have not bought are eventually purchased by the breeder-traders. They are of big help to us. If they were not around, it would be very difficult for us to dispose our products"

"It is to our advantage when breeder-traders buy directly from us because they buy our products at the same price that they pay to the collectors"

Making available other resources (ready-to-lay butterflies or pupae to be used as mother stock). Like the breeder-collectors, breeder-traders also provided the pure-breeders with alternative butterfly species. In return, pure-breeders committed their stocks to the breeder-traders. If the arrangement between the pure-breeders and the breeder-collectors was followed, the former were supposed to supply the latter with their produce, while the latter had to buy the products of the former.

Conflict in marketing. Despite the understanding between the two key players of the butterfly industry, some arrangements were not always followed. Sometimes, pure-breeders sold their stocks to other breeder-collectors or directly to traders particularly when the offer was higher. On the other hand, breeder-collectors failed to purchase stocks from pure-breeders. As one pure -breeder narrated:

"Sometimes breeder-collectors give us money in advance, with the agreement that we would give our produce to them. But sometimes if we urgently need money and the breeder-collector is not ready to claim our produce, we are compelled to sell these to other breeder-collectors who sometimes pay more. Of course, the breeder-collectors to whom we have previous arrangement get angry, but there is nothing they can do about it."

Such form of betrayal caused disappointment to the key players, resulting in the breakdown of good relationships.

Competition between and among breeder-collectors and breeder-traders

Competition between and among breeder-collectors and breeder-traders generally occurred during marketing. There were cases when breeder-traders did not have breeder-collectors in certain areas. As such, the breeder-traders dealt directly with the pure-breeders and thus, offered better prices for the products compared with the breeder-collectors. As one pure-breeder exposed*: "There are breeder-traders who buy from us directly. This is to our advantage because they pay us higher unlike the breeder-collectors"*.

CONCLUSION

The social dynamics of the butterfly industry were investigated in Marinduque, Philippines. This paper concludes that the butterfly industry is dynamic, wherein the key players negotiate between and among themselves on a daily basis. Competition, conflict and cooperation are the social relations observed in among the pure-breeders, breeder-collectors and breeder-traders. They arrange and re-arrange these social relations and material artifacts according to the rules of the game.

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THE IMPACT OF THE INVESTMENT CLIMATE ON TOTAL FACTOR PRODUCTIVITY (TFP) IN THE AGRICULTURAL SECTOR: THE CASE OF HANOI, VIETNAM

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ABSTRACT

This study measures the impact of investment climate factors on the total factor productivity (TFP) of agricultural manufacturing firms in Hanoi, Vietnam. Endogeneity of the production function and of the investment climate variables is addressed by using econometric models, based on individual firm information, and by aggregating investment climate factors by various business lines. Specifically, the analysis is conducted in two steps: first, an econometric production function is estimated to produce a measure of TFP at the firm level; in the second step, variation in TFP across firms is statistically related to indicators of the investment climate as well as firm characteristics. The result yields a number of insights on the factors that underlie productivity. In a variety of business lines, indicators of poor investment climate, especially the *administrative clearance time* variable which has significant negative effects on total factor productivity. Decreasing by one hour in administrative clearance time could increase TFP by 1.7 - 5.7%. Indicators such as *time of land rent, certification of clean production, market competition, age of the firm,* and *educated labor* have positive effects on TFP. However, levels of effects from investment climate factors on TFP are different among business lines.

Key words: agriculture, impact factors, firm level

INTRODUCTION

As a developing country, Vietnam has to face pressure and impact of globalization. In order to address these problems, it seeks ways to stimulate growth and employment within the context of increased openness. Vietnam is now focusing on issues of competitiveness and productivity through micro-economic reform programs after having a reasonable level of macro-economic stability over the past twenty years.

The economic performance of a firm is influenced by two types of factors. The first type is composed of internal factors such as the technology embodied in the firm's capital stock, its management practices and its marketing strategies. The second factor type may be referred to collectively as the investment climate: the policy and institutional environment in which the firm functions. Even the best-managed firms have difficulty flourishing in a bad investment climate.

Many conceptual and empirical researches show that the investment climate can significantly and adversely impact productivity, growth and economic activity (Mendes *et. al*, 2009; Bosworth and Collins, 2003; McMillan, 2004; He et al., 2003; World Bank, 2002 and World Bank, 2004 a, b). Prescott (1998) argues that to understand large international income differences, it is necessary to explain differences in productivity (TFP). His main candidate to explain those gaps is the resistance to

the adoption of new technologies and to the efficient use of current operating technologies, which in turn are conditioned by the institutional and policy arrangements a society employs (investment climate factors). Thus, investment climate assessments have become a standard instrument for identifying key obstacles to country competitiveness and imputing their impact on productivity, in order to prioritize policy reforms for enhancing competitiveness.

In this paper, the impact of investment climate factors on the total factor productivity of agricultural manufacturing firms was examined. Methodologically, a two-step analysis of agricultural manufacturing firms surveyed in Hanoi is conducted. In the first step, we estimate a measure of total factor productivity for each firm in the survey. In the second step, we test for a statistical relationship between the productivity measure and indicators of both types of factors: those internal to the firm and those related to the investment climate.

Previously, some studies examined the impact of investment climate factors on the total factor productivity. With main objective of the productivity impact of the investment climate variables in order to improving country competitiveness and productivity in Guatemala, Honduras and Nicaragua, Escribano and Guasch (2005) developed a methodology to estimate appropriately using the two-step analysis.

Uma and co-authors (2005) measured the impact of the investment climate factors on the total factor productivity (TFP) of firms in China and Brazil by estimating TFP base on production function at the firm level and then, testing TFP across firms with indicators of the investment climate as well as firm characteristics. Mendes and co-authors (2009) also used the two-step analysis to evaluate the effects of infrastructure investments on total factor productivity in Brazilian agriculture.

Analytical Model

Measuring Total Factor Productivity

Productivity refers to the effects of any factor different from the inputs affecting the production process. Measuring TFP generally requires an empirical specification of the production function (1). Because of data restrictions, it is often more practical to specify a value added production function of the form, where Y represents value added, K represents capital services, M represents intermediate materials, and L represents labor inputs.

$$Y = f(K, L, M) \qquad (1)$$

Measurement is usually based either on time-series data or on cross-sectional data. While aggregate or firm-level data can be used for either type of analysis, time-series analysis generally employs data on aggregates of firms and cross-sectional analysis usually employs data on individual firms.

Growth accounting methods are used to identify the rate of growth in TFP in time series data by subtracting the effect of growth in inputs from growth in output. The residual is the growth rate of TFP:

$$\Delta TFP = \Delta \ln Y + \alpha_1 \ln K + \alpha_2 \ln L + \alpha_3 \ln M \qquad (2)$$

where $\alpha_{1,2,3}$ are the cost shares of *L*, *M* and *K* respectively. This type of measure is used by national statistical agencies to track productivity improvements through time. It does not permit a quantitative partition of TFP into technology and efficiency improvements, since both types of improvements occur over the course of the time-series and contribute to growth in TFP.

Cross-sectional analysis generally defines some index of relative TFP for each firm *i* defined

as follow:

$$\phi_i = \frac{Y_i}{f(K_i, L_i, M_i)} \tag{3}$$

such that Φ = 1 indicates the central tendency of TFP in the cross section. A value of Φ above 1 indicates high TFP relative to the firms in the cross section, while a value below 1 indicates low TFP.

Rearranging (3):

$$Y_i = f(K_i, L_i, M_i)\phi_i \tag{4}$$

If we assume Cobb-Douglas production technology and that the TFP index can be written $\Phi_i = v_i$, (4) is specified as,

$$Y_i = AK_i^{\alpha 1} L_i^{\alpha 2} M_i^{\alpha 3} e^{v_i} \tag{5}$$

which can be transformed into a linear expression amenable to regression methods:

$$\ln Y_i = \ln A + \alpha_1 \ln K_i + \alpha_2 \ln L_i + \alpha_3 \ln M_i + v_i \tag{6}$$

In the equation (6), the natural logarithm of the TFP index is equal to the residual term in the econometric production function. However, interpretation of the residual term in this way should be done with caution. Measurement error is also likely to have an effect on the size and distribution of the residuals. A more conservative conclusion is that firm level variations in TFP account for a substantial component, but not all, of the residual values.

The TFP analysis in this paper is based on cross-sectional data at the firm level. It is important to bear in mind that in a cross section collected in one year or over a relatively short interval, all firms have access to the same level of technology. Thus variations in TFP may be attributed principally to variations in efficiency rather than variations in technology. Recent improvements in technology, however, may increase the level of variance across firms as some are more successful than others in moving toward the new productivity frontier (Alvaro and Luis Guasch, 2005)

TFP and Investment Climate

While measurements of TFP are informative in themselves, from a policy perspective it is much more valuable to relate these measures to factors that underlie the environment in which the firm operates. Therefore, we are not only measure TFP for individual firms in the survey, but also try to identify factors that explain a significant proportion of the variability in TFP. The purpose of this section is to evaluate the productivity impact of investment climate factors at different levels of aggregation of firms' characteristics.

In general, a firm's TFP depends on characteristics of the firm itself and on characteristics of its external environment that affect its economic performance (Alvaro and Guasch, 2005; Uma *et. al*., 2005). Relevant characteristics of the firm may include its size, age, ownership, location and various proxies for its innovativeness or the quality of its management (Trung *et. al.*, 2009).

Investment climate refers to the external environment of the firm. Mendes (2005), Zhang and Fan (2004) showed the factors that affect agricultural TFP such as electricity, telecommunications, storage capacity of warehouses, transportation, irrigation, and macroeconomic policies. When assessing the situation of attracting FDI in agriculture and rural development in

Vietnam, Hung (2006) indicated that land ownership is fully not recognized and renting agricultural land has many difficulties because of urbanization. Instability of renting time results in the decrease in economic performance. He argues that unstable situation of land use results in limited investment and then, reduces TFP. Classical input of production function, both of the quantity and quality of labor resources available to the firm, influence its TFP. More skilled employees improve their efficiency more rapidly with experience, move more easily from one task to another and allow the firm to embrace technological improvements more rapidly. Transaction costs associated with regulations and bureaucracy are resources diverted from productive and effective uses of scarce resources and have significant implications for economic performance (World Bank, 2004). Bureaucratic delays and poor institutions have a similar effect on access to markets and trade performance (Hung 2006; Groot, *et. al*, 2004). Martin (1998), Cuong (2005), and Hung (2006) proved the ability to move goods from the production site to markets is critical to efficient production. Poor logistics result in excess costs and delays that reduce TFP. Unreliable logistics services may require the firm to maintain excess inventories, which again divert resources from production. The quality of logistics services depends on a number of factors, including the quality of public infrastructure, (Limao and Venables 2001), the presence of high quality service providers and, especially in the case of import and export logistics, the efficiency of institutions and bureaucracy such as customs (Subramanian and Arnold, 2001; Subramanian, 2001). The level of competition in the domestic market may have a positive impact on productivity (Cuong, 2005; Uma, *et. al*., 2005). In the study entitled "Opportunities and constraints for safe and sustainable food production in Hanoi", Anh and co-authors (2004) showed that effects of food security on TFP are enormous.

Given a set of indicators for both the characteristics of firms and the characteristics of their business environment, we hypothesize that TFP for firm *i* can be defined as:

$$\phi_i = \prod_k F_{ik}^{\gamma_k} \prod_j E_{ij}^{\beta_j} e^{\varepsilon_i} \tag{7}$$

where the *F* are characteristics of the firm, the *E* are characteristics of the firm's external environment, the γ and β are statistical parameters and ε is a "white noise" stochastic term (Uma et al. 2005). Taking logarithms of both sides of Equation (7) yields Equation (8):

$$v_i = \sum_k \gamma_k \ln F_{ik} + \sum_j \beta_j \ln E_{ij} + \varepsilon_i \tag{8}$$

Data Description

A survey was conducted in Hanoi for two main reasons. Firstly, Hanoi has much potential for developing agricultural production because of having many research institutions and universities, good infrastructure, large market, and other favorable natural conditions. Secondly, the urbanizing process results in situations of agricultural land losses that characterizes the situation in Hanoi. Primary data were gathered through personal interviews of individual firms. Additional information related to the research problem was also collected from various agricultural institutions and local municipalities. The information gathered included: (1) characteristics of firm such as general information, agricultural production, operating capital, firm's incomes; and (2) characteristics of investment climate such as policies applied, public utilities, labor resources, land allocation, regulation and bureaucracy. One hundred and sixty agricultural firms consisting of companies, cooperatives and farms were chosen through stratified random sampling.

The survey data in Hanoi includes 160 usable observations that are about evenly distributed across suburban districts of Hanoi which focus on agricultural production: Tu Liem, Thanh Tri, Gia Lam, Dong Anh, and Soc Son. They are also roughly distributed across five business lines (Table 1).

Table 1. Observations by district and business lines.

District	Planting	Animal	Aqua-culture	Mixed production	Processing	Total
Dong Anh	11	10	7	5	5	38
Gia Lam	7	6	3	5	7	28
Soc Son	9	8	8	7	9	41
Thanh Tri	6	9	6	5	3	29
Tu Liem	4	7	6	5	2	24
Total	***37***	***40***	***30***	***27***	***26***	***160***

Source: survey data

Tables 2 indicates that processing firms' TFP is the highest, the average TFP is 1044.85 million VND. Positive skewness value means that the TFP that is obtained by processing firms mainly contains low TFP. The survey data also shows the average TFP of planting firms is 279.72 million VND. The TFP of planting firms varies largely across planting firms because its standard deviation is relatively large as compared to its mean. A positive skewness of 1.51 and kurtosis of 0.92 mean that the TFP of planting firm distribution has a short right tail: some planting firms have small size of TFP.

Table 2. Descriptive statistics for TFP by business lines.

Business lines	Mean	Standard Deviation	Skewness	Kurtosis
Planting	279.72	379.98	1.5109	0.9179
Animal	93.68	135.58	2.3821	5.4360
Aquaculture	158.48	194.32	2.3279	6.5469
Mixed	181.55	317.83	3.3024	11.8473
Processing	1044.85	1952.15	3.2405	11.5366

Source: survey data

The average TFPs of animal, aquaculture and mixed firms also have positive skewness and great values of kurtosis mean that distributions of these firm's TFP have long right tails: many firms have small size of TFP.

RESULTS AND DISCUSSION

Estimating TFP

The first step in the analysis is to estimate the production function (6). The variables *Y, K, L* and *M* are derived from the survey data as follows:

- Value added (*Y*) is calculated by subtracting materials and energy costs from the total value of sales;
- Capital *(K)* is defined as the total book value of assets;
- Labor *(L)* is defined as the total number of employees (including contractual employees) working at the firm's main production facility at a given time; and
- Intermediate material *(M)* is defined as the material costs.

Table 3 present the GLS parameter estimates for equation (6). As the results shown in Table

3, the capital, labor and material factors have positive effects on TFP by five producing lines.

Table 3. Value added production function OLS parameter estimates.

Variables	Planting	Animal	Aquaculture	Mixed	Processing
capital	0.2697	0.2057	0.3298	0.2743	0.2348
	(0.093)	*(0.042)*	*(0.075)*	*(0.030)*	*(0.025)*
labor	0.5302	0.4026	0.2760	0.8047	0.4794
	(0.003)	*(0.084)*	*(0.092)*	*(0.001)*	*(0.004)*
material	0.1596	0.2244	0.1998	0.2242	0.2594
	(0.089)	*(0.011)*	*(0.065)*	*(0.036)*	*(0.037)*
No. observation	37	40	30	27	26
R squared	0.650	0.667	0.526	0.647	0.719
Pro > F	0.000	0.000	0.000	0.000	0.000

Note: P-values (t-test) are shown below parameter estimates (in brackets)
Estimates significantly different from zero at the .01 level are shown in italic.

Estimating the Effects of the Factors on TFP

Based on the definition of TFP and the residual terms estimated from the production functions described above (equation 8), the next step in the analysis is to identify factors, including firm-level factors and characteristics of the investment climate, that explain variations in TFP across agricultural firms.

Educated labor (*edulab*): Factors relating to labor quality are also somewhat ambiguous as to whether they reflect the firm or its environment. Labor skills are naturally limited by the skills in the local labor force, but within the same labor market some firms may choose to hire the highly skilled workers while another chooses the lowest cost workers. From a number of different measures of labor quality we found that measures of formal education were important for *edulab* (including years of education and proportion of college graduates).

Age of the firm (*age*): This firm characteristic included was age, defined as the number of years since the firm went into business. Expectations on age are ambiguous. Learning by doing would suggest that productivity increases with age, but there may also be a negative vintage effect if the age of capital is correlated with the age of the firm.

Time of land rent (*rentime*): Since the firms have to rend land for their operating, we examined this factor, *rentime* that measure of the length of time of land rent (year). The effect of *rentime* is expected to be positive for TFP because of reducing the land rent.

Administrative clearance time (*adtime*): Factors relating to administrative clearance time, *adtime* include time of checking quality of products (poultry, pork, etc.) before they are sold and regulation of market opening time (hour). Learning by doing would suggest that productivity declines with administrative clearance time.

Infrastructure and utility services (*lostirr*): Many variables reflecting the quality of infrastructure and services were examined. These included measures of the reliability of phone, irrigation and electricity services; measures of the length of time needed to get a phone installed or for a check to clear; measures of the quality of transportation services, etc. The variable that proved most consistently important was the loss of sales due to poor irrigation system: *lostirr*, electric failure, etc.

The respondents mark the contribution of infrastructure and utility services to firm's operations that random from zero to ten. This variable is also expected to be positive effect on TFP.

Market competition (*acompe*): Unless the firms are only interest international market, we examined the level of competition in domestic market through firm's assessment. The respondents mark the ability of firms, *acompe* to enhance productivity through access to the domestic market with higher point if the firm access to this market easier. The respondents mark the enhance productivity through access to the domestic market also random from zero to ten.

Certification of clean production (*cerpro*): This factor is defined as a dummy variable, *cerpro* whose value is 1 if the firm is engaged certificate and 0 otherwise. The effect of *cerpro* on TFP is ambiguous.

Table 4 shows the results of estimating equation (8). With the exception of the ambiguous effect of *rentime* for planting, all estimates have expected signs and are significant for remain business lines. Age of the firm, *age* is significant for all business lines. The lack of significance of *lostirr* for three business lines of Animal production, Processing, and Mixed production may be explained by the argument that these business lines relate to industrial production. It also means that effects of irrigation on them are not so large. In general, labor-related variables are highly significant as are administrative clearance time, and market competition. The *cerpro* dummy variable is significant and positive in three of the five business lines, suggesting that there are productivity advantages if firms enhance the certificate of clean production.

The econometric results in Tables 4 allow us to derive some simple results about the effect that the various factors have on TFP. In what follows, we report the result of some simple counterfactual exercises in which the value of one independent variable is altered while holding all others constant in order to estimate the magnitude of its effects on TFP. We limit this analysis to variables whose impact is shown to be statistically significant at the 0.1 level or better.

Educated labor: Table 4 shows the magnitude of the effect of increasing educated labor by one person in three business lines in Hanoi. Employees in the Planting have lower years of education compared to employees in other groups. If the average number of years of education in the planting was increased by 1 year, our results indicate that the TFP of the planting would increase by 3.62%. This is 2.61% for mixed and 3.2% for processing

Age of the firm: Older firms have higher productivity in all business lines. This result may be driven by the greater experience and the long-term, established customer relationships that older firms have. Because of production in agriculture is not rapid change in technology and customer demand; thus younger firms have not many advantages compared to the older ones. In average, one year increase in age of the firm yields a nearly 3.75% increase in TFP for Aquaculture, while for other groups the effect is much smaller.

Time of land rent: The results indicate that *rentime* has positive effects on TFP in four of the five business lines. In average, increase one year in time of land rent would result to TFP increase by 2.4% for animal firms, 2.19% for aquaculture firms, 1.46% for mixed firms, and 0.37% for processing firms. With the exception of the ambiguous effect of *rentime* for Planting, the firms in remain business lines need to stability of land using because of long-time investments such as processing factories, breeding facilities, etc.

Administrative clearance time: The results seen in Table 4 indicate that the number of hours to administrative clearance significantly impacts TFP. For example, a one-hour increase in administrative clearance would result in a 5.7% increase in TFP for Animal, 2.9% for Planting, 2.6%

for Mixed, and more than a 1.7% increase for processing. These results may be taken to mean that slack clearance is a major problem of selling agricultural products in Hanoi. This may be the least efficient firms that suffer the greatest reduction in sales therefore the result should be treated with caution as there may be some issue with endogeneity. For example, food security is always a big problem and quality examination is necessary and effects of this regulation may be negative on TFP.

Infrastructure and utility services: Consistent with the expected, the results in Table 4 and Figure 1 indicate that the increase of a one-point in this infrastructure and utility services increased TFP by 2.43% on average for planting, and 2.32% for aquaculture. These results show that planting and aquaculture production are heavily dependent on irrigation systems which are also very dependent on electricity for operation.

Table 4. Effect of factors on TFP

Variables	Planting	Animal	Aquaculture	Mixed	Processing
edulab	0.5439	0.1075	0.0466	0.3650	0.5279
	(0.0007)	(0.3284)	(0.3899)	*(0.0733)*	*(0.0072)*
age	0.1922	0.5982	0.4492	0.2057	0.2012
	(0.0698)	*(0.0000)*	*(0.0005)*	*(0.0980)*	*(0,0530)*
rentime	0.2150	0.4638	0.3296	0.2845	0.1833
	(0.2573)	*(0.0738)*	*(0.0407)*	*(0.0033)*	*(0.0675)*
adtime	-0.2619	-0.5739	-0.0420	-0.9648	-1.5043
	(0.0021)	*(0.0762)*	(0.6936)	*(0.0139)*	*(0.0295)*
lostirr	0.1700	0.2039	0.1681	0.5424	0.6137
	(0.0035)	(0.5724)	*(0.0146)*	(0.3909)	(0,1596)
acompe	0.4793	0.3479	0.7931	0.6916	0.8783
	(0.3450)	*(0.0075)*	*(0.0535)*	*(0.0957)*	*(0.0718)*
cerpro	0.9736	0.6831	1.1083	-0.0478	0.2054
	(0.0308)	*(0.0161)*	*(0.0051)*	(0.9008)	(0.6246)
Observations	37	40	30	27	26
R-square	0.371	0.398	0.358	0.407	0.438
F-test	35.57	23.09	14.00	16.55	11.08
Prob>F	0.000	0.000	0.000	0.000	0.000

Note: P-values (t-test) are shown below parameter estimates (in brackets)
Estimates significantly different from zero at the .01 level are shown in italic.

Market competition: Ability of the firms in accessing to domestic market has a strong effect, especially in processing. The results suggest that if a one-point in ability of firm was increased, average TFP in processing would increase by 10.97%. The impact is smaller in other business lines. This impact probably reflects more than just the productivity-winning in the domestic market as an advantage, but rather it could serve as a proxy for accessing to international market.

Certification of clean production: The results indicate that TFP for firms that have certificate of clean production in planting is 23% higher than for those have not. The corresponding difference is 21% for animal firms, and 18% for aquaculture. The implications of these differences in terms of the relative food security and business efficiency of the firm in agriculture are obvious.

CONCLUSIONS

The results of our analysis yield valuable insights regarding firms' internal characteristics, in addition to the role of investment climate variables that explain variations in TFP across agricultural

firms in Hanoi.

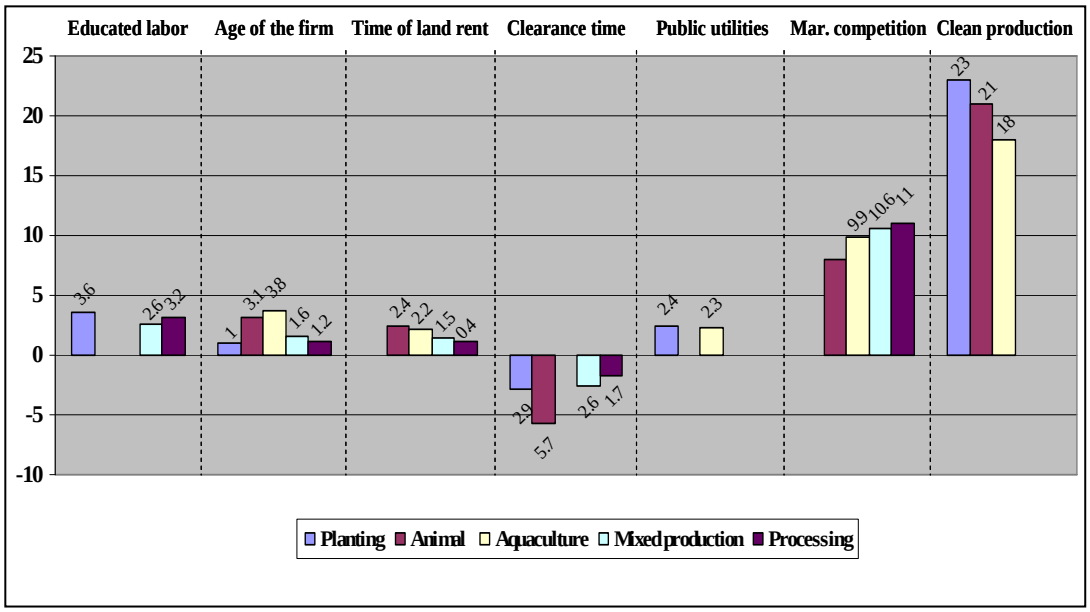

Fig. 1. Effect of the factors on TFP (in percent)

Regarding firm characteristics, educated labor and age of the firm affect productivity. In the case of Hanoi, a single firm characteristic, educated labor, is shown to have profound effect on TFP. Productivity increases by 3.62%, 2.61%, and 3.2% for planting, mixed, and processing respectively when number of years of education was increased by 1 year. One other firm characteristic is age. Due to greater experience and the long-term established customer relationships, as well as changing slowly in production and demand in agriculture, older firms have higher productivity compared with younger firms in all business lines.

Among the investment climate variables, administrative clearance time and has a strong negative effect on TFP for four of the five business lines. On the other hand, market competition and time of land rent have strong positive effects on TFP for almost business lines. A particularly interesting result is the strong positive effect of certification of clean production on productivity. This indicator is probably an encouragement for food security. Poor infrastructure and utility services have positive effects on productivity but it is not so high.

On the other hand, Hanoi is blessed with abundant natural resources for agricultural production. Its fertile land, moderate weather, abundant water (except during a few dry months), and irrigation and drainage systems are all favorable for agricultural activities in and around the city besides qualified labor force and a network of public institutions. These resources impact enormously on sustainable agricultural development. It contributes a large percentage of fresh food to the residents and engages a large number of people in its production, processing and marketing activities.

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EFFECT OF TEMPERATURE AND DIET ON THE LIFE CYCLE AND PREDATORY CAPACITY OF *EPISYRPHUS BALTEATUS* (DE GEER) (SYRPHIDAE: DIPTERA) CULTURED ON *APHIS GOSSYPII* (GLOVER)

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ABSTRACT

The larvae of hoverfly *Episyrphus balteatus* (De geer) are important predators for controlling the aphids in cruciferous vegetable fields in Hanoi. The effects of temperature on the development and the predatory capacity of *E. balteatus* larvae were studied in laboratory. The life span of *E. balteatus* is 21.2 days at 26.6^{o}C and 19.6 days at 29.9^{0}C. The predatory capacity of third instar *E. balteatus* larvae is an average of 32.2 prey per day at 27.5 ^{0}C and 30.6 prey per day at 30.6^{0}C. Honey and pollen increased the longevity of the adults. This paper also shows the effect of different prey species on the feeding capacity of ***E. balteatus*** larvae which was significantly greater on *Aphis gossypii* and *Myzus persicae* than on *A. craccivora*. *E. balteatus* has a high predatory capacity on aphids and therefore can be used as a bio-control agent against aphids of crucifers.

Key words: predatory fly, biological control, cruciferous vegetables.

INTRODUCTION

The hoverfly *Episyrphus balteatus* (De Geer) belongs to the subfamily *Syrphinae* (Stubbs and Falk, 1996; Kaczorowska, 2006; John et al., 2006). The larvae of this species are predators of more than 100 aphid species worldwide (Sadeghi and Gilbert, 2000). This insect is the most common in central Europe (Tenhumberg and Poehling, 1991), in the UK (Stubbs and Falk, 1996; Gilbert, 1993) and in the South Asia. Experiments performed in Indonesia, in which *E. balteatus* were collected from broad beans (*Vicia faba* L.), demonstrated that this species has a potential and important role in the biological control of aphids in the natural agro-ecosystem (Kalshoven, 1981). In Vietnam, the cotton aphid (*Aphis gossypii*) is one of the important insect pests of many crops, particularly cruciferous vegetables. The major method used by farmers to control this aphid species is to use insecticides that have, in many cases, adverse impacts on environment and food safety (Nguyen Thi Kim Oanh 1996, Quach Thi Ngo 2000).

It is necessary to find natural enemies that can control effectively the aphids in such situations. The major objectives of this study were to determine the effect of temperature on the life cycle and predatory capacity of *E .balteatus* larvae on *A. gossypii.* It also sought to assess the feeding capacity of *E. balteatus* larvae on different prey species.

MATERIALS AND METHODS

All experiments were done in the Department of Entomology, Hanoi Agricultural University, Vietnam. *E. balteatus* were collected from various cruciferous vegetables such as *Brassica oleracea var. capitata, Brassica chinensis, Brassica oleracea* var. *botrytis, and Brassica oleracea var. gongylodes* in Hanoi.

Life cycle

The flies were reared following the protocol of Bargen (1998). Adult flies were fed with bee pollen and crystalline sugar. Females readily laid their eggs on cruciferous plants (*B. chinensis*) with cotton aphid colonies attacking these plants. Immediately after hatching, larvae were transferred to the rearing cages (18 x 13.5 x 6.5 cm) and the second instar aphids were provided as food on leaf cuttings. Aphids were collected from cruciferous plants in the fields and reared on cruciferous plants placed in rearing sheft boxes until the second instars emerged. The number of aphids was counted everyday in order to provide additional food for larvae of *E. balteatus* until pupation. Temperatures for rearing were measured in the morning, afternoon and evening, with 80% relative humidity, 16 hours of daylight and artificial lighting of 5000 lux (cd/m^2).

Eggs were observed daily and larvae were observed in Petri dishes. The feeding process of 30 larvae and fresh cruciferous leaver provided daily until pupation. Pupae were observed daily for adult emergence and sex was determined. Eggs, larvae, pupae were also collected daily and preserved in 70 % ethanol.

Effects of various food on the longevity of *E.balteatus* adults

Adult flies were transferred to the rearing cages (18 x 13.5 x 6.5 cm). Three experiments of foods, water (control), pollen and honey + pollen 10% (honey mixed with pollen follow the ratio 1:1), were performed with three replicates. In each experiment, 30 adult flies were provided with food daily until natural death and the life span recorded.

Feeding capacity of *E.balteatus* larvae on *A. gossypii and* different prey species

Immediately after hatching, the larvae of *E. balteatus* were taken and reared individually in Petri dishes. Three aphid species, *A. gossypii, Myzus persicae* and *A. craccivora*, used for this experiment were collected from cruciferous fields. Aphids were reared on cruciferous plants placed in sheft boxes. Aphids at second instar were transferred into each Petri dish as food for larvae of *E. balteatus*. The larval stages of *E. balteatus* (first instar, second instar, third instar) were tracked using 30 individuals for each stage. Each individual of *E. balteatus* was provided with 50 second instar larvae of prey every day. The number of prey eaten daily and the development time of the *E. balteatus* larvae were recorded. The experiments were performed with 3 independent replicates.

RESULTS AND DISCUSSION

Effect of temperature on development of *E. balteatus*

The life cycle of *E. balteatus* was significantly influenced by the rearing temperature. Two temperature modes, 26.6^{o}C and 29.9^{o}C on average, were used to assess the life cycle and developmental stages of the fly. The life cycle was 21.2 days at 26.6^{o}C and reduced to 19.6 days at 29.9^{o}C (Table 1). The egg period was 3.1 and 2.8 days, respectively. The fly has three instars, in which the first instar period was 2.1 and 1.7 days, the second instar period was 2.2 and 2.2 days, and the third instar period was 3.3 and 3.2 days, respectively. The pupal development took 7.9 and 7.7 days, respectively. As with most insects, duration for each development stage decreases with

increasing temperature. The effect of temperature on development of *E. balteatus* was similar with that described by Bargen (1998).

Table 1. Effect of temperature on the developmental stages of *E. balteatus* on *A. gossypii*

	Duration (days) at respective temperature (^{o}C)	
Developmental stage	**29.9**	**26.6**
Egg	2.8 ± 0.13^{b}	3.1 ± 0.10^{a}
First instar	1.7 ± 0.16^{b}	2.1 ± 0.10^{a}
Second instar	2.2 ± 0.13^{b}	2.2 ± 0.14^{a}
Third instar	3.2 ± 0.14^{b}	3.3 ± 0.16^{a}
Pupa	7.6 ± 0.17^{b}	7.9 ± 0.09^{a}
Pre – Oviposition	3.2 ± 0.14^{b}	3.2 ± 0.16^{a}
Total life cycle	**19.6 ± 0.18^{b}**	**21.2 ± 0.14^{a}**

Note: Means followed by different letter in the same column are significantly different ($p < 0.05$).

Effect of food on the longevity of adult *E. balteatus*

The longevity of the adult fly at the two temperature modes is presented in Table 2. The longevity of the adult fly depended on both the rearing temperature and food type. The longevity of adult was slightly prolonged when they were reared at 25.5^{0}C compared with that when they were reared at 28.1^{0}C.

Table 2. Effects of pollen and honey on the longevity of *E. balteatus* adults.

Average Temperature (^{0}C)	Food type	Adult longevity (days)
28.1	Water	3.1 ± 0.2^{a}
	Pollen	6.8 ± 0.3^{b}
	Honey + pollen 10%	7.3 ± 0.3^{c}
25.5	Water	3.6 ± 0.4^{a}
	Pollen	7.2 ± 0.3^{b}
	Honey + pollen 10%	7.8 ± 0.3^{c}

Note: Means followed by different letter in the same column are significantly different ($p < 0.05$).

With food type was water (used as control), the average life span of the adult was lowest, with 3.1 and 3.6 days at the two temperature modes, 25.5 and 28.1 ^{0}C, respectively. When the adults were fed pollen or a mixture of honey + pollen 10%, the average life span of the adult was prolonged. For instance, the life span of the adults reared on honey + pollen 10% was highest, with 7.3 and 7.8 days at the two temperature modes. These observations are similar with those observed by Iwai and Hideki (2007), Tenhumberg and co-workers (1991) and Bargen **(**1998).

It is known that the rearing temperature and food type may affect directly some biological characteristics of insects such as longevity and egg-laying rate. As reported by Bargen (1998), some foods are much more suitable for *E. balteatus* adult; for instance, the honey and crystalline sugar can promote egg production of *E. balteatus*

Feeding capacity of *E. balteatus* larvae on cotton aphid (*A. gossypii)*

The predatory capacity of *E. balteatus* larvae of each stage on cotton aphid was assessed at two rearing temperatures (Table 3). The predatory capacity of first instar larvae was lowest, eating an average 6.5 prey per day at 27.5^{0}C and 6.0 prey per day at 30.6^{0}C. The capacity of the second instar larvae was slightly higher, eating an average 7.23 prey per day at 27.5^{0}C and 7.07 prey per day at 30.6^{0}C. At the third instar stage, the larvae had the highest predatory capacity, eating an average of 17.9 prey per day at 27.5^{0}C and 17.2 prey per day at 30.6^{0}C. In total, each larva can eat an average 32.1 prey per day at 27.5^{0}C and 30.5 prey per day at 30.6^{0}C.

These results demonstrate that *E. balteatus* larvae can be an important predator of cotton aphid.

Table 3. Feeding capacity of *E. balteatus* larvae on *A. gossypii*

Developmental stage	Average temperature (^{0}C)	Predatory capacity of different instars of *E. balteatus* (prey/day)
First instar	30.6	6.0 ± 0.23^b
Second instar		7.1 ± 0.26^b
Third instar		17.2 ± 0.54^b
Total prey eaten		**30.6 ± 1.04^b**
First instar	27.5	6.5 ± 0.19^a
Second instar		7.2 ± 0.26^a
Third instar		17.9 ± 0.28^b
Total prey eaten		**32.2 ± 0.62^b**

Note: Means followed by different letter in the same column are significantly different ($p < 0.05$)
Thirty insects were used in this experiment.

Feeding capacity of *E. balteatus* larvae on different prey species

The results presented in Table 4 show the feeding capacity of *E. balteatus* larvae on diffrent aphid species. The feeding capacity of the *E. balteatus* larvae on *A. gossypii* was similar with that on *M. persicae* (31.2 and 31.4 prey per day, respectively) and significantly greater than that on *A. craccivora* (28.2 prey per day).

Table 4. Feeding capacity of *E. balteatus* larvae on different prey species.

Prey	Average temperature (^{0}C)	Predatory capacity of *E. balteatus* larvae (prey/day)
A. gossypii	29.5	31.2 ± 1.03^b
A. craccivora		28.2 ± 0.55^a
M. persicae		31.4 ± 1.88^b

Note: Means followed by different letter in the same column are significantly different ($p < 0.05$)

Hindayana and co-workers (2001) showed that the predatory capacity of *E. balteatus* larvae was highest on *A. gossypii*. It was significantly higher than that on 3 other aphid species, *A. fabae, Aulacorthum solani* and *Acyrthosiphon pisum*, with 246.5, 147.5, 83.1 and 61.5 total prey eaten per fly larvae, respectively. Our results further demonstrated that the average number of aphids consumed *by E. balteatus* during larval development depended on the body size of the different prey

species. Of the 3 aphid species used in this study, the body size of *A. gossypii* and *M. persicae* is almost the same but larger than that of *A. craccivora.*

CONCLUSIONS

Rearing temperature affected both growth and development of *E. balteatus.* The cycle of this species was prolonged at low temperature. Honey and pollen increased the longevity of the adults. The feeding capacity of *E. balteatus* larvae was significantly greater on *A. gossypii* and *M. persicae* than on *A. craccivora*. The data from this work also provided further evidence that *E. balteatus* has high predatory capacity on aphids, and therefore can be used as a bio-control agent against aphids of crucifers.

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ASSESSING CONSUMER'S PREFERENCE FOR LOCAL RICE IN BRUNEI: AN APPLICATION OF CHOICE MODEL

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ABSTRACT

Consumer analysis was undertaken on preference for rice consumption in Brunei with the aim to study which attributes of rice consumers are valued. The specific methodological approach employed was Choice Model Technique which is used to evaluate non-market goods by eliciting people`s stated preference for different options in a hypothetical setting. It is capable of eliciting respondent preferences for new products and outcomes that do not currently exist in the market place. The economic valuation in this study also involves consumer willingness to pay, which is defined as the maximum value of money that an individual contributed to equalize utility. Our analysis shows how it can yield invaluable information regarding consumer demand that can uniquely assists Brunei policy makers, particularly the government and farmers, in developing new domestic rice production, pricing and marketing strategies.

Key words: food self sufficiency, rice attributes, willingness to pay.

INTRODUCTION

Brunei Darussalam (hereafter Brunei) has relied too heavily on oil and gas as the country's income contributors since it was founded in 1929. Oil and gas contributed B$M 2,600 or 63 percent in 1993 and B$M 3,500 or 57 percent in 2003 to Brunei GDP (DEPD,2007a; DEPD,2007b). Although Brunei has enjoyed the wealth derived from these contributors for the past decades, it cannot rely on them perpetually to generate income as these non-renewable resources will eventually deplete in time. Thus, other alternatives of economic diversification must be put in place in order to alleviate the effects of depletion of the fore-mentioned non-renewable resources.

If economic growth on the whole, is not kept in pace with population growth, it will cause not only economic problems but also social unrest like in many developing and poor countries. Brunei's economy and growth rates are vulnerable to movements in global oil prices and fluctuations in the oil price making it difficult to predict long term prospects. The decline in oil price, for example, might reduce government revenues. Therefore, for these reasons the government has made vigorous effort to find alternatives from over reliance on these hydrocarbon resources (Tisdell,1998; Minnis,1997). The Brunei government sees agricultural development as one of the strategies toward economic diversification. It is one of the most important sectors because it also can provide food security in the country while having the potential to contribute greatly to the country's economy. The contribution of agriculture to Brunei GDP has increased in recent years, where it increased from B$M 125 or 3.1% in 1993 to B$M 180 or 3.7% in 2003 (Department of Agriculture, 2008). Food self sufficiency is an important agenda because Brunei imports a large bulk of overall food requirement from foreign countries. Natural disasters and political uncertainties in the producing countries might

affect food supply to the nation. For this reason, the government perceives that reaching self sufficiency in food production is crucial.

Although rice is the main staple food or traditional diet for Bruneians, domestic or local rice production is still at an unsatisfactory level. About 95 percent of domestic rice consumption is imported with about 3 percent of self sufficiency level (Department of Agriculture, 2008). Migration of rural labor to urban area to seek better livelihood, low production yield and high production cost are some of the main factors that hinder the development of the rice sector (Upex and Ulluwishewa, 2002). However, due to self sufficiency considerations, the government sees that the rice sector should not be just neglected. In addition, it has a potential to provide employment opportunities especially in the rural areas, hence easing the socio-economic pressure in the urban areas. Consequently, the government has aggressively carried out various programs and plans in order to increase rice production. It is the purpose of this study to assist and inform stakeholders like the government, policy makers, private sectors and farmers to determine what kind of rice is highly preferred by the Brunei populace by considering public demand has to be met and that local rice had to suit the taste of the population. Based in this interest, this study applied the Choice Modeling (CM) technique which identifies which attributes rice consumers value.

Most studies which examined consumer preferences on rice applied hedonic prices method to evaluate quality characteristics as well as welfare gains from improved quality under various assumptions. Unnevehr et al. (1992a) assembled the reports that used this method from various countries in Southeast Asia (except Brunei and Singapore) and Bangladesh with the aim to contribute to increased the understanding of the variation in rice quality (attributes) preference across countries and the role market incentives play in rice improvement.

Consumer preferences for quality rice vary from country to country. For example, Efferson (1985) mentioned that Japanese consumers prefer well-milled, very recently processed, short-grain Japonica rice and consumers in Thailand prefer well-milled, aged, long grain Indica rice. Middle East consumers generally prefer long-grain, well milled rice with strong aroma while European consumers prefer long-grain rice with no scent. Unnevehr and co-workers (1985) reported that consumers in the Philippines, Indonesia and Thailand have strong preferences on milling quality (fewer broken grain and more polished) with aroma. Although their preferences in shape and chemical attributes vary, consumers generally prefer intermediate amylose content.

In America, consumer preference for rice is associated with specific cooking, eating, processing characteristics and product uses (Webb et al, 1985). For example, traditional mild tasting long grain varieties are preferred for parboiled rice, quick-cooking rice, canned rice, canned soups, dry soup mixes, frozen dishes and other convenience products. On the other hand, traditional medium and short grain varieties are preferred as dry breakfast cereals, baby food and for brewing. Improvement in rice quality (such as size, shape, aroma, amylose content) is considered important because it enhances consumer welfare and expands market potential (Unnevehr et al., 1992b). If consumer welfare is enhanced through rice quality improvement at a lower price, consumers will demand more rice and producers may thus benefit from an expanded market.

It also important to note that consumer preference for quality rice is highly associated with standard of living (ability to pay) and per capita consumption of rice (Efferson, 1985). The higher the standard of living and the lower the per-capita consumption, the wider is the range of prices consumers will pay for difference in rice qualities. In contrast, the lower the standard of living and higher per-capita consumption, like in developing countries, the smaller the difference in prices consumer will pay. Therefore, as consumers living in this area prefer large volumes at a reasonable price, they will pay little attention to quality differences.

This study sought to assess consumer willingness to pay for local rice variety and determine the variation of rice attributes in demand between urban and rural consumers.

METHODOLOGY

Study Area

Brunei has a small population of 400,000 people and is divided into four districts namely Belait, Tutong, Brunei Muara and Temburong. However, this study was conducted in Brunei Muara and Temburong districts only. Although Brunei-Muara is the smallest districts in term of area with only 570 sq. km, it is the most populous where 66 percent (213,000) of the total population resides. The state capital, Bandar Seri Begawan, is located in this district and is also the centre of government and business activities of the country making it as the most important and bustling district. Temburong, on the other hand, is located in the eastern-most district in Brunei. It is an exclave, as it is separated from the rest of Brunei by Malaysia and Brunei Bay. The main town located in the district is Pekan Bangar which is accessible by boat from Bandar Seri Begawan. The district borders Brunei Bay to the north and Sarawak, Malaysia to the east, south and west. It has a population of 9,300 (2.9 percent) and covers 1,166 sq. km and a large number of the society are still involved in agricultural activity particularly rice farming as a part time job. Therefore, because of the socio – economic difference between the two districts, Brunei Muara district is considered as an urban area in this study, meanwhile Temburong district is the rural area.

This study compared urban consumer's preference with rural consumer's preference in relation to demand for local rice. This is to investigate whether comparison in consumer preferences in both areas could be significant because of their distinctness in socio-economic characteristics.

Analytical Framework

Data was collected through face to face interviews during the whole month of March 2008 and with the help of 7 research assistants (undergraduate students), where 138 rice consumers in the urban (Brunei Muara district) and 80 rice consumers in the rural (Temburong district) areas were interviewed. The survey was performed in various locations including supermarket, wet market and shopping complex in both rural and urban areas. These locations were chosen to ensure a random sampling encompassing a cross section of Brunei people and to survey consumers at the same place and time where actual purchase decisions were made, in order to better elicit their true preferences.

Respondents were randomly selected after their shopping activities and were first asked if they are willing to participate in this survey. If they agreed to participate then the survey objectives were explained to them. This is followed with an explanation of the questionnaire and the choice set. The first part of the questionnaire includes how willing the consumer wanted to pay for local rice if local rice is to be marketed. They were given dichotomous choice to vote `yes' or `no' to pay a kilogram of rice at a 6 different prices. The second part was choice modeling questions (Table 1).

In the choice set, respondents were presented with three options; Option A, Option B and Option C. They were required to choose one out of three options. Option A is local rice and Option B is imported rice. Option A and Option B are imaginary options meaning that combinations of attributes and levels in these options were changed in every set. This was done in order to investigate which attributes of rice consumer are valued. However, in Option C or status quo, the attributes and levels remain unchanged in every set. This option has the attributes and levels of imported rice which is consumed daily by Bruneians.

Table 1. A choice set sample used in the survey.

	A (Local Rice)	B (Imported Rice)	C (Actual Imported Rice)
Physical Appearance	Red + Long	Brown + Short	Bright White + Long
Texture	Glutinous	Non - Glutinous	Glutinous
Taste and Smell	Sweet + Aromatic	Sweet + Non - Aromatic	Tasteless + Aromatic
Health Hazard Awareness	Non - Organic	Organic	Non - Organic
Price	B$1.70	B$0.70	B$1.20
I would choose (☑ one only)	☐	☐	☐

Table 2 summarizes the attributes and levels that were used to create choice sets using 2^4 x 4^2 orthogonal effects design (Louviere et al., 2000) which produced 32 choice sets and were divided into 6 versions. CM technique requires the respondent to compare and select 1 option out of 3 in all the choice sets.

Table 2. Descriptions of attributes and levels used in the Choice Set.

Attribute	Description	Attribute Level
Physical Appearance	The color and size of rice grains	1) Bright white 1) Short 2) Brown 2) Long 3) Red 4) Purple
Texture	Condition of rice after cooking	1) Glutinous 2) Non - glutinous
Taste	Taste of rice after cooking	1) Sweet 2) Tasteless
Smell	Smell of rice after cooking	1) Aromatic 2) Non-aromatic
Health Hazard Awareness	Whether the rice is organically or non-organically produced	1) Organic 2) Non-organic
Price	Amount that consumer will pay for their preferred rice per kg	1)B$0.80 3)B$1.40 2)B$1.10 4)B$1.70

Choice modeling (CM) that used attribute based technique was first applied by Louviere and Hansher (1982) and Louviere and Woodworth (1983) in a report prepared by Adamowicz and co-workers (1998). This technique originated in market research and transport literatures and was recently applied to the environment (Bateman, 2002). CM is also a technique that used to value non-market goods, which is specifically rice attributes in this study. It involves eliciting people's stated preference for different options in a hypothetical setting. Therefore, being a stated preference technique, CM is capable of eliciting respondent preferences for new products and outcomes that do not currently exist in the market place. In CM, people are usually confronted with a series of choice questions that are characterized by specific attributes, levels and prices. Furthermore, consumers derive satisfaction not from the goods themselves but from attributes they provide (Lancaster, 1966). Therefore, one of the main contributions of CM is that it can identify what attributes are significant

determinants people has place on non-market good.

The options chosen by respondents in the CM can be modeled in random utility framework which can be expressed as the sum of systematic component (Adamowicz et al., 1994). The utility obtained by individual i from choosing alternative j in a choice set can be expressed as;

$$U_{ij} = V_{ij} + \varepsilon_{ij} = V(X_i) + \varepsilon_i \quad (1)$$

where V_{ij} is the component utility, X_i is the characteristics of the relevant good and ε_{ij} indicates error component. When the i-th respondent selects j, the utility of V_{ij} of the selected alternative j is higher than the utility V_{ih} of other alternatives, and its probability (π_{ij}) can be defined by equation below;

$$\pi_{ij} = Pr\ \{V_{ij} + \varepsilon_{ij} > V_{ih} + \varepsilon_{ih};\ \forall h \in C_i \quad (2)$$

where C_i is the choice set for individual i. V_{ij} is a conditional indirect utility function and has a linear form,

$$V_{ij} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_n X_n \quad (3)$$

where $\beta_1 - \beta_n$ is vector of coefficient attached to the vector of attributes $X_1 - X_n$. Assuming that the error terms are Gumbel distributed, the probability of choosing option j is

$$\pi_{ij} = \frac{exp\ (V_{ij})}{\sum_{j \in C} exp\ (V_{ij})} \quad (4)$$

The marginal value of a change within a single attribute can be represented as a ratio of coefficients as follows;

$$\text{MWTP} = \frac{-\beta\ attribute}{\beta\ monetary\ variable} \quad (5)$$

Option C was coded as zero value and alternative specific constants (ASC) which were equal to 1, when either option A and B was selected. In this study, the software package LIMDEP 8.0 NLOGIT 4.0 (Greene, 2002) was used to estimate conditional logit model.

RESULTS

The demographic and socio-economic information of the respondents or consumers who participated in the survey both in the urban and rural areas are shown in Table 3. About 52.3 percent of the respondents or consumers were male and 47.7 percent were females and majority were confined within 31 to 40 years old. About 43 percent attained secondary school level, 30 percent high school or vocational level and the remainder 26 percent completed university level and beyond. About 37 percent of the respondents have household incomes of more than B$3,000 and about 30 percent have household incomes between B$1,500 to B$3,000 as well as less than B$1,500.

The percentage of respondents in the rural area who attained higher education was lower compared to those in the urban area and the percentage of rural households' income of less than B$1,500 is higher than these urban respondents.

Because of the survey was conducted in a shopping complexes in both areas, most of respondents came with their family members. Therefore, all the questions like WTP, choice

experiment, statement agreement and so on presented in the questionnaire were discussed among the family members and the results represent the opinions of the household.

Table 3. Socio - economic characteristics of rice consumers in Brunei, 2008.

		Urban		Rural		Total	
Category		**n**	**%**	**n**	**%**	**n**	**%**
Gender	Male	70	50.7	44	55	114	52.3
	Female	68	49.3	36	45	104	47.7
Age	Below 20 years	4	2.9	2	2.5	6	2.75
	21 – 25	15	10.9	8	10	23	10.55
	26 – 30	34	24.6	7	8.75	41	18.80
	31 – 40	33	23.9	23	28.6	56	25.69
	41 - 50	29	21	26	18.8	55	25.22
	Over 51 years	23	16.7	14	17.5	37	16.97
Education	Secondary	54	39.1	40	50	94	43.12
	High school/Vocational	44	31.9	22	27.5	66	30.28
	University	40	30	17	21.5	57	26.15
Household Income	Below B$1500	35	25	28	35	67	30.73
	B$1500 – B$3000	48	35	19	24	67	30.73
	Over B$3000	55	40	33	41	81	37.15

Source; Survey data, 2008.

Household expenditures and consumption of local rice between urban and rural consumers indicate that there is not much difference in information between urban and rural consumers (Table 4). Each urban household had an average of 7.55 members and rural households had 6.85 members. Out of this total, about 5.36 members in each urban household and 5.56 members in rural household prefer to consume local rice. The survey also revealed that each urban household consumed an average of 25.27 kg of rice while rural household consumed 25.54 kg per month. Out of this total, each urban household bought an average of 8.87 kg of local rice while rural household purchased 9.27 kg per month. Generally, urban households spent about B$37.25 while rural households spent B$38.76 in buying rice per month.

Table 4. Rice expenditures and consumption per household per month in Brunei, 2008.

Category	Urban	Rural
Total rice consumption (kg)	25.27	25.54
Local rice bought (kg)	8.87	9.27
No. of persons per household	7.55	6.85
No. of persons consuming local rice	5.36	5.56
Expenses for rice (B$)	37.25	38.76

Source: Survey data, 2008.

Local rice is quite unpopular among younger generations especially the children compared to

older generations. Some of the main reasons are because of the availability of imported rice and people are used to consume imported rice since their childhood. This could have an impact on the country`s local rice production should the population prefer imported rice than local rice creating doubt if there is any interest to consume, should Brunei produce own local rice. However, when asked whether they are willing to buy local rice should it production increase, 83.33 percent of respondents in the urban area and 76.25 percent in the rural area claimed that they are willing to buy local rice (Table 5). This could bring in a positive sign that there are demands for local rice in the future and prospects for developments of rice industry in Brunei.

Table 5. Urban and rural percentage on tasting local rice and willingness to buy local rice in Brunei, 2008.

Item	Urban	Rural
Have tasted local rice (%)	91	95
Willing to buy (%)	83.33	76.25
No. of respondents	138	80

Willingness To Pay (WTP) can be defined as the maximum value of money that an individual contributed to equalize utility. It is also an indicator of a value that an individual is able to pay for a commodity. We are interested in establishing how much the consumers are willing to pay using the bid function approach. They were presented a dichotomous vote “yes” or “no” and were asked if they are willing to pay a kg of rice at bid level ranging from B$0.70 to B$2.00 per kg. This amount is expected to improve the socio – economic and living standard of the farmers and their families. Besides, it also can be used to improve rice output and quality. Both local rice and imported rice in Brunei are subsidized and sold in the market at B$1.20 per kg. Interestingly, this study shows that the mean WTP is relatively higher even after the maximum bid price of B$2.00 per kg (Figure 1 and Figure 2). Therefore, we can assume that from this result, both urban and rural consumers have the ability to pay more than the original price B$1.20 and maximum bidding price of B$2.

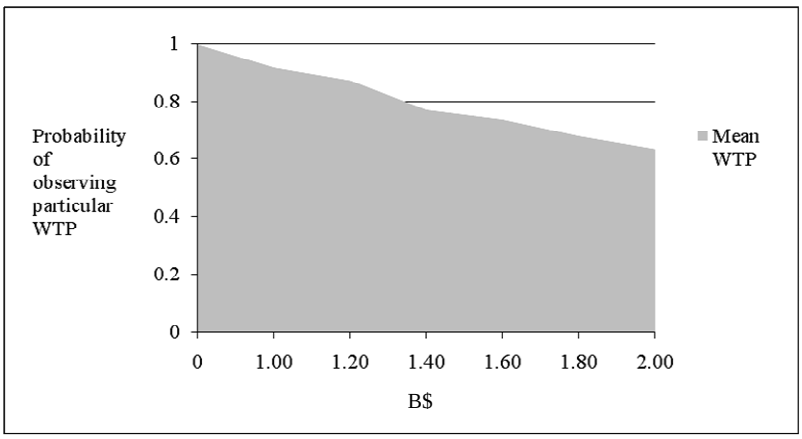

Fig. 1. Urban consumers WTP estimate for local rice in Brunei, 2008.

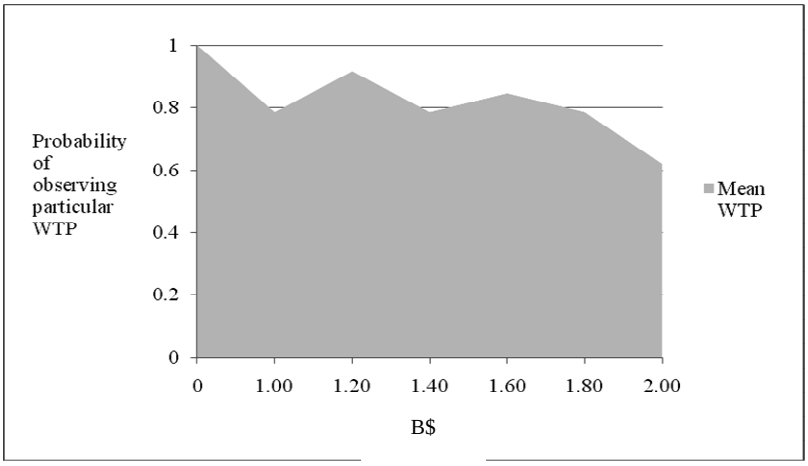

Fig. 2. Rural consumers WTP estimate for local rice in Brunei, 2008.

RESULTS AND DISCUSSION

Two attributes with four levels and three attributes with three levels were estimated using conditional logit model. Marginal willingness to pay for the preferred attributes was also estimated using equation 5. Attributes and levels were coded as shown in Table 6.

Table 6. Explanation of attributes and non-attributes in the Choice Model.

Variables	Attributes	Codes
ASC	Alternative Specific Constants	
WHITE	White	(1=White, 0=Brown)
RED	Red	(1=Red, 0=Brown)
PURPLE	Purple	(1=Purple, 0=Brown)
LONG	Long	(1=Long, 0=Short)
NGLUTIN	Non – Glutinous	(1=Nonglutinous, 0=Glutinous)
SWEET	Sweet	(1=Sweet, 0=Tasteless)
AR	Aromatic	(1=Aromatic, 0=Non-aromatic)
ORGNC	Organic	(1=Organic, 0=Non-organic)

A conditional logit model was specified and estimated from the choice data (Table 7). For urban consumers, most of the variables are found to be statistically significant at 1% and 5%. Only variables RED and SWEET are found to be insignificant indicating that these variables are not important to urban consumers. The statistical model indicates that variables WHITE, PURPLE, LONG, NGLUTIN, AR and ORGANC are factors which positively influence choice for urban households. PRICE is a negative factor as expected, where we predicted that consumers WTP is higher than the price stated.

On the other hand, about half of the variables are found to be significant at 1% and 5% in the rural consumer's estimate. Variables ASC, RED, PURPLE, LONG and AR are found to be insignificant, indicating that these variables are not important for rural consumers. The statistical model indicates that variables WHITE, SWEET and ORGNC are factors which positively influence choice for consumers in the rural. However, NGLUTIN variable showed a negative sign and was statistically significant indicating rural consumer's preference for glutinous rice. As expected PRICE variable showed a negative sign and was 1% statistically significant meaning that rural consumers do not prefer offered price in the options. From these results, rural consumers preferred rice that has these attributes: white, glutinous, sweet and organic.

In the conditional logit model, the coefficients cannot be directly interpreted as the direct effects of the respective explanatory variables on the probability of choosing each particular rice options. Rather, these represent the direct effects associated with each of the explanatory variables on the (unobservable) utility function which can be used to calculate the mean WTP for each attributes. In other words, each of the WTP estimates is calculated as the ratio of the coefficient associated with the attribute of Price coefficient. WTP for each attribute was calculated by using Equation 5 and the result is shown in Table 7. The confidence intervals for the different marginal WTP (MWTP) estimations were obtained following the procedure suggested by Hanemann and Kanninen (1999).

Table 7. Conditional logit model estimation for CM application.

Variables	Coefficient		MWTP		95% C.I	
	Urban	Rural	Urban	Rural	Urban	Rural
ASC	-1.1007**	-0.3292	-4.55	ns	(-7.37, -1.73)	
WHITE	1.3620**	0.8365**	5.63	4.49	(3.18, 8.08)	(0.79, 8.17)
RED	-0.1089	0.2058	ns	ns		
PURPLE	0.5322**	0.1353	2.2	ns	(1.57, 2.83)	
LONG	1.0760**	0.2606	4.45	ns	(2.49, 6.41	
NGLUTIN	0.2543*	-0.3290*	1.05	-1.76	(0.18, 1.92)	(-3.48, -0.04)
SWEET	0.1176	0.2961*	ns	1.59		(-0.04, 3.22)
AR	0.5588**	-0.059	2.31	ns	(1.21, 3.41)	
ORGNC	0.6906**	0.5855**	2.85	3.15	(1.60, 4.10)	(0.86, 5.44)
PRICE	-0.2417**	-0.1860**				
Log-likelihood	-751.87	-444.23				
Observation	737	425				

Note; ** and * indicate statistical significant at 1percent and 5percent respectively.

The MWTP indicates, for each attribute, the average amount of Brunei Dollar (B$) that a person would prepare to pay, indefinitely, for an increase (decrease) of one unit in the attribute level. Urban consumers are willing to pay more for white rice, estimated at B$5.63 than purple rice at B$2.20. This could indicate preference for the former than the latter. The size of the rice grain which has significant utility for urban consumers is the second most favored attribute, with an associated WTP estimate of B$4.45 for long rice. Increase in health concern or awareness as well as education are expected to be the main factors for consumers choosing organic rice, where it is the third preferred attribute with WTP estimate at B$2.85. This is followed with the attributes aromatic, purple and non-

glutinous.

For rural consumers, they are willing to pay for rice that have white, sweet and organic attributes where WTP estimates are B$4.49, B$1.59 and B$3.15, respectively. However, rural consumers are found not willing to pay for non-glutinous rice where MWTP estimate showed negative sign. This appears to support previous results that rural consumers prefer glutinous rice instead.

If we compare both urban and rural MWTP, results indicate that urban consumers have higher WTP for white attributes where MWTP estimate is B$5.63 compared to B$4.49. Urban consumers prefer non-glutinous attribute with MWTP estimate of B$1.05 but rural consumers prefer glutinous attribute because non-glutinous MWTP shows a negative sign.

CONCLUSIONS

Our findings show an interesting point that consumers had the ability to pay more and the mean WTP exceeds the maximum bidding value at B$2.00 while the current price of local rice is B$1.20. This could contribute to immense policy implication on setting the price of rice especially on local rice. Besides, this amount can help to improve the farmer`s socio - economic condition as well as their farm output and rice quality. It is observed that urban consumers prefer rice which has white, purple, long, non-glutinous, aromatic and organic attributes. They also demonstrate to have firm preference for white, long, and organic rice by observing the high amount of MWTP for these attributes. Meanwhile, rural consumers prefer rice which has white, glutinous, sweet and organic attributes. Rural consumers also show strong preference for white, sweet and organic rice by observing the high amount of MWTP for these attributes. Therefore, it is recommended that Brunei should produce rice that have these attributes.

This study also reveals that there is an increase in health awareness among Brunei consumers as health and food safety are priorities when choosing food. This information also can be used as a guide to develop the first organic rice in Brunei as there is great demand for organic rice.

One of the reasons why the price of WTP for local rice is yet to be determined is because of the small sample size. Therefore for future surveys, sample size should be increased to help understand the real WTP and assist policy makers on their decisions about the price of local rice. It is recommended that maximum WTP should be increased by B$2.00 because results show that consumer's mean WTP is higher than this price. Therefore, for the median WTP to be known, it is recommended that in a future study, bidding price should be greater than B$2.00.

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MYCOFLORA OF COFFEE BEANS IN THE PHILIPPINES

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ABSTRACT

The mycoflora of coffee beans in the Philippines were determined after harvest, after drying, and roasted coffee from retail markets. Twenty-six species from 14 genera were recovered. *Aspergillus* was prevalent with eight species such as *Aspergillus chevalieri*, *A. flavus*, *A. fumigatus*, *A. japonicus*, *A. niger*, *A. ochraceus*, *A. restrictus*, and *A. terreus*. *Aspergillus niger* dominated coffee at 52.31% followed by *A. flavus* (12.95%) and *A. fumigatus* (4.61%). Other *Aspergillus* species have less than 1% prevalence. The species of *Penicillium* were *P. janczewskii* (6.12%), *P. corilophylum* (4.67%), *P. citrinum* (2.14%) and *P. oxalicum* (1.34%). *Eupenicillium ochrosalmoneum* and *P. variabile* have less than 1% incidence. Other filamentous fungi were *Cylindrocarpon didymum* (5.96%), *Cladosporium cladosporioides* (3.56%), *Rhizopus oryzea* (1.44%), *Leptosphaerulina chartarum* (1.43%) and *Fusarium verticillioides* (1.38%). Finally, *Acremonium implicatum*, *Crysosporium* spp., *Microascus* spp., *Microdiplodia hawaiiensis*, *Mucor racemosus*, *Nigrospora oryzea*, and *Pestalotiopsis* spp. were also recovered at very low frequencies. The mycoflora and incidence after harvest, after drying, and roasted beans varied according to location where the coffee beans originated. The processing methods such as drying and roasting substantially affected the degree of fungal contamination in coffee beans. The total fungal load in coffee beans increased after drying but was reduced significantly by 93 to 97% after roasting.

Key words: Filamentous fungi, ochratoxin A, postharvest, toxigenic fungi

INTRODUCTION

Coffee is grown in the wide tropical countries surrounding the equator between the tropics of Cancer and Capricorn (Martins et al., 2003). In the Philippines, the production of coffee was once a major industry, which 200 years ago was the fourth largest coffee producing nation. Today, the country produces only 0.012% of the world's coffee supply with an average production of 97,428 metric tons in 2008 (BAS, 2010). Majority of Philippine coffee are produced in the mountain areas of Apayao, Batangas, Benguet, Bukidnon, Cavite, Claveria, Kalinga, and Davao.

Like other crops, coffee beans are subjected to contamination and consequent colonisation by fungi during production and postharvest stages. No coffee producing country is free from fungal contamination (Taniwaki, 2006). Extensive studies have been carried out on the mycobiota of coffee in African, Latin American, Middle East, and Asian countries (Abdel-Hafez and El-Maghraby, 1992; Bokhari, 2007; Ilic et al., 2007; Noonim et al., 2008; Pardo et al., 2004; Taniwaki et al., 2003; Taniwaki, 2006; Téren et al., 1997; Visotto et al., 2008). It is not currently known however, at which point during coffee growth, harvest and processing most fungal contamination occurred and more likely that levels increase when drying and storage are inadequate (Bucheli et al., 2000 and 2001; Bucheli and Taniwaki, 2002; Taniwaki et al. 2003; Taniwaki, 2006). Fungal contamination in coffee and an associated ochratoxin A (OTA) problem was due to faults in harvesting and storage practices (Urbano et al., 2001). Ochratoxin A is an important hepatotoxic, nephrotoxic, teratogenic and

carcinogenic toxin (Pitt, 1987). OTA production was earlier believed to be restricted to *Penicillium verrucosum* (Pitt, 1987; Pitt and Hocking, 1991 and 1997) and *Aspergillus ochraceus* (Ciegler, 1972; Hesseltine et al., 1972) with *P. verrucosum* predominating in temperate regions and *A. ochraceus* producing OTA in warmer areas (Moss, 1996). However, a number of additional *Aspergillus* species can produce OTA particularly those belonging to *Aspergillus* Section Nigri: *A.* a*wamori*, *A. foetidus*, *A. niger*, *A. carbonarius*, *A. lacticoffeatus* and *A. sclerotioniger* (Abarca et al., 1994; Heenan et al., 1998; Samson et al., 2004; Téren et al., 1997; Wicklow et al., 1996; Ueno et al., 1991; Varga et al., 1996) as well as those belonging to *Aspergillus* section Circumdati: *A. cretensis*, *A. flocculosus*, *A. pseudoelegans*, *A. roseoglobulosus*, *A. steynii*, *A.* s*ulphurous* and *A. westerdijkiae* (Frisvad et al., 2004).

As a tropical country, it is likely that environmental conditions in the Philippines are frequently conducive to fungal development in coffee beans. Taking all this information into account, this study enumerated the mycoflora in coffee beans from major production areas in the Philippines at harvest, after drying, and at the retail market outlets.

MATERIALS AND METHODS

A total of 85 samples during the 2008 to 2009 harvest seasons were collected after harvest, after drying, and roasted beans in retail markets of Benguet, Cavite, and Davao. Distribution of coffee samples gathered is shown in Table 1. Samples were brought to Philippine Center for Postharvest Development and Mechanization (PhilMech) (formerly BPRE), Science City of Muñoz, Nueva Ecija, Philippines. Each sample (one kg) was ground using a mill and thoroughly mixed for one hour by dough mixer.

Table 1. Distribution of coffee samples collected from different production areas and postharvest stages.

Production area	After harvest	After drying	Roasted beans	Total
Benguet	7	15	5	27
Cavite	6	14	5	27
Davao	6	16	11	31
Total	19	45	21	85

Fungal load in coffee beans was determined by plate count technique. A representative sample from the grounded coffee beans was drawn using sterile metal scoop and a decimal serial dilution was made under sterile conditions. From the serially diluted solution, 1 ml each was pour plated in dichloran rose bengal chloramphenicol agar (DRBC) or Dichloran 18% Glycerol (DG18) agar. DRBC is a general purpose counting medium but specifically used for the isolation of *A. carbonarius* and *A. niger* from coffee bean samples (Hocking and Pitt, 1980; King et al., 1979; Pitt and Hocking, 1997). Strains of *A. carbonarius* and *A. niger* were recognised by their distinct dark brown to black coloration of conidia (Pitt and Hocking, 1997; Klinch and Pitt, 1988). DG18 agar (Hocking and Pitt, 1980) was also used to determine if *A. ochraceus* was present. *Aspergillus ochraceus* colonies are not densely sporulating and grow on DG18 as pale to light yellow or amber yellow colonies (Klinch and Pitt, 1988). Fungal population was accounted after 5−7 days incubation at 25 °C. All samples were analyzed twice with five replicated plates.

Fungal colonies were isolated in pure culture. Taxonomic identification of the isolates was achieved through macroscopic and microscopic observation with the aid of guidelines published for each genus or general guidelines. *Aspergillus* and *Penicillium* isolates were purified by streaking onto malt extract agar (MEA) to check for purity and then three point inoculated onto czapek yeast

autolysate (CYA) and MEA before identification based on both macroscopic characters (colony growth, colony diameter) and microscopic characters using the identification schema of Pitt (1988), Klinch and Pitt (1988), Pitt and Hocking (1997) and Samson et al. (2004). However, for *Aspergillus* and *Penicillium* species, it has always been difficult to distinguish one taxon from another by cultural and morphological means because the differences are very subtle. Hence, selected isolates belonging to section Circumdati and Nigri were sequenced of the internal transcribed spacer (ITS) gene for confirmation of species identity as described by Noonim et al. (2008) and Houbraken et al. (2007).

The identity of other fungal isolates was also confirmed by molecular method. Mycelial plug was grown on PDA at 25 ºC and harvested after 1 week. From the fungal colony, mycelia was picked by sterile wire loop and resuspended in 1 ml sterile distilled water in a microfuge tube. The tube was centrifuged for 1 minute at 12,000 rpm and the supernatant removed. Then, 200 µl of 5% Instagene™ matrix was added to the pellet and incubated at 56 ºC for 30 minute. The tube was mixed in high speed vortex for 10 seconds and placed in 100 ºC heat block for 8 minutes. The tube was again mixed in high speed vortex for 10 seconds and spinned at 12,000 rpm for 3 minutes. The nuclear ribosomal ITS region was amplified with primer pairs ITS1 and ITS4 (White *et al*., 1990). Polymerase chain reaction (PCR) amplification of ribosomal DNA (rDNA) was performed at 98 ºC for 2 minutes with 30 cycles of incubation for 10 seconds at 98 ºC, 30 seconds at 52 ºC, and 1 minute at 72 ºC. Finally, at 72 ºC for 7 minutes. Gene amplification was performed with the TaKaRa ExTaq system (TaKaRa, Japan). Sequencing was conducted with the ABI-Prism 377 DNA sequencing system (Applied Biosystems, California) and DNA sequencing kit (Perkin-Elmer, USA) following the ABI protocol.

RESULTS

Table 2 gives quantification of the total fungal load of coffee beans collected from different production areas and postharvest stages. Coffee beans from Davao have the highest average viable mould count (2 x 10^3 cfu/g), followed by Cavite (1 x 10^3 cfu/g), and Benguet (3.8 x 10^2 cfu/g). The viable mould count increased in all samples after drying. Davao coffee has the most diverse mycobiota with 20 species, Cavite has 18 species and Benguet with 9 species. The predominant fungi in coffee from Benguet were *P. corilophylum*, Cavite coffee was dominated by *A. niger*, *A. flavus* and *P. oxalicum* while. *A. niger*, *A. flavus* and *Crysosporium* spp. were the main species in coffee from Davao.

Table 2. Quantification of total fungal load of coffee beans from various sources and sampling stages.

Sample origin	Total Fungal Load (cfu/g)			Mean
	After harvest	After drying	Roasted beans	
Benguet	3 x 10^2	7.8 x 10^2	5.3 x 10^1	3.8 x 10^2
Cavite	1.5 x 10^2	2.9 x 10^3	6 x 10^1	1 x 10^3
Davao	2.6 x 10^3	3.5 x 10^3	1.4 x 10^2	2.1 x 10^3

Table 3 shows the mean frequency of isolation of various fungi on coffee beans from Davao, Cavite, and Benguet after harvest (AH), after drying (AD), and roasted beans (RB). Coffee beans have diverse mycobiota composed of 26 species from 14 genera namely: *Acremonium, Aspergillus, Cladosporium, Cylindrocarpon, Crysosporium, Fusarium, Leptosphaerulina, Microascus, Microdiplodia, Mucor, Nigrospora, Penicillium, Pestalotiopsis,* and *Rhizopus*.

The dominant fungi of coffee was *Aspergillus* composed of eight species such as *Aspergillus chevalieri, A. flavus, A. fumigatus, A. japonicus, A. niger, A. ochraceus, A. restrictus,* and *A. terreus*. Two black aspergilli were the most frequently found fungi, isolated in 55% of the coffee beans analyzed. Of these 2,892 isolations of black aspergilli, 2,891 were *A. niger* and only one *A. japonicus*.

The closely related bi-seriate black aspergillus to *A. niger*, which is *A. carbonarius*, was not identified. *Aspergillus niger* and *A. carbonarius*, can easily be differentiated by conidia dimensions (3-5 µm for *A. niger* and 7-10 µm for *A. carbonarius*). The black uniseriate aspergillum isolated in this study was identified as *A. japonicus*. *Aspergillus fumigatus* was the second prevalent aspergilli at 9.5%. The green-colored aspergilla, identified as *A. flavus*, had 3.65% incidence in coffee beans. Other *Aspergillus* species have less than 1% dominance in coffee beans. The genus *Penicillium* had 16% share in the total mycobiota of coffee beans. The dominant strains were *Penicillium corilophylum* at 9.52%, *Penicillium citrinum* (4.7%) and *Penicillium oxalicum* at 1.38%. Other *Penicillium* species have less than 1% prevalence in coffee beans and identified as *Eupenicillium ochrosalmoneum*, *Penicillium janczewskii*, and *Penicillium variabile*. Finally, other fungal species were isolated and identified as *Cylindrocarpon didymum* with 5% occurrence, *Fusarium verticillioides* at 3.75%, *Cladosporium cladosporioides* at 1.52%, and *Rhizopus oryzea* at 1.20%. Additional strains associated with coffee beans at very low frequencies (1.94%) were *Acremonium implicatum*, *Crysosporium* spp., *Leptosphaerulina chartarum*, *Microascus* spp., *Microdiplodia hawaiiensis*, *Mucor racemosus*, *Nigrospora oryzea*, and *Pestalotiopsis* spp.

Table 3. Mean frequency of isolation of various fungi in coffee beans collected from Davao, Cavite, and Benguet after harvest (AH), after drying (AD), and roasted beans (RB).

Taxon	Benguet			Cavite			Davao		
	AH	**AD**	**RB**	**AH**	**AD**	**RB**	**AH**	**AD**	**RB**
Acremonium implicatum	20	7	0	0	0	0	0	4	0
Aspergillus chevalieri	9	23	0	3	63	0	0	0	2
Aspergillus flavus	10	89	3	0	0	10	7	53	19
Aspergillus fumigatus	0	21	4	0	0	2	138	328	4
Aspergillus japonicus	0	0	0	0	0	0	1	0	0
Aspergillus niger	3	29	11	25	1081	0	151	1572	19
Aspergillus ochraceus	0	3	0	0	0	0	0	2	0
Aspergillus restrictus	1	0	0	0	0	0	0	0	0
Aspergillus terreus	1	0	0	0	0	0	0	0	0
Cladosporium cladosporioides	25	30	0	0	0	0	3	22	0
Chrysosporium spp.	0	0	0	0	0	4	0	0	2
Cylindrocarpon didymum	13	5	0	0	0	0	188	50	0
Fusarium verticillioides	0	0	0	0	0	0	1	195	0
Leptosphaerulina chartarum	0	8	0	0	0	0	0	8	0
Microascus spp.	6	0	0	0	0	0	0	0	1
Microdiplodia hawaiiensis	10	5	0	0	0	0	0	0	0
Mucor racemosus	0	3	0	0	0	0	0	25	0
Nigrospora oryzea	0	0	0	0	0	0	3	0	0
Eupenicillium ochrosalmoneum	0	1	0	0	0	0	0	0	0
Penicillium citrinum	2	173	0	0	30	0	9	0	32
Penicillium corilophylum	18	275	0	0	0	0	4	201	0
Penicillium janczewskii	0	0	3	0	0	3	0	0	14
Penicillium oxalicum	1	1	0	47	9	0	5	9	0
Penicillium variabile	0	0	0	0	0	1	0	0	0
Pestalotiopsis spp.	0	0	0	0	0	0	1	5	0
Rhizopus oryzea	1	8	1	1	30	0	0	22	1

DISCUSSION

The fungal contamination in coffee beans in the Philippines was 97%, close to 98% contamination in Thai coffee (Noonim et al., 2008) and 93% contamination in Vietnam coffee (Ilic et al., 2007). Coffee beans in the Philippines have various mycobiota as we recovered 26 species from 14 genera. Species of *Aspergillus*, *Cladosporium*, *Fusarium*, *Penicillium*, *Mucor* and *Rhizopus* have been found before and confirm the widespread natural contamination of coffee with these fungi (Abdel-Hafez and El-Maghraby, 1992; Batista et al., 2003; Bokhari, 2007; Daivasikamani and Kannan, 1986; Gonzalez-Salgado et al., 2005; Mislivec et al., 1983; Perrone et al., 2007; Roussos et al., 1995; Silva et al., 2000; Vissoto et al., 2008). The range of filamentous fungi recovered from coffee beans in the Philippines appears to be much greater than previously reported elsewhere. Additional species include: *Aspergillus restrictus*, *Cylindrocarpon didymum*, *Crysosporium* spp., *Fusarium verticillioides*, *Leptosphaerulina chartarum*, *Microascus* spp., *Microdiplodia hawaiiensis*, *Nigrospora oryzea*, *Eupenicillium ochrosalmoneum*, *Penicillium variabile* and *Pestalotiopsis* spp.

Aspergillus and *Penicillium* were the dominant and important species recovered from coffee beans in the Philippines. Many studies revealed that *Aspergillus* and *Penicillium* are natural coffee contaminants, and are present from the field to storage (Nakajima et al. 1997; Silva et al. 2000). *Aspergillus niger* and *A. ochraceus* are the two species reported to be capable of producing OTA (Abarca et al., 2001; Bayman et al., 2002; Joosten et al., 2001; Mantle and Chow, 2000; Taniwaki, 2006; Taniwaki et al., 2003; Peronne et al., 2007; Noonim et al., 2008). *Penicillium* species capable of producing OTA was not isolated from coffee beans from all sampling sites however, the presence of *P. citrinum* samples has to be considered as it is an important mycotoxin-producer (citrinin) (Pitt and Hocking, 1997). Likewise, investigation of other fungi which produce enzymes that can reduce coffee quality is also encouraged.

Black Aspergilli was consistent in Philippine coffee with overall average occurrence lower than reported in Brazil, Thailand and Vietnam (Leong et al., 2007; Martins et al., 2003; Noonim et al., 2008; Taniwaki et al., 2003). The black Aspergilli that we isolated were about 99+% *A. niger* and less 1% *A. japonicus*. *A. niger* was reported to produce OTA in coffee (Abarca et al., 1994; Heenan et al., 1998; Samson et al., 2004; Téren et al., 1997; Wicklow et al., 1996; Ueno et. al., 1991; Varga et al., 1996). The closely related bi-seriate *A. carbonarius* was not identified from the representative isolates subjected to molecular technique. Whilst the incidence of *A. ochraceous* in Philippine coffee was less than 1%, this strain is a relatively important potential source of OTA in coffee products (Bayman et al., 2002; Mantle and Chow, 2000). The ochratoxigenic *Aspergillus ochraceus* has frequently been proposed as the major cause of OTA in green coffee (Frank, 1999), although a cause and effect relationship has not been demonstrated (Mantle, 1998).

Several reasons could be attributed for the variability and complexity of fungal load in coffee beans. Variation in climatic conditions, harvesting, processing method, and drying could substantially affect degree of fungal infection in coffee beans (Silva et al., 2000). The fungal load seems to be related to farmers' practice of harvesting, processing and drying. In Cavite for example, berries which fall to the ground are collected and mixed with mature and good berries for sun drying in the open ground, cemented pavement, or road for 10-29 days. Cherries fallen onto the soil are likely to have increased levels of OTA and might harbor OTA-producing molds which could rapidly be propagated in the drying yard (Bucheli et al., 2001; Bucheli and Taniwaki, 2002). The direct contact of coffee with ground soil could have increased mold count after drying. Ground patios must be avoided, since soil is the natural habitat of ochratoxigenic fungi and other microorganisms as well (Batista et al., 2009). Meanwhile, the lesser fungal load in Davao coffee could be attributed to the modified dry process that involves immediate removal of the pulp after harvest and a shorter drying time. Berries contain plenty of water (59-63%), with an easily accessible carbon source in the form of free sugars that makes them an ideal substrate for the development of molds and OTA formation

(Bucheli and Taniwaki, 2002). The wet processing and drying method in Benguet yielded lowest fungal count. The depulping process reduces significantly the fungal load and risk of OTA contamination during the subsequent fermentation and drying steps (Bucheli and Taniwaki, 2002). Wet processing appears less susceptible to infection by *Aspergillus* spp. and OTA contamination (Frank, 1999) as manifested by low incidence of this genus in the samples collected from Benguet. Since the fruit pulp is an excellent substrate for the growth of OTA-producing strains (Joosten et al., 2001), its removal eliminates a very suitable substrate. Moreover, the careful drying of depulped berries in Benguet using plastic net, laminated sacks, galvanized sheets, or bamboo mats could have reduced mould infection and subsequent OTA formation. The roasting process (218°C for 30 minutes) decreased the total fungal load in coffee beans from 93 to 97%. Fungal contamination of *A. niger* was reduced from 63 to 100% after roasting the coffee beans.

Our study provided first report on the mycoflora in coffee in the Philippines. We aimed to use these data as benchmark information for follow-up studies to improve the quality of coffee destined for local and export markets. Such study, for example, is the evaluation of the toxigenic potential of *A. niger* and *A. ochraceus*. The variability of fungal contamination from different growing areas and postharvest stages suggests follow-up investigations of the relationship between the mycobiota and presence of OTA in coffee, local climatic conditions and processing factors. Particularly, studies on the a) distribution of fungi with the potential to produce OTA, in coffee beans throughout the harvest, drying, and storage; b) investigation of the relationship between the presence of OTA in coffee and local climatic conditions; and c) the influence of processing practices on OTA production.

Meanwhile evaluation of the presence of OTA in coffee beans is very important in the context of consumer protection and food safety. Regulatory authorities in some coffee consuming countries have set maximum limits for OTA in coffee in recent years. For green coffee limits range between 5 and 20 parts per billion (ppb); between 3 and 10ppb for roasted coffee; and between 4 and 10ppb for soluble coffee (FAO, 2010). Likewise, the time of invasion of coffee by toxigenic fungi is also of great importance in understanding the problem of OTA in coffee and developing control strategies. The solution to the problem of OTA in dried coffee appears to lie in improvements in agricultural practice (Taniwaki et al., 2003).

CONCLUSIONS

Coffee beans in the Philippines have diverse mycobiota with *Aspergillus* and *Penicillium* as prevalent and important specie recovered. The coffee beans from Davao have the highest mean viable mould count followed by Cavite and Benguet. The processing methods such as drying and roasting substantially affect degree of fungal infection in coffee beans.(What abt roasting?) The high fungal contamination was characterized by fruit contact with the soil and by inadequate postharvest handling of the product during drying in ground patios. Ground patios must be avoided, since soil is the natural habitat of ochratoxigenic fungi and other microorganisms as well. The adoption of the Good Agricultural Practices (GAP) will significantly reduce the risk of microorganism contamination under the conditions of coffee fruit and bean deterioration as well as reduce OTA production. The present study showed that there is a need for follow-up studies to improve the quality of coffee destined for local and export markets.

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PRODUCTION MANAGEMENT PRACTICES OF JASMINE (*Jasminum sambac* [L.] Aiton) IN THE PHILIPPINES

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ABSTRACT

Jasminum sambac [L.] Aiton, locally known as sampaguita in the Philippines, is a traditional plant cultivated for its fragrant flowers. The study was conducted to evaluate the present cultural management practices as well as problems and issues that confront the farmers/producers in major jasmine production areas in Laguna, Quezon and Pampanga, Philippines. Specifically, the study focused on production schemes and pest management to enhance the viability of jasmine production.

The major problems identified by the 172 respondents were the high production costs, inefficient farm management, seasonality of bud formation, and lack of proper information dissemination. Farmers regularly pruned, defoliated and applied commercial fertilizers to enhance bud formation. The occurrence of morphological and physiological disorders was noted. Farmers perceived opportunities in increased production due to the foreseen income potentials for fresh flowers and other products. The income of farmers from fresh buds ranged from Php 3,000 to Php 26, 000 per month. The major insect pests were whiteflies (*Dialeurodes kirkaldyi* Kotinsky) and microlepidoptera (tiny moth). Drying of the roots and yellowing of the leaves were observed. Cultural management and harvesting practices need to be improved through adequate production inputs and proper tools and equipment for rapid farm operations. It is important to create an integrated pest management (IPM) protocol for jasmine farming and come up with a resistant variety most especially when jasmine is intercropped with cash crops. Institutional and financial support are also important for research on technologies in processing jasmine into high-valued products to increase its economic value and widen the market potential.

Key words: propagation techniques, morphological disorders, production seasonality, defoliation, pruning, pest and disease management.

INTRODUCTION

Jasminum sambac (L.) Aiton (syn. *Nyctanthes sambac* Linn.) is a species of jasmine native to southwestern and southern Asia, in the Philippines, India, Myanmar and Sri Lanka (http://en.wikipedia.org/wiki/Jasminum *sambac*). The term jasmine is derived from the Arabic Persian word? "yasmin" or "gift from god". The commercially important species grown for cut flowers and perfumery industry are *J. sambac*, *J. grandiforium*, and *J. auriculatum* (Rimando, 2003). In the Philippines, three types of *J. sambac* (traditionally termed sampaguita) flowers are grown, the single-petal or "Maid of Orleans", semi-double or "Belle of India" and the multi-petal or "Grand Duke of Tuscany". Sampaguita is a Spanish word for the local phrase "sumpa kita", meaning "I promise you" so that the flower became a symbol of fidelity, purity and eternal love in the Philippines. It is the Philippine national flower and is considered as a symbol of honor and dignity (Tan, 2004). As a fresh flower, jasmine is used in bouquets and garlands to honor guests. The

different parts of *J. sambac* such as the leaf, stem, bark and roots are important as source of chemicals that are useful in the pharmaceutical industries.

Very limited research on production requirements and marketing has been reported (Rimando, 2003). Hence, research is necessary to increase volume of production and improve the blossom quality to exploit local and export markets. The study sought to evaluate jasmine production practices in selected major production areas in Laguna, Lucena City (Quezon) and Pampanga. Specifically, it evaluated the present cultural management practices in the selected areas; identified and analyzed the problems and issues in the establishment and maintenance of jasmine farms; and evaluate the system of harvesting and handling of the blossoms. The results of the study are envisioned to benefit the stakeholders not only in the selected production areas but also other jasmine production areas in the country.

MATERIALS AND METHODS

Coordination meetings were conducted with the key informants from the provincial and municipal agriculturists' office and other stakeholders. Site visits to the different production areas were done for initial gathering of information which served as baseline data for evaluation/assessment of farming systems and management of jasmine as a main or alternative crop. Issues and problems were also gathered for process evaluation. The questionnaires were based on the baseline data.

The study sites were selected based on the degree of involvement of the farmers as identified by the traders. The jasmine producers were identified by the Municipal Agriculturist Office. Snowball sampling determined the number of respondents as well as the willingness of the farmers to participate in the survey, resulting in 172 respondents that included 86 in Laguna, 47 in Pampanga and 37 in Quezon province (Figure 1).

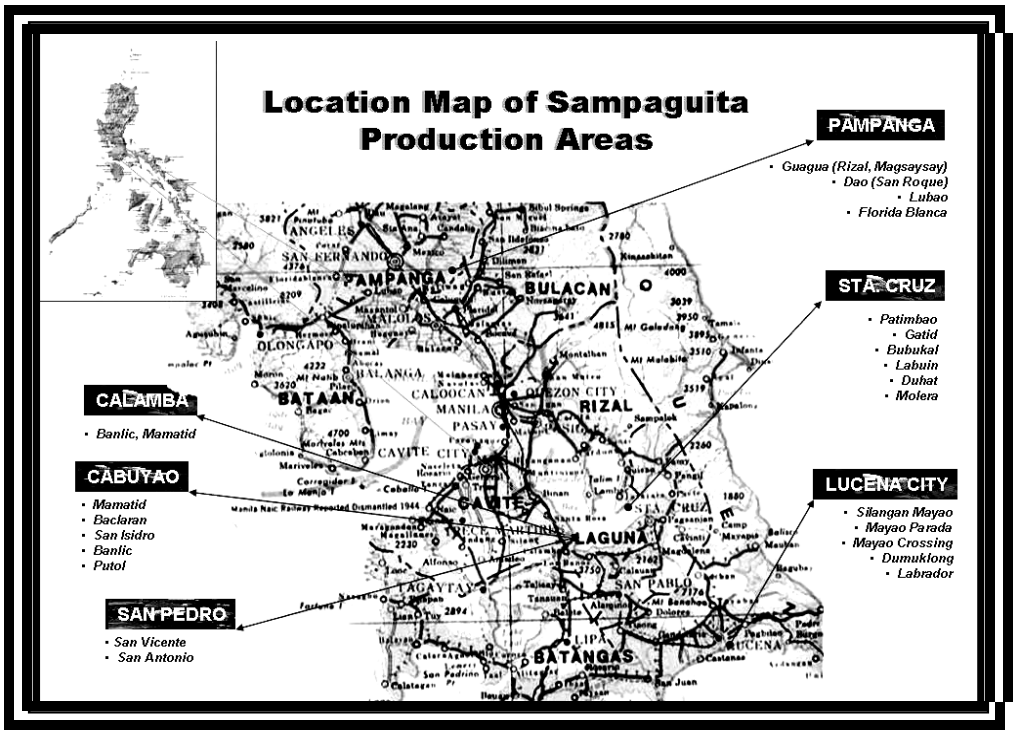

Fig.1. Production sites of jasmine in Luzon, Philippines

The municipalities in Laguna included: Calamba (Banlic), Cabuyao (Mamatid, Baclaran, San Isidro, Banlic, Putol), San Pedro (San Vicente, San Antonio), and Sta. Cruz (Patimbao, Gatid, Bubukal, Labuin, Duhat, Molera). In Lucena City (Quezon Province), jasmine farmers from Silangan Mayao, Mayao Parada, Mayao Crossing, Dumuklong and Labrador were interviewed. Lastly, the respondents from Pampanga included the producers in Guagua, Dao, Lubao, San Roque and Florida Blanca. The number of respondents from Sta. Cruz, Laguna was relatively higher compared to other production areas since the buds provided them their daily income.

Based on the data generated, current production practices, issues and concerns of the farmer/producers were assessed. Strategies were formulated for improvement of jasmine production in the Philippines.

RESULTS AND DISCUSSION

The farmer/producer respondents were 20 to 77 years old where young producers (20-25 yr. old) got involved in the operation after inheriting the farm from their parents. Their exposure to jasmine production equipped them to master the trade. Farmer/producer respondents consisted of 58 % male and 42 % female. The level of educational attainment of the farmer/producers was relatively low, where 37.8% and 32.6 % graduated from elementary and high school, respectively and 22.66 % either started or finished college education. All the respondents are married and about 85.5% relied on jasmine production as their main income. About 14.5% of the respondents, who are either involved in rice farming, livestock, orchard, vendor, furniture making, fishing, selling dry goods, laborers or contractors, considered jasmine production as an additional source of income. In the province of Laguna, the respondents were involved in jasmine farming for 8 to 51 years where those in San Pedro for 3 to 41 years, in Cabuyao for 2 to 25 years, in Sta. Cruz for 3 to 51 years and 3 to 16 years in Calamba. On the other hand, jasmine farming was done for 2 to 35 years by the respondents from Pampanga, and 2 to 16 years in Lucena, Quezon.

Cultural management practices of jasmine in selected areas

The prevailing climate conditions in the Philippines are favorable for the culture of *J. sambac*. Jasmine is sun-loving, thrives best under relatively dry conditions and requires light intensities ranging from 4,000-8,000 foot candles for profuse flowering (Pal and Krishnamurthi, 1967). High temperature (30°C) and cumulative heat are favorable for growth and flower induction (Rai, 1984). The commonly planted *J. sambac* variety is the single-petal type where its main use is for fresh flower buds. The double-petal type commonly called *kampupot* is rarely planted. The single-petal jasmine flowers whole year round while the double-petal type blossoms only once a year. The cultural practices are almost similar in the different sites from the establishment of the plants to harvesting of the buds. Farm activities such as propagation from cuttings or marcots, weeding, watering, pruning, defoliation, fertilization and pesticides application are the common cultural practices involved in jasmine production.

Propagation and planting

The common planting materials are stem cuttings (8 to 10 inches) while in Sta. Cruz, (Laguna), Pampanga and Lucena a few farmers used marcotted plants since these are expensive and not readily available. The stem cuttings are usually bought in Talisay (Batangas), Mamatid (Cabuyao) and Bulacan and are easily handled, available and much cheaper than marcots. Farmers however, prefer marcotted plants due to the assurance of the survival and early flowering. Other asexual propagation methods include layering, grafting, and budding (Rimando, 2003). For mass production of planting materials, shoot tip cuttings of about 15 cm. long with four leaves are rooted in vermiculite, volcanic cinder, or coir dust and grown in screen house provided with misting facilities.

In other countries, jasmine propagation is done by ground layering and sucker, cutting and rooting, and tissue culture method for large scale multiplication of uniform and disease-free plants (Banerji and Dwivedi, 2007). These methods increase supply of planting materials for expansion of production areas. *J. sambac* was reported to be planted as 1.2 m x 1.2 m. or 0.75 m x 0.75 m (Rimando, 2003) however, the study found that the common spacing used is 0.5 m between plant and 1 m between rows. This spacing is convenient as it facilitates harvesting and cultural maintenanc. Therefore, there is a need to determine the right distance of planting that is convenient for the farmers while producing maximum yield of jasmine flowers.

According to the Bureau of Plant Industry, there are many inquiries about steady supply of fresh flowers for garlands and for essential oils for industrial and medical applications. However, there is no large-scale jasmine production. Since jasmine is easy to grow, thrives on many types of soils in a wide range of climatic conditions, it is recommended that government should give attention to this potential dollar earner plant of the country (Anon. 2010).

Water requirements

Stem cutting propagation of jasmine using medium-mature stems (8 to 10 inches long) is done by planting in perforated plastic bags filled with sandy-loam soil and watered daily. The water supply is one of the difficulties faced by the farmers. Although water is available in the vicinity, its source is several meters away from their farm. In jasmine cultivation, water is critical especially during the establishment period where rooting and rapid plant growth occurs. Studies have shown that the soil should be saturated with moisture to the root zone for good growth (Rimando, 2003). The flowering of jasmine is not correlated with the amount of rainfall although the water status in the soil prior to induction may influence the intensity of flowering (De la Paz 1986). However for potted jasmine, a total of eight flowering cycles per year is achieved at 44 days between cycles during dry months and 55 days during wet months. Furthermore, the low flower yield during the wet season is not correlated to the available water but to the high incidence of pests and diseases.

Weeding and mulching

Weeding is considered by farmers as a backbreaking maintenance activity. The presence of too much weeds in farm serves as breeding ground for some insect pests. Jasmine farmers weed as often as necessary and is done on the average, 2 to 3 times a week. In Sta. Cruz, farmers use rice stalk not only as mulching materials but also for weed management while in Pampanga, farmers used thick black plastic (polyethylene) sheet to cover the basal portion of jasmine plant (Fig. 2). Other mulching materials such as decomposed leaves and stem from pruning and defoliation operations and rice hulls were utilized by some farmers.

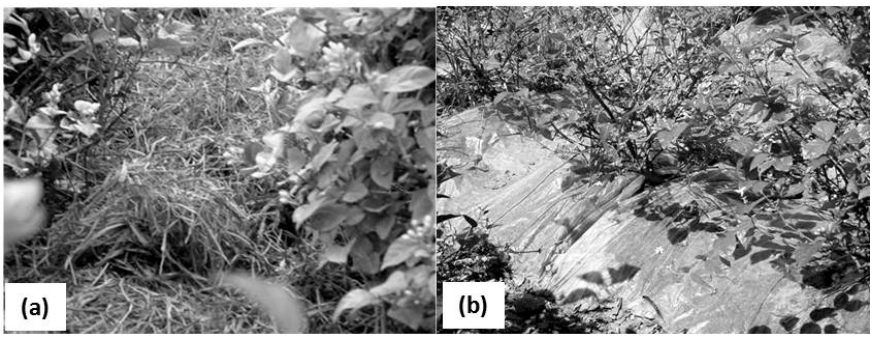

Fig. 2. Use of (a) rice stalk as organic supplement and (b) black polyethylene plastic for weed control

Production inputs

One of the major costly inputs of farmers in jasmine production is the use of chemicals like fertilizers and pesticides. The producers used both organic and inorganic fertilizers to produce high quality buds of jasmine. Common organic fertilizers included decomposed plant parts and animal manure. According to some of the respondents, organic fertilizers are seldom used because it is not effective as the inorganic fertilizer for plant growth and development. Commercially available inorganic fertilizers applied by farmers are urea, complete fertilizer and ammonium sulfate as well as potash. Based on farmer's experience, these fertilizers increase the productivity of their jasmine farms from 40% to 50% of their usual harvest. The application of nitrogen fertilization for increased flower yield are supported by the findings of Kumar and Gill (1983) who reported that the application of 30 g. N per plant gave the highest flower yield of 635.8 g per plant. In addition, the recommended fertilizer rates in India are 50 g N, 200 g P_2O_5 and 150 g K_2O per plant per year if farmyard manure has not been applied. If manure is applied at the rate of 10 kg per plant per year, N may be reduced to 5 g and the P_2O_5 to 100 g. In the case of the respondents, the mixing of different kinds of fertilizers before application is more effective in improving quantity and quality of the flowers. The frequency of application would depend on the availability of cash, plant size and quantity of the buds and foliage color. Some farmers used mulching materials such as the jasmine trimmings after pruning and defoliation activity as fertilizer input.

The commercial pesticides used by farmers are those that are readily available in the nearby market and recommended by the chemical representatives. Some of these pesticides are methomyl, carbaryl, deltamethrin, benomyl, carbofuran, endosulfan, cartap hydrochoride, cypermethrin and malathion. Pesticide application varied from 2 to 3 times a week similar to fertilizer application. The farmers observed some problems such as leaf twirling, yellowing of buds, discoloration of foliage and "burning effect" or toxicity in using these chemical pesticides. Probably the problems arose from improper application methods, frequency, timing and quantity applied. Improper methods of application of these chemicals also affected farmer's health because some of them experienced dizziness, vomiting and skin itchiness or allergies which may be caused by the absence of safety gadgets during application and improper use of the chemicals.

Defoliation and Pruning

Farmers practiced defoliation and pruning to initiate flowering and enhance production of buds. Based on their observation, these practices influenced the quality and quantity of the harvested buds. These practices are considered unique, interrelated and sequential maintenance activities applied by jasmine producers and usually done before the onset of rainy season to prevent pest and diseases occurrence, to have sufficient water supply, and to promote rapid shoot formation. Generally, these practices are done after the first to second flowering season or if jasmine is matured enough to be defoliated and pruned. According to the farmers, frequency of defoliation and pruning would also depend on the demand of buds in the market.

Despite of the positive effect of defoliation for bud production, producers also complain that it is time-consuming and labor intensive requiring the hiring of additional labor. Defoliation techniques applied to other plants should be tried in jasmine to be able to lessen the labor cost and shorten the time devoted in doing this activity (Anon., 1980). It was observed that for the sequential and simultaneous defoliation, pruning and harvesting operations, the farmers in Pampanga divided their farms into several equal blocks depending upon the size of the farm where one block is defoliated; another block is pruned, and another block harvested while the rest of the blocks are at the stage of shoot formation. Under this rotation of activities, there is sustainable farm production of buds. Based on the farmer's observation, defoliation and pruning practices influenced the quality and quantity of the harvested buds. These practices are considered unique, interrelated and sequential

maintenance activities applied by jasmine farmers during the onset of rainy season. These practices prevent occurrence of pest and diseases, assure sufficient water supply, and promote rapid shoot formation. Generally, these practices are done after the first to second flowering season or if jasmine is matured enough to be defoliated and pruned. The frequency of defoliation and pruning would also depend on the demand of buds in the market. It has been reported that pruning at six months intervals increase the flower formation (Muthuswamy and Rao, 1980).

Harvesting practices

Jasmine flower blooms only for less than a day on the plant, lasting for about 12 to 20 hours. The peak of flower opening is around 6 to 8 in the evening when the ambient temperature becomes cooler. The common practice of the farmers is to pluck or harvest the unopened matured flowers early in the morning although Rimando (2003) reported that fully developed unopened buds are picked late in the afternoon till sunset. Harvesting is one of the significant stages in jasmine production and there are three key players involved, the farmer/producer, the pickers (may be hired) and the runners (also considered as dealer in Pampanga) who collect the harvested buds in the farm. Harvesting usually starts as early as 3 to 5 in the morning. This activity requires efficient time and effective labor to harvest more buds at the earliest and shortest time before sunrise when buds tend to open. Although open flowers may find utilization as raw material for oil extraction, there is no technology yet established in the country. Also, large volumes of open flowers are needed for oil extraction which is not available this time

The maturity index of jasmine should be studied and established because this would help predict the proper time of harvesting. If the time of harvesting matured buds can be projected, then it would be easy for the farmers to calendar farming activities.

Crop protection management

About 53.5% of jasmine farmers in all provinces surveyed viewed whitefly (*Dialeurodes kirkaldyi*) as a serious problem both during wet and dry seasons (Table 1). It sucks the plant juices causing stunted growth and drying of plants under severe infestation. Based on the ocular inspection of jasmine production sites, the said insect was indeed prevalent at an alarming level during the dry season coinciding with the peak of bud production. The damage caused by this insect led to the reduction of flower formation. *Microlepidoptera* and whitefly were considered major pests. However, inspection of the area during the wet season, when *Microlepidoptera* population should be relatively high did not support the farmers' perception. Approximately 90% of jasmine plants were visibly infested by the whitefly, while only 5% were infested by *Microlepidoptera*.. Bud borers also infested jasmine flower buds. Despite the fact that jasmine is a perennial crop, white grub and termites were not considered serious by jasmine farmers. Some farmers mistook the lygaeid bug ("*atangya*") for a pest although it is a beneficial insect.

Some of the morphological disorders observed are discoloration of foliage, white spots, folding of foliage, basal rot, gradual death of the plant and damaged buds. Sooty mold was perceived as the most important disease. However, sooty mold is more of a symptom of infestation of a sucking insect such as the whitefly and can be washed away from leaves. Drying of roots is mainly due to infection by the soil-borne mold, *Sclerotium rolfsii*. Yellowing of leaves may be due to the yellowing mosaic virus which is of low incidence.

Table 1. Farmers' perception of pest and disease problems of jasmine.

Perceived Problems	Number of Respondents				
	Laguna	Quezon	Pampanga	Total[1]	Percentage
Insect					
Whitefly	47	19	26	92	53.5
Microlepidotera	50	18	33	101	58.7
Flower bud borer	11	0	3	14	8.1
White grub	8	0	3	12	7.0
Termite	1	3	0	4	2.3
Lygaeid bug[2]	15	5	0	20	11.6
Others	1	0	6	7	4.1
Disease/ Symptoms					
Sooty mold	27	4	18	49	28.5
Drying of roots	15	4	2	21	12.2
Yellowing of leaves	15	7	2	24	13.9
Others	11	0	0	11	6.4

[1]Total respondents for all provinces was 172. [2]Lygaeid bug is a predator of other insects and not a pest.

All farmers interviewed relied heavily on the use of chemicals for insect pest and disease management (Table 2). A few used other control measures such as handpicking of infested or infected leaves and treatment with smoke. Insecticides used were methomyl, carbaryl, cartap hydrochloride and several pyrethroids such as lambda cyhalothrin, cypermethrin and deltamethrin. Combinations or "cocktails" of 2 or 3 insecticides was practiced which may result in overdosing, insect resistance and excessive exposure of applicators to chemicals.

Table 2. Pest management practices of jasmine farmers.

Control Method	Number of Respondents				
	Laguna	Quezon	Pampanga	Total[1]	Percentage
Use of Insecticides					
Methomyl	40	7	13	60	34.9
Carbaryl	13	7	10	30	17.4
Cyhalothrin	3	1	9	13	7.6
Cypermethrin	5		2	7	4.1
Deltamethrin	5	1	2	8	4.6
Others	26	7	2	35	20.3
Cocktails					
Methomyl + Carbaryl	6	9	0	15	8.7
Methomyl+ Cyhalothrin	4	1	1	6	3.5
Other cocktails	17	7	5	29	16.9
Use of fungicides					
Mancozeb	7	0	0	7	4.1
Benomyl	1	2	0	3	1.7
Other methods (handpicking, etc.)	2	0	6	8	4.7

[1]Total respondents for all provinces was 172.

Very few farmers used fungicides for disease control. Some farmers used insecticides to control diseases, which reflects the lack of proper information about chemical usage and disease control. Nearly 20% of farmers applied chemicals twice a week and another 17.4%, thrice a week (Table 3). While these application frequencies are already excessive, a few farmers admitted having applied chemicals everyday or every other day. Excessive application of chemicals often results in the rapid build-up of pest populations due to extermination of natural enemies and/or development of resistance to chemicals by the pests.

Table 3. Frequency of pesticide application by farmers on jasmine.

	Number of Respondents				
Application Frequency	**Laguna**	**Quezon**	**Pampanga**	**Total[1]**	**Percentage**
Once a week	5	1	4	10	5.8
Twice a week	22	4	8	34	19.8
Thrice a week	15	10	5	30	17.4
Other frequency	16	9	4	29	16.9

[1]Total respondents for all provinces was 172.

Issues, concerns and strategies in jasmine production

The production areas of jasmine in the Philippines are still considered as a backyard or secondary operations and is rarely planted solely for commercial purposes. In the selected sites, jasmine is planted either along the highways, railroads, as secondary crop in the rice fields and vegetable production and in small patches in backyards. Some areas were planted for decades (51 years ago) in San Pedro, Laguna but are now converted to poultry and orchard farms, residential areas, dumpsites, subdivisions and industrial sites resulting in declining jasmine production. There was a continuous increased production of jasmine buds in Sta. Cruz, Lucena City and Pampanga. In all the production areas surveyed, the farmer plant intercrops to augment their income and maximize farm space. In Sta. Cruz, vegetables and rice crops are commonly integrated in their jasmine farm. Meanwhile, in San Pedro, Pampanga and Lucena, ilang-ilang (*Cananga odorata*), champaca (*Michelia champaca*) and camia (*Hedychium coronarium*) are planted for their flowers as accessories in special garlands. Calamba and Cabuyao farmers incorporate corn, citrus and vegetables to fully utilize the entire narrow farm spaces.

Based on the existing production schemes several issues and concerns in jasmine production were identified in the study. These include 1) limited production areas devoted for jasmine production; 2) seasonal production and unstable price of jasmine buds; 3) lack of quality control in the harvested buds; and 4) non-availability of modern farming techniques in terms of asexual methods of propagation, availability of growth promoting chemicals and resistant plant variety which could tolerate pest and diseases.

The lack of comprehensive recommendations for growing aromatic crops as an intercrop or mixed cropped with traditional agricultural crops has also been identified in India, which is a major world producer of aromatic plants. Incomplete recommendations targeting increased production of aromatic plants have limited use as these are difficult and uneconomical for farmers (Tewari, 2010). On the other hand, improved production systems can also utilize exogenous chemicals such as the application of hormones, NAA or PP 333, which can improve floral bud formation (Huang et al 2009).

Enhancing the benefits derived from jasmine production will encourage the farmers/entrepreneurs to venture in the business. One strategy is the availability of plant materials that will facilitate the establishment of commercial farms in the country. The seasonality of jasmine production which results in unstable price for jasmine buds is the major concern. Peak production of blooms is usually from April until June and the price is relatively low. Improved plant varieties like tissue culture, selection and mass propagation of non-seasonal blooming variety of *J. sambac* are important research areas to solve the seasonality of flower formation. Another strategy is to design a planting scheme where jasmine production areas are distributed all over the country. The regions in the Philippines differ in rainfall distribution so that harvesting of flowers can be rotated resulting in stable prices through year round production.

Quality of jasmine buds tends to be variable due to the uncontrolled production environments and differences in the production and post-harvest handling practices (Sanchez, et. al. 2003). The quality of buds is affected by the production environment: pest and diseases, seasonal bud production, and variation in bud size (as influenced by the farm inputs used such as fertilizers and pesticides) and availability of storage facilities to maintain bud freshness. The price of jasmine varies depending on whether the buds were stored overnight or are freshly harvested. Cold stored buds are cheaper because of lower scent quality. Therefore, quality standard for different grades of jasmine buds should be developed by concerned government agency to encourage improved farming practices.

Information dissemination regarding the proper and improved cultural and pest management of jasmine is needed from agriculturists, extension workers and horticulture specialists. Most farmers relied on the recommendations of chemical sales representatives even without farm trials. Other problems mentioned by the producers that need attention are irrigation systems, transportation and government subsidy for fertilizers, pesticides and micro-financing for their operating expenses.

CONCLUSION

There is a need to improve the production technology, insect pests and diseases management and harvesting practices of *J. sambac*. Selection of cultivars for high quality flower production should focus on varieties that could produce flowers even during the rainy months. Another option is infrastructure facilities that could house jasmine during the rainy months to prevent pest infestation of blossoms. A planting scheme can be designed to have jasmine production areas distributed all over the country so that floral buds are available the whole year thus stabilizing the prices.

Population density, fertilization and height of pruning are among the most important factors affecting the production of jasmine flowers. New production techniques and crop protection practices, which could address the current issues on irregularity of flower production, must be dealt with. Farmers should be given sufficient support in terms of materials, tools and technology to support their manual technique in inducing flower production. These could be done by having effective and efficient tools in harvesting and using environmentally safe chemicals or plant growth regulators to support the defoliation and pruning practices. Similarly, there is a need to determine the optimum maturity index and to improve harvesting practices for the fresh market.

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Building Resilient Communities through Agriculture

ABSTRACTS OF PAPERS AND POSTERS

APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM (GIS) ON THE VULNERABILITY ASSESSMENT OF WATERSHEDS AS A TOOL IN REDUCING CLIMATE CHANGE IMPACTS ON AGRICULTURAL PRODUCTION, BIODIVERSITY CONSERVATION AND ENVIRONMENTAL HAZARD AVOIDANCE: THE CASE OF YABO NAGA WATERSHED, CAMARINES SUR

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Due to climate change, natural phenomena and man-made disasters have become more frequent and devastating, threatening agricultural production systems and the livelihood of many people. The vulnerability of Yabo-Naga watershed in terms of natural and human induced risks and its impact to agricultural production were assessed following the Integrated Ecosystem Management Approach or "ridge to reef" policy of the DENR. The vulnerability of the Yabo Naga watershed was analyzed using Geographic Information System (GIS). Spatial maps and overlaying surface components of combined factors were generated to validate the relative contribution of various attributes to the occurrence of hazards. Consequently, less hazard prone areas most suitable for development; areas where further evaluation are required; and areas where mitigating measures should be prioritized were defined. Biophysical and socio-economic parameters were determined and reflected in thematic maps that serve as primary inputs in determining hazards and degrees of vulnerability.

Final output consisted of vulnerability maps indicating the degrees of susceptibility to flooding, soil erosion, biodiversity loss, water pollution and grassland fire. These vulnerabilities were analyzed in terms of impact to agricultural production. The watershed vulnerability to flooding, landslides and soil erosion, biodiversity loss, grassland fire, and water pollution ranges from moderate, high to very high, adversely affecting agricultural production both in upland and lowland areas. Due to their incapacity and lack of understanding of such hazards and vulnerabilities, the people and the communities are at risk. The empirical data and information generated by the study contribute insights and understanding to address the roots of vulnerabilities and reduce losses of lives, further degradation of resources and environment due to natural and human induced hazards. The outputs of the study also help in designing effective and efficient strategies and approaches to manage and reduce risks, and hence the occurrence and magnitude of disasters.

INDICATIVE SPATIAL SOIL FERTILITY MAPPING OF LAND MANAGEMENT UNITS (LMU'S) FOR RICE USING QUANTUM GIS

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The application of fertilizers is one important intervention in raising crop yield such as in rice. Generally, soil test and/or plant tissue analyses are used as basis to determine appropriate rate of fertilizer to apply on individual crop. Unfortunately, data on soil analysis especially at the Land Management Unit (LMU) level are often unavailable. If ever they are obtainable, many farmers do not

know how to use soil and/or tissue test results. Indicator-based mapping can generate maps that can be made easy for both ordinary farmer and technicians to use. The Geographic Information System (GIS) is one valuable tool that can help generate databases of soil properties at the same time present the spatial data into simple maps. This study utilizes Free and Open Source Software for Geomatics (FOSS4G) tools such as Quantum GIS and Open Office to develop soil databases and LMU-based indicative spatial soil fertility maps. The study utilized soil survey reports to gather basic soil information. Meanwhile, provincial production data were obtained from the Bureau of Agricultural Statistics to match rice performance record with soil data. Random key informant interviews were conducted to gather additional data (e.g. farmer profiles, rice varieties, and yield). In order to update soil information, soil samples were collected from each representative LMUs which were qualitatively analyzed for NPK and salinity level using the ASC-UPLB Soil Test Kit (STK). Nutrient Manager (NM) was utilized to find out what and how much fertilizer must be added for rice varieties planted in the sampled farms. Overall, the LMU's with clayey soil texture has high potential to supply essential nutrients to rice crop as indicated by the >24 cmol kg^{-1} CEC values and the medium base saturation (>20%) level. However, it was noted that several farms have very low (1-2%) organic carbon. This means N is generally limiting in most rice fields included in the study and therefore would require regular application of N fertilizer in order to maintain high and sustainable yield level. Further, the observed variability of fertilizer recommendations based on NM for different rice variety and under different LMUs would suggest that blanket fertilizer recommendations are not advisable to improve rice yield. It will not also help increase fertilizer use efficiency.

HOW VULNERABLE ARE THE UPLAND COMMUNITIES TO CLIMATE CHANGE? A SYNTHESIS OF COMMUNITY-BASED FOREST MANAGEMENT (CBFM) CASE STUDIES AND POLICY ANALYSIS

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CBFM as a strategy refers to all organized efforts of the government to work with local communities in and adjacent to public forestlands. It underscores the principles of social equity, sustainability and community participation in forest management and biodiversity conservation. Through the CBFM strategy, the government empowers and allocates to local communities portions of the forestlands for development, protection, management, conservation and further grants them access to utilize forest resources. Thus, CBFM is seen as a key forestry program that can meet the challenges associated with climate change. The various CBFM activities including natural forests management, degraded lands rehabilitation and agroforestry are supportive of the objectives of promoting ecological stability and promoting livelihood opportunities for upland communities. This study assessed the readiness of the CBFM program to meet the challenges of climate change by doing a content analysis of its various policy issuances and by looking into the actual bio-physical and socio-economic accomplishments of CBFM program. Different sets of criteria and indicators were formulated and tested to determine its contribution in reducing the impacts of climate change and whether the CBFM program adds to the resiliency of the forests and forest communities to adapt to climate change. Content analysis showed that climate change concerns are not mainstreamed in the various CBFM policy issuances, as these concerns are not explicitly mentioned in the policies. Despite this, CBFM policies are directed towards forest conservation, sustainable resource management and the enhancement of socioeconomic welfare of forest-dependent communities that have the potential to reduce current vulnerability of forests and upland communities. Review and analysis of the accomplishments of CBFM on ground revealed that: (1) current CBFM programs and projects help improve forest condition in a number of places; (2) CBFM may not have significantly reduced current vulnerability of communities to climate-related and other socioeconomic stressors considering the limited livelihood opportunities developed by the project.

DEVELOPING SITE-SPECIFIC SPATIAL AND SYSTEMS MODEL OF LANDSLIDE SUSCEPTIBILITY INDEX (LSI): THE CASE OF GEN. NAKAR-INFANTA, QUEZON

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Landslides are responsible for the considerable loss of agricultural production, infrastructure and lives in the entire world aggravated by increased urban development, landuse change and abnormal weather (rainfall). Successive typhoons hit Infanta-Gen. Nakar area from November 13, 2004 to December 03, 2004 causing floods and landslides. This study attempted to develop a site-specific landslide susceptibility index (LSI) model using Geographic Information System (GIS) for spatial analysis and STELLA for dynamic systems modeling. Landslide prone areas were sampled and analyzed for soil texture, atterberg limits and Cation Exchange Capacity (CEC). Random household survey and key informant interviews were also conducted to solicit first-hand information on the experiences and the possible causes of landslide in the area. Landuse maps were generated from 2002 and 2008 TerraLook satellite images. Modeling was done thru GIS and STELLA. Result of the soil survey and analysis showed that the soil in the study area is generally deep to very deep (>1m), red clayey soils, low-medium clay activity (CEC=16-45 cmol(+)/kg) and increasing plasticity index (PI) with increasing clay. In the span of six years (2002-2008) drastic change in landuse of the case study site was observed resulting in 52.27% reduction in forest cover, increase in annual crops, coconut mixed with crops and shrubs and built-up areas, respectively. The spatial landslide susceptibility model showed that as 24-hr total rainfall reaches 150mm, susceptible and highly susceptible areas increased by 37% and 110%, respectively. The site-specific LSI systems model also reveals that changes in vegetation accompanied by unusually high 24-hr total rainfall had high susceptibilities. Susceptibility to landslides is greatly affected by vegetation, geophysical characteristics and climatic conditions. On the other hand, human activities (e.g. charcoal making) indirectly affect landslide susceptibility thru removal and change in vegetation cover.

ASSESSMENTS OF THE HANUNUO WOMENS' UPLAND FARMING SYSTEM AND IMPLICATION TO CLIMATE CHANGE ADAPTATION

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This paper aimed to analyze the sustainability of the upland farming system of the Hanunuo Mangyan women in Occidental Mindoro and find out its bearing on the present condition of the environment. This further intended to either enrich or debunk the theory within the mainstream society that the Mangyans have been a party to the unabated destruction of the forest resources due to their economic activities. This also determined the Hanunuo women's socio-economic and psychological characteristics, farming practices, and perceptions regarding natural resource management. The women are young with basic education and are actively involved in community organizations. They are small landholders with swidden farming and charcoal making as the major sources of living. The Mangyans aspire for a better life. They believe these are possible through hard work, patience, perseverance, and faith in their capability, and strong government support. Their greatest fear is getting sick and having a fatal accident. The women's problems are low productivity and income, proliferation of vices in the community, and deliberate deterioration of their children's values. The ecological problems experienced include land deterioration and erosion, emergence of crop pests and diseases, natural calamities, and climate change. Some of the women's farming practices are not environment-friendly. The lack of viable economic options forced them to abandon other traditional ecological practices. Similarly, modern agriculture not appropriate to their upland conditions has slowly penetrated their farming system. The women are aware that some of their economic undertakings are detrimental to the environment. But the thought of environmental degradation is not a concrete motivation for them to stop engaging in those activities because of their greater cash need for food and children's education. The upland farming system is traditional and

subsistence agriculture. The women are in the quandary being deliberate wayward stewards of the environment as they are confronted with intertwined social, cultural, economic, environmental, and political problems and issues.

SAGIP-LUPA: SOIL CONSERVATION TECHNOLOGY AND WEED MANAGEMENT

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Sagip-Lupa (GSL) Soil Conservation Technology and Weed Management is a study that advocates for the technology that shall address the concerns of preventing soil erosion through sustainable agriculture. GSL also seeks to determine the best option that is environmentally friendly, safe to users, cost effective and practical to use in light of sustainable agriculture. The project started in February 2005 to end this year 2010. The five (5) study sites are Quezon (corn-corn-corn) with slope topography of 12%, Batangas (upland rice-corn-upland rice) – topography of 10%, Benguet (potato-cabbage-potato) – topography of 30%, Isabela (corn-corn-corn) – topography of 15-20% and Nueva Ecija (lowland rice) – flat topography. There were two treatments in the study. The use of non-selective, contact and post emergent herbicide (NSH) at the rate of 2-3 li-prod/ha versus the conventional farmer's practice (FP) of weed management. The results showed significant soil erosion reduction in all GSL sites as compared to FP. GSL percent soil erosion reduction over FP in Quezon, over a period of five (5) years was 62.90%, 56.31% in Batangas, 55.05% in Benguet and 52.10% in Isabela. Another advantage of the GSL technology is economic benefits. Reduced input costs were found to all GSL sites. Cost savings over FP was 37.96% in Quezon (corn); 20.61% (upland rice) and 26.38% (corn) in Batangas; 58.85% (cabbage) and 61.86% (potato) in Benguet; 35.12% in Isabela (corn) and 44.7% cost savings in Nueva Ecija (rice). Five-year period in the GSL treatments and sites showed significant trends of yield increase over FP. Over-all, the GSL technology on its 5th year proved to be an effective alternative remedy in minimizing soil erosion, while providing high yield and excellent weed control in sloppy areas.

SHOWCASING INTEGRATED FARMING (CROP-LIVESTOCK) TECHNOLOGIES AS COPING MECHANISMS FOR LOWLAND AND UPLAND TYPHOON DEVASTATED COCO BASED FARMS: A REHABILITATION STRATEGY

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With the onslaught of Super Typhoon Reming in Albay in 2006, the coconut farms were devastated. It was estimated that it would take about four to five years for the coconut to fully recover. The challenge therefore is to encourage these farmers to rise up by giving an alternative source of income while waiting for the coconut to recover. Thus the focus of the intervention was to showcase adaptive agricultural technologies that would encourage farmers to fast track rehabilitation. This research aimed to showcase technologies that would address rehabilitation of both upland and lowland cocobased farms. The two set-ups differ on its implementation strategy but basically adopted the Science and Technology Based Farm (STBF) approach of PCARRD under the Techno Gabay program. The first set-up in a hilly land farm followed the standard STBF modality with only the Magsasakang Siyentista involved in the establishment of the Techno-demonstration in Malabnig, Guinobatan, Albay. The upland farm had now fully recovered with well established contours and cash crops including the native chicken and goats. Coping strategies such as establishment of contour hedgerows to prevent soil erosion, practice of minimum tillage to avoid over exposure of the soil to

extremes of temperature and use of indigenous or native varieties adaptive to changing climate were the good agricultural practices showcased. The overall total income of the farm manifested a positive trend with a remarkable ROI. The second set up was a techno demo farm which was established in a lowland cocobased location at Paulog, Ligao City. Overall attaining a 65% ROI for the total crops grown in the site, the potential therefore of the technologies showcased cannot be overlooked. As part of the project output, a simple tunnel type structure dubbed as "Teknolohiyang Maogma asin Kayang Kaya" was developed. The structure was modified to suit the financial capability of local farmers and suitability to local conditions, is the first of its kind in the area. The structure was tested to withstand the strong winds, heavy downpour and severe heat of the sun. Thus, its acceptability to the farmer was unquestionable. The farmer members have now adopted the technologies introduced in their farms and have a common leased farm growing sweet corn and vegetables. Integration with native chicken has the potential of elevating the ROI. The native chicken was the source of income of the farmer during the El Nino from February to June 2010. Two groups of farmers underwent the season long training with a techno demo farm and adapted the technologies. With these experiences, the rehabilitation of these agricultural farms can be ensured. With emphasis on agribusiness ventures, the opportunity for contributing to agriculture resiliency can be sustained as an adaptive strategy to address climate change impact and can be a venue for replicability for other areas in the country.

REGIONAL BOTANICAL GARDEN: A MODEL FOR CONSERVING RAINFOREST AS A CLIMATE MITIGATION MEASURE IN THE PROVINCE OF APAYAO

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Dubbed as the "Last Forest Frontier in the North," the province of Apayao is endowed with rich forest resource covering almost 70% of its total land area. Threatened with the increasing number of upland dwellers, the Apayao State College, Local Government Unit of Luna, and the Department of Environment and Natural Resources came together for a common goal of establishing the Regional Botanical Garden, as model for forest protection. The Regional Botanical Garden (RBG) is situated at Marag Valley, once the haven of the New People's Army during the 80's, and now habituated by various indigenous people such as Isnags, Ibanags, Igorots and others. The RBG has a total land area of 1,025 hectares. Impact of the project includes biodiversity conservation, a climate change mitigation measure to reduce risk of drought and other natural disaster, and increase awareness of communities on forest conservation.

MANAGING WATER RESOURCES: CLIMATE CHANGE MITIGATION LESSON FROM THE INDIGENOUS PEOPLE OF APAYAO

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The Nagan and Maton River, located at Pudtol, Apayao are the main river tributaries of the mighty Apayao River. The Apayao River supports irrigation to thousands hectares of farmland in the municipalities of Pudtol, Luna and some parts of Abulug. To conserve and protect the river systems and their watershed (the Agora Wildlife sanctuary), the Isnags headed by Mayor Batara Laoat organized the NARIMAG (Nagan River Management System). NARIMAG utilizes indigenous knowledge and practice (IKP) in protecting Nagan and Maton River including Agora Wildlife sanctuary. The IKP is interfaced with government laws on water management. The impact of NARIMAG to climate change mitigation includes: reduction of drought incidence; provision of haven to flora and fauna species (aquatic and terrestrial); lessening the threat to loss of biodiversity; reduction of expenditures especially on imports of major food crops (rice and corn); and strengthening social capital to sustain IK climate change mitigation measures.

PROMOTING AGROBIODIVERSITY: STRATEGY FOR CLIMATE VARIABILITY ADAPTATION IN THE UPLANDS OF APAYAO

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Conventional farming system in the uplands of Apayao follows monocropping system usually rice. Decline in the productivity of rice production system has been experienced by upland farmers for the last two years due to erratic weather patterns and other environmental factors. Addressing this concern, this project has been conceptualized. This paper focuses on the promotion of agrobiodiversity as a strategy for enhancing adaptive capacity of upland farming communities in the province of Apayao. It utilizes various modalities for promoting diversified farming system models which could withstand the erratic weather condition of the province. Agrobiodiversity system utilizes various crop combination models to newly established plantations and enhances existing agroforestry farms.

THE DISASTER PREPAREDNESS MEASURES IN THE HIGH-RISKS BARANGAYS OF THE PROVINCE OF ALBAY

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This paper looks into the preparedness of the different identified high-risk barangays in the Province of Albay. Specifically dealt with in this paper are the status of the disaster management program, and the level of preparedness of the province along the different phases of the disaster management cycle. The phases of the cycle are prevention, mitigation, response, recovery and rehabilitation. Finally, this looks into the policies that may be suggested to further enhance the practices mandated and done at the grassroots level. The crunch and release model is used as the prime theory for this study, duly supported by the AGIL Scheme of Talcott Parsons and the normative theory on comprehensive disaster management. This utilized the survey for the 115 barangay captains/Barangay Disaster Coordinating Council Heads of the listed high-risk communities in the Province. The findings of the study revealed that (1) there is an existing organizational structure within the province from its level down to the barangay level that responds to disaster. The resources that are existing and functioning very well in the society are barangay officials (manpower), tricycles (transportation), barangay halls (infrastructure support) and megaphones (equipments). Department of Social Welfare and Development is the one with whom the barangays has the greatest linkage and majority of the barangays do not have linkage with private entities. (2) The province is adequately prepared when it comes to prevention, moderately prepared in mitigation; response, and; recovery and rehabilitation. (3) The problems related to disaster preparedness: dredging canals (prevention), lack of proper coordination (mitigation), delayed distribution of relief goods (response) and, lack of funds (recovery and rehabilitation). (4) Among the policies identified for formulation are forced evacuation, availability of training programs, proper information dissemination, conduct of barangay assembly during times of disaster, funding for medicines and, strict implementation of building codes. The different municipal/city disaster coordinating councils and the province share the same vision, mission and goals when it comes to disaster management but this still needs to be e formulated, agreed upon and worked on by all the municipalities and cities. The level of capability of the province along the different phases of disaster management is varying. Finally, the paper also presents various recommendations to several local government units.

COCONUT-BASED FARMING SYSTEMS IN RIZAL, OCCIDENTAL MINDORO AND ITS RELATION TO SELECTED FARMERS' CHARACTERISTICS

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Characteristics of coconut farmers in Rizal, Occidental Mindoro and their adopted farming systems are not yet documented. Aware of this, a total of 54 coconut farmers were purposively selected and interviewed. Using the descriptive-correlational design, a researcher-constructed interview schedule was used in the data gathering. Coconut farmers had a mean of 33.06 years of experience in coconut farming. Majority were high school graduates, owners of coconut farms measuring on the average 1.48 hectares. Households were composed of three members, who also contributed labor for the different activities in the farm. As to communication, they had relatively low exposure to sources of information, indicating that they failed to avail the different relevant information about coconut farming that was offered by these sources or media. Monoculture was still practiced by coconut farmers. However, there are those who adopted intercropping of vegetables, fruit trees and forest trees to the coconut trees. Raising of poultry, goats, swine and cattle were likewise adopted. The primary purpose was to have a better living by having a diversified source of income and readily-available food. Likewise, these were intended to increase the productivity of their coconut farms. Correlation analysis found out that the variable farm size and exposure to media were significantly and moderately related to the adoption of coconut-based farming systems. Other profile variables were not significant correlates. It is recommended that relevant information should be relayed to the coconut farmers to make them equipped with new knowledge and skills. Various communication media must be tried. Likewise, focus group discussion (FGD) and key informant interview (KII) are recommended. Further related studies should also be conducted.

CAPABILITY AND VULNERABILITY TO FLOOD OF THE MUNICIPALITY OF MILAOR, CAMARINES SUR

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Milaor's geographical location determines a significant weight on the social and economic structures of its neigboring the towns and city. It is characterized as flat to gently sloping with 0 – 3 percent slope. The area particularly the western barangays being situated in the low-lying portion of the Bicol River basin area and is 0.2 meter below sea level makes a large portion of the municipality susceptible to frequent flooding. Further, it has two types of soil texture, namely clay and clay loam, and is being traversed by the Bicol River and specifically passes along seven barangays. The study was conducted to look into the capability and vulnerability to flood of the Municipality of Milaor, Camarines Sur. Results of the study revealed that the elements at risks to flood of the Municipality of Milaor are its population - 26,452 (NSO 2007), lifelines (water system, power supply and communication facilities), social structures (educational institutions, parish church and the formation center), infrastructures (municipal offices, provincial and barangay bridges and concrete road) and sources of livelihood (farming and agri-related income-generating activities). Population most at risk during flood is 45.89% (12,138 persons or 2467 families) (MSWO 2008). The capability of the community is manifested through the resiliency of the households and by equipping themselves with "salbabida", boats and life vests, strong family ties, existence of 13 formal education institutions and 5 evacuation centers.

While the vulnerability is its geographical location (0.2 m. below sea level), the high poverty level on the eastern part, and majority of the houses are single-storey and made of wood. The Municipality of Milaor focuses its efforts on preparedness in terms of response. It reinforces the community's capacity by providing trainings for Basic Life Support, Watermanship and other relevant disaster response trainings. The recommendations are: creation of the Milaor Disaster Management Office and Barangay Disaster Management Offices; capability building/enhancement; trainings/ education of household members; advocacy and aggressive information dissemination; and mitigation and intervention strategies such as formulation of local policy and sanction on sanitary solid waste management; installation of creek floodgates; and relocation of perennial flood victims.

THE ECONOMIC POTENTIAL AND ECOLOGICAL VULNERABILITIES OF THE FISHERY RESOURCE OF BACON DISTRICT, SORSOGON, PHILIPPINES

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Ecological safeguarding is essential in the face of the aggressive stance of the government to promote development along various areas. This is crucial in as much as economic development attained at the expense of the fragile environment is meaningless and unsustainable. The Rapid Resource and Social Assessment of Bacon District by the City Government of Sorsogon is a bold step to address scarcity of research-based inquiries regarding the status of fishery resources at least for the Bacon sector only, and the first comprehensive account of a coastal part of Albay gulf. The research undertaking made use of participatory resource assessment. The principal coastal habitats of a typical tropical marine ecosystem are found in Bacon District: coral reefs, extensive seagrass and seaweeds and mangroves. Their presence in sound states in Bacon district is a competitive advantage of the place against the impacts of many environmental challenges. Overall, the three habitats are in sound state, except to some signs of disturbances especially to corals inside Sogod Bay, which were reduced to rubbles due to blast fishing in the past. Siltation is also high in Sogod Bay and also a threat to a good coral assemblage off Sto. Nino and Osiao due to erosion of immediate upland periphery. The capture fisheries of Bacon District is a multigear type which harvests various species of mainly coastal and oceanic pelagics and hard bottom demersal fishes. Peak fishing operations happens from February, when the northeast monsoon weakened, up to June, prior to the onset of the southwest monsoon. Bulk of the fishing trips and 64% of the municipal fisheries production of the district is generated during this period. The fishing gears have diversified from 20 types in 1998 to 33 at the present time, a signal of increasing fishing intensity and scarcer resources. The coastal waters of Bacon District, Sorsogon City characteristically supports more production of the marine organisms because of the diverse plankton community and good water physical characteristics. Salinity, pH, temperature, turbidity and conductivity complied to DAO-34 standards set by DENR-EMB. The fisherfolks of Bacon District are original Bacongnons, mostly Catholic, have an average residency of 23 years and majority are elementary and high school graduates. The mean household size is 6.45 members. They have been fishing on an average of 24.17 years, and presently exert fishing intensities of 10.15 months per year, 3.19 weeks per month, 4.93 days per week and 1.43 times per day. Illegal fishing perpetrators are claimed to be people from outside of the repondents' barangay. The local government unit is viewed as the one responsible in stopping illegal fishing through its FARMC and law enforcement authorities.

ECOFEMINISM: WOMEN'S WORK ON ENVIRONMENTAL CONSERVATION IN THE PROVINCE OF SORSOGON

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This paper describes the perspectives of ecofeminism and the roles of women in environmental protection and conservation. Likewise, this paper delineates the interrelatedness between the oppression of the women and the degradation of the environment. The discussion is based on the issues such as women's perspectives of the environment; the nature of their participation in environmental protection and conservation; the challenges they encountered and the approaches they adapted in relation to the challenges; the roles played in the environmental protection and conservation; and their views on the connection between women and environment. This paper further argues that women are directly affected by the state of environment because of the traditional roles imposed by the patriarchal system of the society to the women like providing and preparing food; cleaning of the house; washing of the clothes and dishes; gathering of fuel wood; fetching water; and taking care of the children. The special links between women and the environment underscore the

following concerns: the position of women, the origins of women's victimization within the ecological crises and the solutions offered to save the environment and empower women.

GENDER-BASED ROLES, MANAGEMENT PRACTICES AND NEEDS OF WOMEN FARMERS IN OCCIDENTAL MINDORO

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Women do not only contribute to the agricultural labor force but also perform as agricultural managers and decision makers. They are involved in the production of food for the household and business but as to how much they have contributed, labor force statistics does not emphasize. Hence, development programs fail to address their specific needs. This paper describes the personal, family, and socio-economic characteristics of women farmers of Occidental Mindoro, Philippines. Their farm management practices and needs are also determined to identify interventions appropriate to their specific needs. They are small landholders who practice multi-cropping and are engaged in small-scale animal production. They are not affiliated to any organization and have not attended trainings especially those related to agriculture and farm business management. They have not received any technical and financial assistance from government and non-government organizations. The women do occasional farm record keeping but is not up-to-date which they use for planning and decision making. They do not seem to appreciate the importance of preparing project proposal. Sourcing of funds is the women's foremost consideration. The women farmers wish they could improve agricultural productivity and income so that they also attain better life. Study results show that development programs have not yet really served women probably because planners and policy makers still think that women nowadays are confined to traditional home management and child rearing roles. If there are any programs available in the communities, these have not benefited most women because these are designed for the men or for those who belong to organizations. Most women do not think of farming as a business but only a source for family subsistence so that they are not focused on other farming strategies or mechanisms that may give then higher return on investments.

COPING MECHANISMS OF THE NEGRITOS OF LUNA, APAYAO

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The Negritos are one of the deprived or perhaps the most deprived cultural minorities in the country. These tribal people do not give importance to formal education or school- based learning. Their opposition to school-based learning may be due to racial prejudice and their nomadic character. In spite of being poor and nomadic, they were able to cope up with the change in time amidst technological advancement. It is then important to look into the Negritos way of life able to cope up with changes in their environment. This paper deals with the coping mechanisms of the Negritos which has been a lesson for many generations of their existence against various disasters that came along their way.

RESILIENCE IN FARM LEVEL FOOD SECURITY: LESSONS FROM THE ISNAGS OF APAYAO

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The Isnags are the dominant ethnic groups in the province of Apayao. They were of malay-type ancestry who used to establish houses along bodies of water. Over the years, they have developed techniques to cope with farm stresses resulting to fluctuating yields of major crops. Some of their techniques are part of their cultural traditions which is handed down to generations. This paper

discusses the strategies of the Isnags in securing food over major disasters such as typhoons, floods and drought that contributed to the development of their resilience capacity.

WEAVING MEANING TO THE PROCESS OF ENDING HUNGER AND POVERTY WHILE CARING FOR MT. MASARAGA WATERSHED

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Conventional development approach looks at economic growth and maintaining ecological stability of the environment as incompatible goals. The Extension Service efforts of Bicol University College of Agriculture and Forestry since 2003 to present, has sought to end hunger and poverty while taking care of the environment. This paper presents the interventions to put to ground the attainment of the above mentioned goal. The search for meaning of a well grounded process of ending hunger and poverty while caring for Mt. Masaraga Watershed started in 2003 to 2006 via the implementation of the Program on Sustainable Agriculture and Biodiversity Conservation and Management as approaches. While initiatives undertaken yielded positive results, yet it fell short of realization of goal. In 2009, taking lessons from PSARD and addressing climate change impacts, the Values-Based Development Alternative for the Welfare of the Needy in Mt. Masaraga Project was conceptualized, funded and implemented. Strategies to implement the above mentioned goal are: (a) Self Help Group Formation, Stabilization and Empowerment, (b) Capacity Building, (c) Adaptive Research, (e) Community Managed Biodiversity Conservation and Management, (f) Community Managed Sustainable Nature-Based Enterprises, (g) Community Managed Disaster Risk Reduction and Management, (h) Participatory Domiciliary Nutrition Rehabilitation, (i) Participatory Project Self-Review and Planning, (j) Livestock-Based Agroforestry Farming Systems Development and Management and, (k) Local Environmental Governance.

IMPACTS AND INFLUENCES OF SMALLHOLDER UPLAND DEVELOPMENT PROJECT IN ALLEVIATING POVERTY IN THE PHILIPPINE UPLANDS

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For more than ten years, the Philippines has adopted the Community-Based Forest Management (CBFM) Program as a forest restoration strategy and for poverty alleviation in the uplands. The pattern of upland development since the adoption of the CBFM in 1995 has involved the provision of the following: a) security of long-term tenure to forestlands; b) assistance by the government to forest plantations, livelihood activities, and infrastructure and other support services; and c) involvement of government and NGOs in strengthening and empowering communities to implement such projects. The concept of CBFM departs radically from the traditional notion that considers forest occupants as the culprits of forest degradation. CBFM directly involves upland communities in developing, rehabilitating and protecting the forests. The implementation of CBFM assures the generation of employment opportunities in the uplands through seedling production; plantation establishment; forest protection and conservation activities; harvesting; processing; transporting and marketing of CBFM products. This paper documents and evaluates the impacts and influences of the CBFM program on the human well-being of the upland communities following the Millennium Ecosystem Assessment (MA) framework. This framework postulates that people are integral parts of the ecosystem and that dynamic interaction exists between them. This study showed that the CBFM participants had attained improvement in their well-being – i.e. marked increase in income over the benchmark income before they were awarded a CBFM project; and acquisition of several household and farm assets which were before uncommon to forest-dependent communities. There appeared to be inequitable access and enjoyment of resources, opportunities and eventually

material benefits generated by the CBFM Project. This study had identified several issues and concerns as well as policy recommendations toward this end.

EMPOWERING COMMUNITIES FOR CLIMATE CHANGE ADAPATION THROUGH SUSTAINABLE AGRICULTURAL DEVELOPMENT EXTENSION PROGRAM (SADEP) IN OCCIDENTAL MINDORO

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The Sustainable Agricultural Development Extension Program (SADEP) is now on the ninth-year of actively promoting environmental education and sustainable livelihood in the uplands and farming communities of Occidental Mindoro. This program aims to promote the use of ecologically sound farming practices; generate income through proper utilization of locally available resources; train farm households to increase their productivity; and increase community awareness on environmental conservation. The College forged partnerships and collaborations with organizations, and private individuals in the implementation of projects in agriculture, environment, livelihood, and education. Observed impacts include: (1) adoption of ecologically sound farming practices, (2) generation of sustainable livelihood, (3) increased farm productivity and income, (4) creating healthier, cleaner and greener communities, (5) improved farmers' access to information, technology, and service institution, (6)forging of partnerships among development organizations and agencies, and (7) **e**nhanced decision-making capability. The program can be a very effective instrument in bringing development to the countryside. It has achieved the following: enabled the generation of sustainable livelihood among farming families; enhanced community awareness on environmental conservation and protection; rekindled aspirations of the people to attain better lives; and helped strengthen the Institution's working relationships with other organizations. The collaborations formed reinforced the projects of SADEP and opened many socio-economic opportunities to the communities. It is recommended that partnership with the community and other local organizations must be institutionalized to help monitor, evaluate, and sustain the different extension projects. Existing linkages must be strengthened and other organizations with similar undertakings must be invited to improve delivery of services. Continuing capability building of communities especially in natural resource management and entrepreneurship is necessary. An impact study should be conducted to find out the projects' contribution to the quality of life in the rural communities.

ENHANCING PRODUCTIVITY OF BICOL RICE FARMERS THROUGH INTEGRATED FARMING SYSTEM: THE PALAYAMANAN MODEL

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Palayamanan, a project coined from the two words "palay" – a Filipino term for rice at any stage prior to husking and "yaman" – also a Filipino term which means wealth was introduced. The Palayamanan Models are composed of well-integrated components harness and maximize use of farm resources and highlights the interconnectivity between each resource and by-products in the various farming systems. Productivity of many small farmers remains low because of declining productivity of growing monocrop rice. With the increasing cost of lands and inputs and yields of inbred rice varieties reaching a plateau, the income of the farmers has increased tremendously. The income derived from growing a hectare of rice is below the poverty threshold and makes it difficult to meet the tool requirements for the farm family. There is therefore a need to promote diversified and integrated farming system to generate more income. Diversified rice-based farming systems by

integrating crop production, pomology, aquaculture and waste recycling resulted in higher productivity and income that assures food security, reduced production risks and economic stability and sustainability of the farm system. The Community-based Palayamanan Model Farms were piloted in seven sites nationwide representing the upland, and saline-prone areas nationwide. Each community-based Model composed of a core group of 10-15 farmers, who conduct the participatory technology development. One Palayamanan Model Farm was also established in each community which served as community seed bank for planting materials and animal stocks and as learning center. A core group of 5-10 farmers attended the farmers' field school and other capacity enhancement activities. The number of farmers increased exponentially over time. Each community-based model was provided Php 100,000 for the acquisition of farm inputs that were loaned to the farmers. The proceeds from the loan were funneled back to the project. Partnership and complementation with 565 ECB Philippine Army, Department of Trade and Industry, Department of Environment and Natural Resources, Department of Agrarian Reform, Ginintuang Masaganang Ani Programs and various LGUs enhanced the pooling of technical knowledge and financial and physical resources in delivering services and development mechanisms to sustain gains in Palayamanan.

EMPOWERING RURAL COMMUNITIES THROUGH VALUES ENHANCEMENT AND LIVELIHOOD PROGRAMS

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This research cum extension program jointly undertaken by Sorsogon State College and Energy Development Corporation (EDC) aimed at empowering rural communities through values enhancement trainings and livelihood projects. Using survey questionnaire, interview, observation, and focus group discussion in data gathering, the 577 respondents of the nine barangays of Sorsogon City and Manito, Albay claimed to possess positive attitude toward improving their skills and supporting the development projects in their communities. Justice and peace, faith, and love of God are their common values. They hope for a progressive community, aspire for unity and cooperation and believe that they can still improve their social, spiritual and economic status in life. Majority preferred to have more trainings on agriculture/fishery, baking rice products, and meat/fish processing. The extension program, *Advocacy for Livelihood Intervention and Values Enhancement (ALIVE)* was implemented in the nine barangays benefiting 1,353 members. The following were undertaken: (1) organized the residents into various sectors and cooperative; (2) undertook self-awareness and values enhancement trainings; (3) conducted trainings on various livelihood projects along the four sectors; and (4) established livelihood programs for the members such as aqua-silviculture, lambaklad, fish corral and fish net loan assistance for fishing sector; rice production, agricultural loan assistance and food processing for lowland agriculture; production of high-value vegetables and coco coir production for upland sector; and labor contracting like welding, riprapping, and other construction-related work for the labor sector. Most respondents have positive perceived values. Thus, it is recommended that a continuous training on values be conducted among the residents. Nevertheless, the trainings on self-awareness have enhanced the level of awareness of their capabilities, confidence and commitment to improve themselves. The livelihood programs have increased family income and made them more self-reliant, productive and empowered to manage some livelihood enterprises in their communities.

SOCIO-ECONOMIC PROFILE AND PRACTICES OF RICE TERRACES FARMERS IN UPPER APAYAO

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This study was conducted to determine the socio-economic profile and practices of rice terraces farmers in Conner, Calanasan and Kabugao, Apayao. Descriptive survey method was employed in the study. Most of the respondents are male, age 31-40 years old, married, have attained elementary level, with 5 and more children studying in public schools. The primary source of income is farming, and in order to augment income they do livestock raising, vegetable and root crop gardening. Most of the respondents owned a house and lot but in semi-concrete, bungalow type. The respondents are members of farmer's association and have attended trainings on farming. Some of the cultural practices includes pisit, bunyag, tadog, say-am, atang, mangatugangan, mogahupag, magdewas,pasalip and ragragsak. The farmer-respondents cultivate both native and commercial hybrid varieties within the rice terraces in Conner, Calanasan and Kabugao, Apayao. Organic farming is employed by farmers. There is a need to strengthen indigenous practices in the conservation of rice terraces and management practices to increase rice yield and maximize income of farmers, conduct further study to correlate the relationship of the social and economic status, and cultural practices in the conservation of rice terraces; and conduct information dissemination on the advantages of using traditional varieties of rice.

ENHANCING THE EMPLOYABILITY OF AFNR GRADUATES IN THE BICOL REGION

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The Colleges of Agriculture in the Philippines are facing some major challenges requiring new educational strategies, innovative leadership and institutional reforms that take into account the current trends and factors that influence agricultural and rural development. Due to the declining opportunities of agricultural graduates, student demand on agricultural education has been decreasing rapidly in the recent years as evidenced by the dwindling student enrollment suffered by all agricultural colleges in the Philippines. The changing nature of agriculture in the Philippines provides both "push" and "pull" dynamics for agriculture graduates to engage in entrepreneurial activities. For agriculture and potential new entrants into agriculture to capitalize on opportunities in the business environment, a shift in focus from *agricultural producer* to *agricultural entrepreneur* is imperative. The project aims to enhance the employability and entrepreneurial abilities of AFNR graduates in the Bicol Region. The project trained 150 AFNR graduates from six SUCs. Training modules on entrepreneurial personality, enterprise planning, marketing, bookkeeping, and financial management were used. The training included the employability enhancement, job fair, internship, business plan preparation and presentation. The entry level of entrepreneurial competencies of trainees reveals weakness on risk-taking which is very important in entrepreneurship. However, after the training this became very satisfactory. Both male and female trainees were only satisfactory in demand for quality and efficiency and risk taking. These became very satisfactory after the training. Post-test showed improvement in the trainees' knowledge on the principles and concepts of entrepreneurship. After six months of completion of the training, the post-evaluation reveal that 70 trainees (47%) have established their own business enterprise. Out of this number, 58 trainees (39%) availed loan financing from the project and 12 trainees (8%) used their own money to establish their business. There were 56 trainees (37%) who were presently employed in various agribusiness firms.

AFNR CURRICULAR PROGRAM ENHANCEMENT THROUGH THE INTEGRATION OF ENTREPRENEURSHIP IN TECHNICAL COURSES

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Traditionally, agricultural education in general is geared towards the acquisition of necessary knowledge, skills and capacities related to the specific technical or scientific field for employment. The objective is very seldom to enter into business or to create a new venture, although it might be a final outcome. It is this fundamental difference in context that necessitates a re-look at the applicability of current entrepreneurship education models to the Philippine agricultural context. The project aimed to enhance the AFNR curricula through entrepreneurial skills integration for AFNR students. The curricula for all AFNR courses in the seven SUCs in the Bicol Region were subjected to review for purposes of looking into the feasibility of integrating entrepreneurship into these courses. Implementing guidelines/mechanics for this purpose was formulated in a workshop. The students together with their parents were given orientation regarding the integration in their courses. The faculty-mentors who were trained by the project in the integration carried out the following activities: (1) enhanced their teaching syllabi by including topics on the principles and concepts of entrepreneurship; (2) conducted lecture-discussion on the topics included; (3) supervised the preparation of business plan of students; and (4) supervised and monitored the implementation of the planned enterprise projects of the students. After the two semesters of integration, the following were the results: (1) Parents appreciated the integration of entrepreneurship; (2) Students expressed their appreciation and acceptance of the integration; (3) faculty-mentors recognized that the integration equipped the students with the knowledge and skills they need in case they decide to engage in business after graduation. They also accepted the challenges of their additional tasks; and (4) Post-test showed improvement in the students' knowledge on the principles and concepts of entrepreneurship.

LEVEL OF AWARENESS AND PRACTICES ON SOLID WASTE MANAGEMENT OF STUDENTS OF ASIST LAGANGILANG

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This study aimed to determine the solid waste management awareness and practices and exposure of students of Abra State Institute of Sciences and Technology. It also looked into the relationship between the profile of the respondents and their level of awareness, practices and exposure to different sources of information on solid waste management. There were 238 student respondents. This study used the descriptive analytical method of research. A questionnaire adopted from the study of Fontanilla (2003) was used as the main instrument in gathering data. The student respondents showed a moderate level of awareness on solid waste management and the level of practice showed that items on the different components of solid waste management are sometimes practiced by them. Results further reveal that the level of awareness and the course and year level of the students have no significant relationship. But there was a significant relationship between level of awareness and occupation of parents. On the other hand, there was no significant relationship existing between the level of practice and the course and year level. And there was a significant relationship between the level of practice and occupation of parents. Likewise, there was a significant relationship between the level of exposure and the occupation of father particularly on mass media.

THE LAPAT SYSTEM: AN INDIGENOUS NATURAL RESOURCE MANAGEMENT SYSTEM OF THE ISNAGS IN APAYAO

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The study documented and validated the *Lapat* System in the Municipalities of Conner, Kabugao, Pudtol and Calanasan, Apayao as a way of conserving natural resources. Being the youngest province of Cordillera, Apayao is endowed with rich cultural and natural resources known to be the last frontier of forest cover and one of the provinces covering the watershed cradle of the North. Such a potential feature is attributed to the indigenous peoples (IP) culture- bound initiatives in conserving their natural resources. The practice of *lapat* by the Isnags has in it the unique characteristics of providing a wealth of knowledge in environmental management. Today, lapat is still practiced by the elders to declare a body of water, plantations, forests and residential lots as sacred in honor of a dead member of the family. These areas are preserved by the bereaved family within a year or two by imposing penalties to intruders, thus making the area untouched within the prescribed period. Lifting of the *lapat* is commenced through they say- am or a grand festivity with many rituals usually help within 3-5 days to a maximum of one week celebrated by all members. By application and through consistent practice by the Isnags, *lapat* has contributed significantly in preserving and conserving the natural resources in the province.

LESSONS FOR THE ROAD: THE APOSTOLIC VICARIATE OF SAN JOSE LIVELIHOOD MOVEMENT, INC. EXPERIENCE IN MANAGING THE INTEGRATED PEST MANAGEMENT (IPM) PROGRAM IN OCCIDENTAL MINDORO

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The Apostolic Vicariate of San Jose Livelihood Movement, Inc. or LM is a church-based intermediary non-government organization (NGO) picked by the National Agriculture and Fishery Council (NAFC) to lead the implementation of the IPM program in Occidental Mindoro. This case study aimed to find out the experiences of the NGO in managing such government program particularly how it worked with other government organizations. Specifically, this aimed to describe the strategies employed and the problems encountered in managing the project, and determine the impact of IPM program in the farming communities. This was a response to the felt need of its farmer beneficiaries who had difficulty in paying back production loans due to poor harvest. To effectively implement the project, LM forged partnership with other organizations; targeted farmers' organizations and cooperatives; conducted continuing education and training for IPM workers; collaborated with educational institutions; utilized multi-media to promote IPM, and established linkage mechanisms with partner agencies. The problems encountered were weak local government support, delayed release of LGU funds, poor work ethics of LGU staff, and lack of sincerity of other partners. Lack of transparency and managerial leadership crisis within the lead agency had also resulted in the disintegration of people directly involved in the project. Initial performance evaluation conducted by the lead agency a year after the implementation revealed an almost 100% decrease in pesticide use among farmers, 20% reduction of production cost, and an increase of net income by at least PhP3000 per hectare. In 2009, an impact study result showed that those farmers still had high knowledge about and positive attitude towards ecologically sound farming practices but the practice of technologies relative to IPM was very low. The study revealed that the main root of the problem was attitudinal in nature especially among the field personnel. Participatory management style must be enforced where everyone is involved in planning, implementing, and evaluating of the project. There is also a need for transparency especially in terms of money and sharing of risks benefits among partners.

PROMOTING CACAO PRODUCTION: AN AGROFORESTRY APPROACH FOR FOOD SECURITY AND ENVIRONMENTAL CONSERVATION IN APAYAO

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Cacao, *Theobroma cacao*, is a source of chocolate. Aside from cocoa, there are many other by-products that can be derived from cacao. These are livestock feed from cocoa pod husks, the mucilage which contains 11 % glucose for wines, alcoholic drinks and crystallized glucose for the use of pharmaceutical industries, fish food from powdered fruit husks for juvenile tilapias, soap making from cocoa butter fat and fertilizer from cocoa /pod husk ash. Cacao grows well in the tropics. It can be integrated with other crops in a multistorey cropping system. It starts to bear fruits after 18 months of planting. Because of its potentials, the college in collaboration with the Techno Gabay program of PCARRD through the Highland Agriculture and Resources Research and Development Consortium (HARRDEC) promoted the production of cacao as a major component of agroforestry farms. Activities undertaken as part of the promotion include documentation of Magsasaka Siyentista Ortega (MS best practices) cacao production technology, germplasm collection, establishment of cacao bud wood garden, establishment of demo farm and nurseries, and conduct of training to farmers and food processors.

THE EXTENT OF IMPLEMENTATION OF ENVIRONMENT PROTECTION PROJECTS IN THE SELECTED BARANGAYS OF NABUA, CAMARINES SUR

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Camarines Sur Polytechnic Colleges conducted this study to formulate a program that will improve the implementation of programs on environment protection. More specifically it sought to determine the existing projects being implemented by the Municipality of Nabua on Environment Protection, the level of awareness of the respondents on the projects being implemented, the extent of project implementation, and propose a program to improve the implementation of the Environment Protection project in the community. Majority of the respondents affirmatively believed that there are programs and projects on environment protection awareness campaign implemented in the barangay but only very few household were aware on how these programs were implemented. It is therefore concluded that awareness on the programs is still missing. Thus, it is recommended that massive information dissemination and trainings on how environment protection will be fully practiced in every household must be done in every barangay.

AWARENESS ON THE ECOLOGICAL AND ECONOMIC BENEFITS OF ESTUARIES IN MAGSAYSAY, OCCIDENTAL MINDORO

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This study was conducted to determine the level of awareness of respondents on the ecological and economic benefits of estuaries in Magsaysay, Occidental Mindoro. Employing the descriptive method of research, specifically the correlation design, the randomly selected residents of Magsaysay, Occidental Mindoro were interviewed using the researcher constructed interview schedule. Results revealed that most of the respondents reached elementary school, (74.5 percent); at the age range of 30 to 39, and had been residing in Magsaysay estuaries. The households' size was more than 6 members, and any few (32.4 percents) are member of organization. Majority is engage in farming and fishing generating an income as P4000 to P6000 As to their level of awareness, the respondents were aware at a moderate extent of the economics benefits (mean=3.28), and benefits (mean=3.30).

Statistical tests had revealed that the profiles are not significantly related to the level of the ecological, economic and conservation benefits.

VICARIOUS EXPERIENCES ON THE OTHER SIDE OF AGRICULTURAL SCIENCES RESEARCH: BASES FOR PREVENTIVE MEASURES

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This study sought to determine some agricultural technologies claimed to be of negative effects, analyze them, and on the basis of such information, formulate and forward approaches that could serve as bases for precautionary measures to future agricultural technology researchers, developers and extension workers. It made use of documentary survey (existing data search) and evaluation (critical analysis). Findings show the following agricultural technologies are alleged to be damaging or to have caused negative effects: biofuels, pesticides, biotechnology and GM crops, and "confined (intensive) livestock operations". The negative side of *biofuels* was highlighted by the unregulated tearing down of forests, threatening an ecological disaster, and the conversion of edible crops into fuels despite the fact that billions of people have almost nothing to eat. The use of *pesticides* has polluted and is polluting arable lands and usable waters, it has also developed strong resistance among pests. *Genetically modified crops* endanger the ecosystem and the consumers' health. *Intensive livestock operation* causes the growth of antibiotic resistant bacteria and makes the workers sick. On the basis of these findings, the approaches that may be forwarded to "prevent" the downside of these technologies are: the conduct of preventive agricultural technology impact assessments that predict both positive and negative outcomes of technologies, a critical analysis of the technologies' environmental and social costs, damage to farms and fisheries, pollution of groundwater and surface water by animal wastes and pesticides, and increased health risks from these pollutants compared to the benefits they bring- abundant food (to those who can afford), convenience, and economic contribution from growers to harvesters to processors to sellers, and the formulation of agricultural R&D policies and protocols to address these issues.

SCALING UP COASTAL RESOURCE MANAGEMENT IN AN AGRARIAN REFORM COMMUNITY

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Over the years, the coastal ecosystem in and all over the country is under stress from the combined impacts of human overexploitation, physical disturbance, pollution, sedimentation and general neglect. Results of which include the continuing decline of fish catch of marginalized fishing communities which is often coupled with the vicious cycle of the lack of access to various basic services from the government and other livelihood opportunities. To answer this diversified problem and the increasing need for conservation, protection and sustainable management of coastal and terrestrial resources, the Deagan Island Coastal Resources Management Project (DICOREMAP) was implemented in Dimasalang, Masbate. The DICOREMAP initiative is an academe-interagency-municipal partnership in an attempt to address the interrelated political, institutional, socioeconomic, and environmental concerns plaguing a common agri-fisheries ecosystem. This paper brings into the forefront the undertaken activities emanating from the Comprehensive Agrarian Reform Program by utilizing the Agrarian Reform Community concept. Such resulted to a holistic convergence of services offering a spatial framework for community and beneficiaries development. This initiative of convergence primarily focusing on the prospects and opportunities in an island which is part of the MAMIA Agrarian Reform Community in Dimasalang, Masbate, has been a collaborative effort of the Department of Agrarian Reform Masbate Provincial Office and Bicol University in Legazpi City towards achieving institutional and governance on ecosystem resources management.

BIOASSESSMENT OF THE WATER QUALITY OF THREE SELECTED RIVERS OF ABRA

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The study determined the water quality of three selected rivers of Abra namely: Lingas- Baay, Tineg and Sagnit Rivers from September 2008 and January 2009. Bioassessment on the water quality was based on parameters of Species Diversity Indices, Ephemeroptera, Plecoptera, Trichoptera (EPT) Index and Biological Indicators of macrobenthic invertebrates. The physical factors (water velocity, depth and width of the river, air, surface and under water temperatures and substrate composition) as well as chemical factors (Dissolved Oxygen and pH) were also determined. Three riffles were selected from each river system and were divided into three sampling stations. Physical and chemical parameters were determined *in situ*, while macrobenthic invertebrates were collected, identified and classified. Diversity indices such as Shannon-Weiner, Simpson and Margalef's indices and EPT Index as well as the presence and absence of biological indicators were used in the data collected for bioassessment. There were no significant differences in water velocity. The water depth was significantly higher (0.48 m) in Sagnit River, while the width of Tineg river was significantly higher. Moreover, surface and under water temperatures registered higher at Tineg River. Sand and gravel were the common substrates in the three rivers. Dissolved Oxygen was highest at 6.16 mg/L in Lingas-Baay River. The pH in the 3 rivers was slightly alkaline. Fourteen different species of macrobenthic invertebrate were collected, taxonomically identified and described in the 3 rivers. The Index of Similarity showed a high degree of similarity among the macrobenthic species. These could be attributed to some physical (velocity, substrate) and chemical (slightly alkaline pH) characteristics, which were common to the 3 rivers. Lingas-Baay ranked first in terms of Diversity Indices and EPT Index, and 2nd for biological indicators, while Tineg River ranked first for Biological Indicators, 2nd and 3rd for EPT index and diversity indices, respectively. Sagnit river ranked 2nd for the diversity indices and both 3rd for EPT Index and biological indicators. On the basis of these indices on bioassessment, Lingas-Baay over-all ranked first which indicates that of the 3 rivers, it had the best water quality, followed next by Tineg river which was moderately clean. Sagnit river had the least water quality.

COMPARATIVE ANALYSIS OF GEMELINA PLANT GROWTH IN A GENTLE AND STEEPER SLOPE SOIL: THE SIXTH-MONTH SITUATION

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The main objective of this study is to describe the gemelina (Gmelina Arborea) plants six months after they were planted in two lots of different slopes. The plantation sites were part of the two adjoining lots of almost equal areas and of the same soil type. They differ on ground formation since one is a gentle slope while the other is steeper. The soil water content, climatic condition, temperature, wind speed and precipitation were observed. The plants were propagated by seeds and were transplanted at a height of 20-45 cm. To attain straight body growth, young branches were cut and removed. Weeding was conducted regularly. After six months, a total of three hundred three (303) gemelina trees are growing in the two areas. The average height of the plants in gentle slope soil is 59.8 cm. while the average body diameter is 0.46 cm. The average height in the steeper slope is 113.86 cm. and the average body diameter is 0.57 cm. The tallest height attained in the gentle slope is 210 cm., and the shortest is 20 cm. The tallest height attained in the steeper slope is 410 cm. while the shortest is 20 cm. The two sites are appropriate for gemelina plants to grow. The climatic condition is suited to attain normal growth. After six months of cultivation, the plants grow at remarkable performance. However, the species in the steeper slope soil show better growth performance than in the gentle slope soil.

IDENTIFICATION AND GERMPLASM COLLECTION OF DYE YIELDING PLANTS IN APAYAO

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This study was conducted to identify, collect and maintain germplasms of potential dye yielding plants in Apayao. The survey method of research was used coupled with investigation and experimentation. Plants that possess dye potentials were extracted by beating and boiling. Yarn was dyed in dye bath metamordanted with salt. Results of the study show that the researcher collected 30 potential dye yielding plants. The collected dye yielding plants were maintained at ASC luna campus.From the results of the study, it can be said that abundant dye-yielding plants are present in the province. In the light of the findings, the following are recommended: explore other sources of natural dyes; investigate local mordants suitable for each dyestuff; expand germplasms collection area; mass propagate the identified potential dye yielding plants.

BIOMASS PRODUCTION OF MALATAYUM *(Indigofera tinctoria)* AS AFFECTED BY PLANTING DISTANCE

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The study was conducted at ASIST Experimental Area of the Research Department from April 2009 to April 2010 to determine the effect of planting distance of best rate of carbonated rice hull to Malatayum and to find out the interaction effect between planting distance and CRH application on biomass production. Based on the findings of the study, the different distance of planting evaluated had significant effects on the final height, canopy of the plants, number of branches, yield per plot and the computed yield per plot. Malatayum plants spaced at 1.0 m x 1.5 m registered the widest canopy, produced more number of branches, obtained the highest yield per plot and the computed yield/ ha. With regards to the rate of Carbonated rice hull applied to the plants, the application of 25 tons/ ha of carbonated rice hull manifested the tallest height, widest canopy, produce more number of branches, highest yield per plot and the computed yield/ha. There was a significant interaction effect between the distance of planting and CRH application on the yield per plot.

DYE AND YIELD OF MALATAYUM MIXED WITH DIFFERENT MORDANTS APPLIED IN COTTON YARN

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This study was primarily conducted to compare the Fresh and Fermented Malatayum Leaves Dyestuff Using Indigenous Mordants on Cotton Yarn. It aimed to determine the yield of the dyestuff as affected by the fresh and fermented Malatayum leaves using five different indigenous mordants; compare the absorptive capacity of the cotton fabric as affected by the fresh and fermented Malatayum leaves dye extracts; and compare the colorfastness of the cotton yarn as affected by the fresh and fermented Malatayum leaves dye extracts. Malatayum leaves were collected and prepared for eight weeks fermentation and extraction. Indigenous mordants such as vinegar, rust, gabi extract, ash and salt were selected and prepared to mix to the dyestuff produced in both fresh and fermented leaves. CRD was the experimental design used in this study. The dye yielding performance of fresh and fermented malatayum was significantly different. Fermented malatayum leaves produced more crude extract then fresh malatayum leaves. Among the mordants used salt showed the greatest dye yielding performance of both the fresh and fermented malatayum leaves. Nonetheless, native vinegar, gabi extract and salt has no significant difference with the crude extract produced as compared to rust and ash. Fermented dyestuff was significantly different from fresh malatayum dyestuff in terms of the absorptive capacity of the cotton yarn. The effect of mordant to the cotton yarn was highly significant

to vinegar, ash and salt as compared to gabi extract and rust. The colorfastness of fermented malatayum dyestuff mixed with following mordants brought out the army green color (vinegar); battleship gray (rust); dim gray (gabi extract); chamoisse (ash) and (ecru salt) colors to the cotton yarn. Likewise, the fresh malatayum dyestuff gave desert sand and tan (vinegar); seal brown, follow and khaki (rust), fawn and tan (gabi extract), ecru and follow (ash) grollu and follow (salt).

PERFORMANCE OF MALATAYUM LEAVES DYE PROPERTIES ON SILK FABRIC EXTRACTED AT DIFFERENT PLANT TERMINALS AND MONTHS AFTER TRANSPLANTING

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The study was conducted to determine which plant terminals of malatayum leaves and the best months after transplanting (MAT) in harvesting the leaves for dye extract that give the best color effect for silk fabric. The study was conducted at the ASIST Research Laboratory from January 2009 to April 2010. Three Plant Terminals (D) as factor A: D_1 – mixture of top and base leaves (leaves harvested 15 cm from the top), D_2- top leaves (leaves harvested 7.5 cm from the top and D_3- base leaves (half of those leaves harvested 15 cm using the lower portion) and Factor B: A_1- 4 month's after transplanting, A_2- 5 months after transplanting A_3- 6 months after transplanting, A_4- 7 months after transplanting and A_5- 8 months after transplanting. Base on the findings, different colors were obtained. The best colors identified were indigo (Web), Persian Indigo, Liver, Medium purple color. These were the best color identified because these were the nearest colors of indigo that malatayum plants yielded. Indigo (Web) color was obtained from the mixture of top and base leaves extract of malatyum harvested at 5 months after transplanting when dyed to silk fabric. The five months after transplanting was the peak of blooming stage of the malatayum plants which contributed to the color yielded. Liver color was identified from the base leaves extract harvested at 5 months after transplanting. Persian Indigo (Dark blue) was obtainedfrom top leaves extract harvested at 8 months after transplanting when dyed to silk fabric. This may be due to some matured pods that were included that added the color. This was also the ripening stage and pods are also sources of color. Indigo (Web), Persian Indigo and liver color were the best color identified for silk fabric using harvested leaves at different months after planting.

INDIGENOUS FERMENTED PLANT JUICE (IFPJ) AS NUTRIENT SUPPLEMENTS OF MALATAYUM PRODUCTION

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The study was conducted to determine which among the Indigenous Fermented Plants Juice (IFPJ) application will give high biomass of Malatayum production. The study was conducted at ASIST from October 2008 to September 2009. Five IFPJ were used: F_1- Control, F_2- Shiny bush "Pansit-pansitan" *Peperomia pelucida*, F_3 -Malabar nightshade "Alugbati" (*Basellarubia*),F_4- Spiny Amaranth "Kalunay" (*Amaranthus spinosus*)and F_5- Pigweed "Ngalog" *(Portulaca oleracea)*. Based on the results, plants sprayed with fermented Pigweed juice gave the highest growth increment, plant canopy and biomass. The four treatments do not differ significantly on their increment and plant canopy. Plants applied with fermented pigweed and spiny amaranth juices were significantly different over the control plants. Plants sprayed with fermented pigweed juice responded the widest plant canopy which was highly significant. But the different treatments were not significantly different from each other because more or less their phosphorus content analysis was the same. And they were significantly different from the untreated plants. This shows that phosphorus had promoted rapid and vigorous growth of the malatayum plants from the fermented plant juice applied to the plants during their vegetative growth. Plants applied with fermented pigweed juice registered the most leaves biomass of malatayum. The different treatments were significantly different from each other. Plants

without application IFPJ produced the lowest biomass per plant with a mean weight of 3.42 kg compared to 4.89 kg from that plant applied with pigweed fermented plant juice. Therefore Pigweed as Indigenous Fermented Plant Juice as fertilizer supplement for Biomass of malatayum production is recommended.

ADAPTABILITY TRIAL OF LOWLAND RICE VARIETIES UNDER ABRA CONDITIONS

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The study was conducted for two growing season at the Research Experimental Area on rice, at the Abra State Institute of Sciences and Technology Lagangilang, Abra to determine the adaptability and yield performance of six (6) lowland rice varieties selected. Result of the study revealed that there were significant differences in the height of seedlings at transplanting and at maturity, number of grains per panicle, number of filled grains, number of unfilled grains, length of panicle, harvest index, weight of 1000 seeds and yield per hectare of the different lowland varieties. Result of the study indicates that the varieties tested showed highly significant differences in the parameters studied except in percentage survival and production of tillers. PSB Rc 18 outranked the other varieties in yield probably because it had produced the highest number of tillers per hill, grains (filled and unfilled) per panicle, high harvest index and yield per hectare of 5.2 tons. PSB Rc 82 were the tallest at transplanting time hence were the tallest at maturity, had high percentage survival and the longest panicle. NSIC Rc 112 produced the highest number of productive tillers and the heaviest weight of 1000 seeds. PSB Rc 28 produced the least yield because of low production of tillers, number of grains produced, low harvest index and short panicles. The yield of all the varieties exceeded the average national production of lowland rice, which is 3.4 t/ha (Agriculture Magazine, 2000). PSB Rc 18, 82, NSIC 110 and 112 and IR 64 could be grown by rice farmers in lowland condition in Abra because they exceeded the average national yield and found acceptable by consumers.

ASSESSMENT OF LOWLAND RICE (NSIC 112) GROWN IN COCONUT OIL MILL EFFLUENT-AFFECTED AREAS

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An experiment was conducted at Balatas Anayan, Pili, Camarines Sur in order to assess the growth and yield performance of lowland rice (NSIC 112) as influenced by Coconut Oil Mill (COM) effluent at varying distances, to characterize the physical and chemical properties of the soil and water before the experiment, and to compare the return on investment of rice production as influenced by COM effluent as irrigation water on the affected areas in the municipality of Pili, Camarines Sur. A total of 30 plastic pots filled with ten kilograms soil were taken from the affected areas and one from the unaffected area which served as control. The Completely Randomized Design was used involving five treatments replicated six times. The following were the treatments: control (unaffected area), 1.0 km, 2.0 km, 3.0 km and 4.0 km downstream from COM effluent affected areas. The chemical characteristics of water samples were within the range of unpolluted water limits. The soils were slightly acidic and with adequate level of CEC. The percent base saturation was deficient in the unaffected area while adequate in the affected areas. The chloride level at 1.0 km and 3.0 km were low and the rest of the treatments medium. There were no significant differences among treatments in terms of number of days to flowering, number of unproductive tillers and grain weight. However, there were significant differences among treatments in terms of plant height, number of tillers, grain yield, and number of filled grains per panicle, percent unfilled grains per panicle, panicle number and harvest index. The correlation analysis between distance and yield was found to be highly significant. The farther the distance from the oil mill industry the lower was the yield. The highest return on investment (ROI) was obtained in the coconut oil mill effluent unaffected area.

BASELINE SURVEY ON THE RICE TERRACES AND INDIGENOUS RICE PRODUCTION IN ABRA

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The study was conducted to document the rice terraces in Abra and the cultural management practices employed by the farmers in such areas that will serve as baseline sources of data. The key respondents are the rice terraces farmers from eight upland and three lowland municipalities. Data were gathered by using a semi- structured interview, by observation, and documented with the use of camera. Results showed that there are rice terraces in Abra which are mostly found in the upland municipalities and that farmers still grow traditional rice varieties, so it follows that they apply indigenous practices in the cultivation of these varieties. Some of which are the conventional method of land preparation, incubation method of seedling production, use of the wet seed bed, randomized transplanting, hand weeding, use of organic fertilizer through basal application, use of botanicals to control crop pests and diseases, yatab harvesting, manual threshing and winnowing, sun drying, storing bundled rice, storing harvested crops in a primitive warehouse locally known as "Agamang" and primitive milling.

PRODUCTION PRACTICES AND NEED ASSESSMENT OF SELECTED VELERO CROPS IN APAYAO

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The study was conducted to identify vegetables, legumes and rootcrops (VELERO) production practices in Apayao. The study made use of the survey method of research with questionnaire as the main data gathering tool. Interview with VELERO farmers and observation of VELERO farms were conducted to gather additional data. The respondents produce vegetables, legumes and rootcrops (VELERO) as ingredients for pinakbet and dinendeng. There primarily source of income is farming. VELERO producers have been using organic fertilizers for many years but some shifted to the use of commercial fertilizers, without considering the bad effect of these chemically manufactured fertilizers. Organic VELERO producers produce their own organic fertilizers from decomposed plants, manure of animals and other biodegradable materials. Practically VELERO production is for family consumption and for sale to augment their income. Selling their VELERO products can be done individually by carrying their basket of VELERO going from house to house. Others may just sell theirs in the local market. Producers of selected VELERO just utilize a little portion of their land area in the backyard or in the mountain sides with approximately less than a hectare.

MARKETING PRACTICES FOR SELECTED VELERO CROPS IN APAYAO

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This study was conducted to determine the marketing practices for selected VELERO crops in Apayao. Descriptive survey method was used in the study. The results of the study disclose that most of the respondents prefer to sell their own VELERO production individually. VELERO or vegetables, legumes and root crops sold are those of ingredients for pinakbet and dinengdeng, Filipino delicacies. Sellers are the ones who set the price of their VELERO products. Local markets and talipapa served as VELERO outlet. In terms of packaging, VELERO are disposed by bundles rather than by sacks. Organic and non-organic VELERO have the same price in the market. There should be a strong information dissemination on the advantages of eating organic VELERO, seminars about the production of organic VELERO especially addressed to the farmer- sellers, trading post or markets outlets should be established by local officials.

EVALUATION OF POTATO ENTRIES FOR ORGANIC PRODUCTION IN BENGUET

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The study was conducted to evaluate the growth and yield of organically grown potato entries and determine the profitability of growing potato entries for organic production at Balili, La Trinidad and Loo, Buguias, Benguet. Ganza had high percent survival, high vigor, wide canopy, heaviest weight of marketable and non-marketable tubers, and had the highest return on cash expense (ROCE) in both locations. Ganza was also resistant to late blight and leaf miner incidence. Among the MLUSA entries grown in Balili, La Trinidad and Loo, Buguias, MLUSA 8 had wide canopy, plant height, and higher number and weight of marketable and non-marketable tubers leading to relatively high ROCE.

PRODUCTIVITY, NUTRIENT USE EFFICIENCY AND ENERGY UTILIZATION OF YAM BEAN [*Pachyrhizus erosus (L.) Urban*] GENOTYPES IN ILOCOS NORTE, PHILIPPINES

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The study was conducted in three sites of varying climatic and edaphic characteristics in Ilocos Norte from April 2008 to April 2009 to determine the productivity, nutrient use efficiency, cost and return analysis, and energy cost of producing yield of five yam bean genotypes grown under four fertilizer treatments namely: unfertilized/control, dried chicken manure (DCM), 50% dried chicken manure (DCM) + 50% inorganic fertilizer (IF), and inorganic fertilizer (IF). The performance of the five yam bean genotypes under different fertilizer treatments in each site were evaluated based on the following parameters: shoot growth, root growth, dry matter production, dry matter partitioning to the economic yield, yield, nutrient uptake and conversion efficiency of absorbed nutrient to produce dry matter yield, net income, return on investment, and energy utilization in the production of economic yield. Based on the combination of experimental variables, such as fertilizer treatments and genotypes grown in three sites with varying edaphic and climatic characteristics, the application of 50% DCM + 50% IF produced the highest yam bean yield in Sarrat and Dingras, which have a relatively good soil characteristics and climatic conditions. The application of DCM in Bangui, which is characterized by sandy texture, uneven rainfall, windy condition or in general drought prone area, produced the highest yield. None of the test genotypes had consistent performance (yield) across sites. Plants applied with DCM were efficient in converting absorbed N, P and K into yield. Among the genotypes, Genotype 5 was the most efficient in converting absorbed N, P and K. The ROI across sites is constantly highest in unfertilized plants, which reflects low cost of production under low yield levels. The application of IF is the most energy consuming in producing yam bean, as reflected in the highest LDOE. The lowest LDOE was obtained in the unfertilized yam bean crop.

GROWTH AND YIELD PERFORMANCE OF DIFFERENT VEGETABLES APPLIED WITH ORGANIC FERTILIZERS

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The study was conducted to determine the effects of organic fertilizers on the growth of different vegetables and to find out which among the different vegetables will give the best yield when applied with organic fertilizers. The study was conducted from October 2009 to February 2010 at ASIST, Main Campus, Lagangilang, Abra. The experiment was laid out following a Randomized Complete Block Design. The five different vegetables were tomato, mungbean, cowpea, pepper and eggplant set in each treatment with three blocks. The different treatments are as follows: T1- Farmers Practice T2- Organic fertilizer T3- Fermented Plant Juice *(Spiny amaranthus*). Based on the result obtained in the study, no significant result was observed among the different fertilizers in terms of initial height, plant

height at flowering and number of days to harvest on tomato, mungbean, cowpea, pepper and eggplant. However, statistical analysis showed highly significant result on the number of days to fruit setting of pepper applied with fermented plant juice compared to the other treatments. There was no significant effect of the different fertilizers on the number of marketable fruits and weight of marketable fruits on tomato, mungbean, cowpea and pepper except on eggplant which showed that those plants applied with fermented plant juice produced the greatest number and heaviest weight of marketable fruits. In terms of the computed yield per hectare, statistical analysis showed insignificant result on the yield obtained per hectare on tomato, mungbean and pepper; however, highly significant result was noted on the yield per hectare of cowpea and eggplant applied with fermented plant juice. The result of the study is supported with the findings of other researchers that fermented plant juice contains rich nutrients which can be easily absorbed by plants and bioactive substances that stimulate plant growth. Thus, cowpea and eggplant applied with fermented plant juice of *Spiny amaranthus* produced the greatest number of fruits and heaviest weight of marketable fruits that resulted in higher yield obtained per hectare.

GROWTH AND YIELD RESPONSE OF ONION *(Allium cepa)* 'RED PINOY' VAR.ON VARYING BLENDS OF LIQUID TRICHODERMA AND SEAWEED *(Euchema sp.)* EXTRACT

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This experiment following the Analysis of Variance in Randomized Complete Block design was conducted to determine the effects of varying blends of liquid trichoderma on the growth and yield of onion. This field experiment was conducted in OMSC, Murtha, San Jose, Occidental Mindoro from December 15, 2009 to March, 15, 2010. Three hundred sixty seedlings of onion were used in the study. Twenty seedlings (20) were randomly distributed for each treatment of 20 plants per replication. All the plants were subjected to same care and management except for the varying blends of liquid trichoderma and seaweed extract. Two hundred fifty (250 mL) of the blends were sprayed to onion one month after transplanting and every one month thereafter for a period of three months. Treatment 1, complete fertilizer; Treatment 2, 75 % liquid trichoderma and 25 % seaweed extract; Treatment 3, 50% liquid trichoderma and 50 % seaweed extract; Treatment 4, 25% liquid trichoderma and 75% seaweed extract; Treatment 5, 100% liquid trichoderma, and Treatment 6 100% seaweed extract. Based on the findings, plants treated with 50:50 blended liquid trichoderma and seaweed extract produced the highest yield performance of the plant in terms of the fresh and dry weight of bulb. Mean fresh weight of 54.66 grams and mean dry weight of 53.85 were registered by plants treated with 50 % Liguid trichoderma and 50% seaweed extract. It is therefore recommended that 50:50 mixtures of liquid trichoderma and seaweed extract be used in order to attain higher yield performance comparable to conventional way of growing onion. Onion growers can now make use of this farm input which is less expensive and is not harmful to man and the environment.

THE EFFECT OF MAGNETISM ON THE GERMINATION AND GROWTH OF EGGPLANT SEEDLINGS

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The study was conducted to determine the effect of magnetism on the germination and growth of eggplant seedlings, specifically aimed to determine the effect of the four magnetic treatment orientation if it enhances the germination and growth of eggplant seedlings, and to find out the effect of the four (4) magnetic treatment if there are significant result on plant height, leaf length and diameter, shoot and root length, shoot and root biomass, total biomass and root-shoot ratio. Randomized Complete Block Design (RCBD) was used in the study. There were 3 blocks of soil placed on a polyethylene plastic divided into 5 treatments as follows: T_0 – Control, T_1 – North / South,

T_2 – East / West, T_3 – Northwest / Southeast, T_4 – Northeast / Southwest. Result revealed the following findings: as to seed germination, significant effect was observed at 6 and 7 days after sowing (DAS) in favor of the seeds treated with magnets while not significant differences was observed at 8,9 and 10 days after sowing. As to the plant height no significant differences among the treatment mean at 11, 18, and 25 days after sowing. Significant result was revealed to the 1st (first) true leaf diameter at 11 DAS while no significant result at 18 and 25 DAS. Significant effect was noted on the 1st leaf length at 25 DAS. There was a significant increase on the second true length and diameter. Significant differences was noted on the shoot length, average shoot weight, root biomass and total ovendry biomass while insignificant on root-shoot ratio. Based on the findings T_2 with East West orientation of magnets found out to be the best treatment followed by T_3 with Northwest Southeast orientation and T_4 with a Northeast / Southwest and T_1 North / South.

YIELD RESPONSE OF TOMATO *(Lycopersecum escullentum)* 'Diamante' var. ON FERMENTED GOLDEN APPLE SNAIL

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This experiment following the Analysis of Variance in Randomized Complete Block Design was conducted to determine the effects of varying amounts of fermented golden apple snail on tomato. This field experiment was conducted in OMSC – Murtha, Murtha, San Jose, and Occidental Mindoro from December 2009 - January 2010. Seventy two (72) plants of tomato were used in the study. Tomato seedlings were randomly distributed for each treatment of 4 plants per replication. All the plants were subjected to same care and management except for the kinds and amount of fertilizer used. These are as follows: Treatment 1, Control no fertilizer was applied. Treatment 2, RR of complete fertilizer, 1 L per hectare, 2 L per hectare, 3 L per hectare and 4 L per hectare of fermented golden apple snail was used for Treatment 3, 4, 5 and 6, respectively. Based on the findings, fermented golden apple snail has a significant effect on the yield of tomato as revealed by the increase in number and weight of fruits as compared to the use of chemical fertilizer. The application of 30 L per hectare of the experimental liquid fertilizer gives highest yield of tomato.

TILLAGE SYSTEM AND NITROGEN MANAGEMENT EFFECTS ON GROWTH AND YIELD OF SOYBEAN (*Glycine max* (L) Merill) GROWN IN RAINFED LOWLAND SOILS

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A dry-season field experiment was conducted to assess the effect of tillage system and nitrogen management on the growth and yield performance of soybean (UPL Sy 2) in Ligao clay loam and Guinobatan sandy loam types of rainfed lowland soil. The experiment was laid-out in split plot in Randomized Complete Block Design with three replications. Tillage systems namely: plowing + harrowing (P+H) and conventional tillage (C) are assigned in the mainplot and nitrogen management: all of the recommended nitrogen was applied evenly by hand at planting (N_1), 2/3 of the recommended N was applied basally at planting and the remaining 1/3 was sidedressed at flowering stage (N_2), 2/3 of the recommended N was applied basally at planting and the remaining 1/3 was sidedressed at pod formation stage (N_3), 2/3 of the recommended N was applied basally at planting and the remaining 1/3 was applied foliarly at flowering stage (N_4), 2/3 of the recommended N was applied basally at planting and the remaining 1/3 was applied foliarly at pod formation stage (N_5), and 2/3 of the recommended N was applied basally at planting and the remaining 1/3 was applied foliarly in equal doses at flowering and pod formation stages, respectively (N_6). Drought condition prevailed during the conduct of the preliminary experiments. Total amount of rainfall recorded from sowing to 10 weeks after planting (WAP) was only 133.4 mm. Foliar N application when used as supplement and not as substitute for standard soil fertilization was beneficial for soybean production. Combining

early soil application and foliar application of N at flowering was effective in increasing yield in both soil types. Yield increase was attributed to higher number of pods per plant mainstem and branch yield.

TILLAGE SYSTEM AND ROW SPACING EFFECTS ON SOIL MOISTURE AND ON GROWTH AND YIELD OF SOYBEAN *(Glycine max (L) Merill)* GROWN IN RAINFED LOWLAND SOILS

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A field experiment was conducted to determine the effect of tillage system and row spacing on soil moisture content and on growth and yield performance of soybean (UPL Sy 2) in Ligao clay loam and Guinobatan sandy loam types of rainfed lowland soil. The experiment was laid-out in split plot in Randomized Complete Block Design with three replications. Tillage systems namely: furrowing (F), plowing + harrowing (P+H), plowing + rotovation (P+R), and conventional tillage (C) are assigned in the mainplot and row spacing (25 and 50 cm) were assigned in the subplot. Drought condition prevailed during the conduct of the experiment. Total amount of rainfall recorded from sowing to 10 weeks after planting (WAP) was only 133.4 mm. In both soil types, soil moisture content showed the same trend of result in the order of F>P+H>P+R>C as far as tillage system is concerned. Soybean response to tillage system was similar in both soil types but greater effects of tillage were observed in Guinobatan sandy loam than in Ligao clay loam type of rainfed lowland soil. The relative yield advantage of less-tilled soils (F and P+H tillage systems) over the highly tilled soils (P+R and C tillage systems) in terms of moisture conservation in both soil types was associated to the significantly higher dry matter yield, higher proportion of three- and two-seeded pods, and greater number of pods per plant. The 25-cm row spacing showed no significant yield advantage over the 50-cm row spacing in both soil types under below normal precipitation.

ESTABLISHMENT OF A SUSTAINABLE PAPAYA BASED CROPPING SYSTEM

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The study basically aimed to come up with the a sustainable cropping system for papaya through the development of a cost effective strategy with the intent of establishing a benchmark information on production practices, fertilizer management, best variety combined with appropriate fertilizer management scheme and cropping system that could withstand the incidence of the ring spot virus diseases as it is grown in an infested area. The premise is to be able to showcase a good agricultural practice on papaya growing that would improve the usual farmer's practice since they would not give up papaya growing despite the viral disease infestation in the area. Research efforts had been towards the development of a variety that is either resistant or tolerant to papaya ring spot virus disease. The Participatory Technology Development Approach was used in this study with some modifications. The aim was to be able to fast track the transfer of technology to other farmers at the same time expose them to the conduct of doing an actual field research. It can be concluded that Red Lady Papaya (hybrid) variety grows best when grown as a single crop and with fertilizer applied following the recommendation based on soil analysis. It also yields longest and heaviest and biggest fruit. The disease incidence is also lesser as compared to the native variety. The Native variety tends to perform better when planted in a multicrop system and fertilizer applied following recommendation based on soil analysis thus producing taller trees, producing more fruits and the incidence of PRV is lower. It is therefore recommended that similar studies should be undertaken to further verify the results of these tests. Research such as this must be conducted in campus because of difficulty in monitoring the crop. Participatory technology development approach must not be with a single farmer cooperator but must be a farmers' group activity. The choice of the cooperator must include leadership skills and

good interpersonal relation in the area. Farm research must be more on showcasing technologies and good agricultural practice for replication by other farmers.

MODIFIED FRUIT BAGGING TECHNIQUES FOR MANGO

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Mango is one of the commercially important fruit crops in the Philippines. Mango is prone to attacks of insect pests and diseases in all stages of development. One management practice which can help address these problems is fruit bagging because it is another way of preventing contact between the host and insects/diseases as well as minimize mechanical injuries thus improving quality. The project aimed to determine which of the bagging materials and forms gave the best quality of fruits; determine the effect of the bagging materials and forms on pest incidence, and find out which of the bagging materials and forms gave the highest yield and net income. The project was conducted at the Integrated Sustainable Agri Techno Demo Farm of the Pangasinan State University, Sta. Maria Campus, Sta. Maria, Pangasinan: Study 1- Bagging materials (White plastic bag, Black polyethylene bag, Brown paper bag, Glossy paper bag and Newspaper bag); and Study 2- Bag forms (Triangular/Marsman style, Flat form/Cebu technology, Modified square form, and Conical form). There were 16 experimental trees split into four blocks, in each block there were four trees and in each tree all the treatments were present in each study. Fruits were bagged at 46 days from the last spraying of KNO^3. Each treatment had 10 sample fruits bagged. Sampling was randomly done. Brown paper bag, white plastic bag and glossy paper bags and triangular/Marsman style, flat/Cebu technology and modified square as bag forms securely protected the mango fruits against pest incidence. Fruit bagging with brown paper bag and triangular bag/Marsman style exhibited the highest ROI. However, a verification study along this line for a more conclusive result is recommended.

PERFORMANCE EVALUATION OF SIX SWEET SORGHUM LINES FOR BIO-ETHANOL AND GRAINS UNDER PANGASINAN CONDITION

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The study sought to conduct evaluation trial of six sweet sorghum lines under Pangasinan condition. Specifically, it aims to determine their agronomic characteristics and incidence of pests and diseases and recommend lines that are suitable for stalk, grain and bio-ethanol production. There were significant differences observed for plant height, plant appearance score, lodging score, days to 50% flowering, stalk diameter, stalk juice volume, seed size, *Brix values, stalk yield, stripped stalk yield, stalk diameter, stillage yield, stalk juice yield, panicle weight, grain weight and yield. The mean agronomic characteristics of the lines evaluated showed that, in terms of plant height, stalk yield, stripped stalk yield, stalk juice yield, stalk juice volume, and stalk diameter, the ICSV 700 and ICSV 93046 lines have produced the greatest yields. On seed and grains characteristics, the NTJ 2 and SPV 422 lines have produced the greatest yields. In terms of grain weight, the ICSV 700 and ICSV 93046 lines have the heaviest grains. The ICSV 93046 and ICSV700 lines have the least resistance to lodging, lower plant stand, and longest days to attain 50% flowering. ICSV 93046 and ICSV 700 are good planting materials for stalk and stalk by-product purposes. The NTJ 2, SPV 422, and IS 2331 lines produce greater grains. NTJ 2 and SPV 422 are the most resistant to sweet sorghum pests and diseases.

ARBUSCULAR MYCORRHIZAL FUNGI: BIOLOGICAL CONTROL AGAINST STRIGA *(STRIGA HERMONTHICA)*, A PARASITC WEED

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Conventional agriculture is identified as a major contributor of pollutants and greenhouse gasses resulting in the degradation of soil and water quality and increasing atmospheric temperature. Natural and organic farming is seen as the best alternative in mitigating the effects of agriculture in environmental degradation and climate change. In Africa, a parasitic weed known as *Striga* is causing tremendous devastation in croplands. Sorghum, a major cereal crop in Africa is a host plant. The germination, growth and proliferation of *Striga* are triggered by the root exudates of its host plants. As *Striga* germinates it attaches itself to the roots of its host causing the latter to be stunted and eventually die. Since the point of attachment and parasitic activity is at the root system of the plant, control was made at the same point by encouraging mycorrhizal activity in the root zone. Arbuscular Mycorrhizal (AM) fungi, first proven in many scientific studies to help plants absorb phosphorus and micronutrients from the soil were used in this study. A pot experiment using sorghum as host plant treated with arbuscular mycorrhizal fungi was studied in a tropical glasshouse at Wageningen University, The Netherlands to study how these fungi would suppress the germination and growth of *Striga*. Results showed that where there were mycorrhizal fungi, the germination of *Striga* was significantly lower. This result was validated in a laboratory experiment by means of root exudates from the test sorghum plants used in the pot experiment. The root exudates were collected by soaking the root system of the test plants in water overnight. Seeds of *Striga* were treated with the root exudates of the test plants. Validation test results showed significantly lower percentage of germination of *Striga* treated by exudates collected from sorghum plants with mycorrhizal fungi. It was concluded that Arbuscular Mycorrhizal fungi are indeed potent biological control against *Striga*. Similar experiments with AM fungi can be conducted to study its effect on parasitic weeds and pests and diseases attacking root systems of plants in the Philippines.

PSU MUSHROOM RESEARCH, DEVELOPMENT AND EXTENSION INITIATIVES IN ILOCOS REGION

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Ilocos region is a potential mushroom growing region in the Philippines due to its favorable agro-climatic conditions and availability of agro-industrial and forest wastes from rice, other cereals and wood shavings for spawn and growing mushrooms. The paper showcases the mushroom research, development and extension initiatives of PSU-MRDC in Ilocos region. It discusses the best practices developed and disseminated in the different PHEIs, municipalities and cities in Ilocos region. There were six major strategies used in the development and promotion of the technologies. These involved (1) technology generation where technologies were developed for spawn and mushroom production for *Volvariella volvacea*, *Pleurotus spp.* and *Auricularia polytricha* are results of findings from scientific researches; (2) capability building for the stakeholders to equip them with knowledge and skills on mushroom production technologies; (3) techno-demo was undertaken to showcase the technologies; (4) development, production and distribution of IEC materials; (5) forging of memoranda of agreements with partner agencies; and (6) mushroom production included as subject for BSA. The results of the technology generation and promotion of the mushroom production technologies in Ilocos region conducted from CY 2000-2010 show (1) new technologies on spawn and mushroom production using indigenous materials; (2) promotion of the adoption of mushroom production technologies; (3) increased number of farmers adopting the technologies; and (4) strengthened partnerships/linkages. It is therefore recommended to have: 1) continuous conduct of capability building and updating of the technologies to ensure optimum production and utilization; 2) integration of the technologies not only in the BSA curriculum but in the other courses as well.

GROWTH PERFORMANCE OF CACAO (*Theobroma cacao* Linn.) SEEDLINGS USING VERMICOMPOST

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The study sought to determine the growth performance of cacao seedlings in decomposed agricultural waste through vermicomposting. Specifically, the study aimed to find out if there is a significant difference in the growth performance of cacao when grown in different potting media using vermicompost in terms of height increment, root collar diameter increment, root length, ovendry root biomass, ovendry shoot biomass and ovendry total biomass; and determine the best potting medium that enhances better growth and survival of Cacao seedlings in the nursery. The experiment was laid-out in CRD with three replications per treatment. The growth of cacao seedlings was affected by using pure vermicompost and its combination as potting media. Height increment, root collar diameter increment, ovendry root biomass, ovendry shoot biomass, and total ovendry biomass have significant effect. Root length showed insignificant result. Growing cacao seedlings in vermicompost in different proportions caused significant effect on the growth of cacao seedlings within five (5) months. Pure vermicompost and combinations of sand and vermicompost at 2:1 ratio showed the best growth response. Seedlings grown in pure vermicompost (T1) has the highest height increment and root collar diameter increment, while those grown in combination of sand and vermicompost at 2:1 ratio obtained the heaviest oven dry root and shoot biomass, and total oven dry biomass. Hence, pure vermicompost and combination of sand and vermicompost at 2:1 ratio are best for growing cacao seedlings in the nursery. It is recommended that a follow-up study be conducted prolonging time of observation to at least 8 months for nursery experiment using the same potting media to verify the result; future studies of this kind should be encouraged for cacao seedlings and other agro-forestry species in order that agricultural wastes will be subjected to vermicomposting and will be utilized properly; field trials using similar potting media should be used; and promotion on the result of the study should be made.

INOCULATED COMPOST PRODUCTION FROM *Jatropha* PRESS CAKE AND COMPOST TESTING IN *Jatropha* PLANTS

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Pot experiments were set up to test the effects of inoculated *Jatropha* press cake compost on the growth of *Jatropha* plant. Inoculated compost application induced marked increases over the control in basal stem diameter (6-37%) during the first few months of growth after germination in the screen-house. The plants that were held in the screen-house were out-planted in the field in July 2008. Flower initiation commenced 6 months after out-planting with initial harvest being conducted in February to June 2009. Continued flowering and bearing of fruits were observed during the period. The highest fruiting was observed in the months of April and May. Averages of 1.0-1.5 kg dried seeds were harvested monthly (total of all 21 plants) from trees that received applied fertilizer as chemical or organic form during early stage of development. One year after transplanting, a marked increase of 16-41% in basal stem diameter over the control in plants treated with organic fertilizer or chemical fertilizer was observed. Flowering and fruit development declined in July 2009. However, the trees flowered again after this period but no fruits were collected in the succeeding months due to the heavy rains that caused serious fruit fall-off as young and mature nuts. Yield comparisons among treatments were therefore not conducted during the year. Further observation and monitoring are still in progress to verify the quantitative increases in nut yield as effected by the application of inoculated press cake compost and/or chemical fertilizers.

MICROBIAL INOCULANTS FOR *JATROPH A* PRESS CAKE COMPOST PRODUCTION

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Composting heaps were prepared for the purpose of determining the effects of microbial inoculation on Jatropha press-cake compost production. The different treatments were: T1, control; T2, enriched jatropha press cake extract; T3, + 2% $(NH_4)_2 SO_4$; T4, + Trichoderma and Azotobacter; and T5, + mixture of 12 microorganisms from *Jatropha* press cake. Heap dimension was 2.0 m x 1.20 m x 0.5 m and contained 250 kg *Jatropha* press cake. The physical and chemical properties and microbial load of press cake in the course of composting were determined. The pH of all treatments increased from 5.0 to 8.5 that could have caused the decrease in nitrogen content of the compost. The initial total nitrogen content of press cake ranged from 3.06% to 3.51%. After 56 days of composting, a decrease in total N was observed which ranged from 2.24% to 2.91%. The highest decrease in total N was observed in the control heap (2.24%, total N) that was a decrease of 32.33% compared to that with ammonium sulfate. On the other hand, an increase in phosphorus content was observed. The highest increase in total phosphorus was recorded in heap enriched with Jatropha press cake extract, 0.75% (increase over control of 20.97%) followed by the heap inoculated with mixed microbial strains 0.73% (increase over control of 19.67%). Total carbon content generally decreased in all treatments. The results showed the different qualities of compost that can be prepared from *Jatropha* press cake using some defined protocols with or without microbial inoculation.

POTTING MEDIA FOR PHYSIC NUT (*Jatropha curcas*) SEEDLINGS GROWN UNDER OPEN AND GREENHOUSE CONDITIONS

Fe B. Perlas and Rhueda R.Alejo
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The study was conducted to determine the effects of the potting medium on the growth of jatropha seedlings, determine the relationship between the chemical properties of the potting media and the growth parameters of jatropha and compare effect of two light intensities on the growth of jatropha seedlings. The Completely Randomized Design (CRD) was used with six (6) treatments replicated five times. The treatments were: T1 = (Control) garden soil, T2 = (1:1) garden soil, sawdust, T3 = (1:1) garden soil, coco peat, T4 = (1:1) garden soil, sand, T5 = (1:1:1)garden soil, sand, mudpress, and T6 = (1:1:1) garden soil, sand, sawdust. The different potting media did not significantly affect the plant height of jatropha seedlings under open conditions at 14 and 42 days after transplanting. Significant difference in plant height was observed. The different potting media significantly affected the plant girth of jatropha seedlings only at 28 and 70 days after transplanting. The highest plant girth was observed in the garden soil + sand + sawdust treatment. Significant differences were observed in the leaf area in the open condition. Significant differences in plant height under green house condition were observed after transplanting. The garden soil + sand + mudpress treatment was observed to have the tallest seedlings, biggest plant girth and leaf area under green house conditions. Plant girth was significantly affected and was bigger under open conditions. The leaf area of jatropha seedlings was significantly affected by the two light intensities with bigger leaf area under green house conditions. Under open conditions, plant girth was significantly affected by organic matter content, total calcium and total magnesium, while leaf area was significantly affected by the total phosphorus content. The correlation coefficients between total calcium and total magnesium as well as between total phosphorus and leaf area were positive. The growth parameters such as plant girth, plant height and leaf area were not significantly affected by the chemical properties of the potting media under green house condition. A negative correlation coefficient was observed between organic matter content and the growth parameters.

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GERMINATION MEDIA FOR PHYSIC NUT (*Jatropha curcas*) SEEDNUTS

Fe B. Perlas and Floramae V. Baloro
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This study was conducted to determine the chemical properties of the germination media and determine the effect of the germination medium on physic nut germination The Completely Randomized Design (CRD) was used in the study with twelve (12) treatments replicated three times. In each treatment, 15 tuba seed nuts were sown. The garden soil + mudpress had the highest pH reading of 6.87. The garden soil + coco peat had the highest percent water holding capacity with 90.08%. The soil + sand treatment (T7) had the lowest water holding capacity with 34.45%. The garden soil + compost) had the highest organic matter content with 15.20%. The soil + sand treatment (T7) had the lowest with 3.33%. The garden soil + mudpress) got the highest total phosphorous content of 1.14%, The garden soil + coco peat) got the highest total potassium content of 0.146%, the soil + sand treatment (T7) had the lowest total potassium content of 0.052%. The garden soil had the highest total calcium with 1.32%, the lowest total calcium was observed in the garden soil + coco peat treatment (T5). The garden soil + sawdust) and T8 (garden soil + sand + compost) got the highest total magnesium content of 0.25%, the lowest was observed in the treatments with garden soil+ sawdust (T4) and garden soil + coco peat (T5). The garden soil + sand + mudpress had the highest percent germination and percent germination energy and the longest length of germination while the lowest was in the garden soil + sand + rice hull medium. The shortest pre-germination period was observed in the garden soil + rice hull which was significantly different with the rest of the treatments. Correlation analysis showed that the chemical characteristics of the growing media did not significantly affect the germination of tuba.

SURVIVAL OF PHYSIC NUT (*Jatropha curcas*) AS INFLUENCED BY PLANTING METHOD

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The study was conducted in San Jose, Pili, Camarines Sur covering a total area of 550 square meters. The area was previously planted with vegetables and corn for 10 years and now abandoned with vegetation dominated by cogon (*Imperata cylindrica*). The randomized complete block design (RCBD) was used with three treatments replicated three times. The treatments were the following: T1- Direct-Seeding, T2- Bareroot Seedling and T3- Potted seedling. The percentage survival of Jatropha was highly significant as influenced by planting methods. The potted seedlings had the highest average percentage survival from 14 DAP until the end of the experiment. Apparently, there is a declining trend on the rate of percentage survival in all methods due to the El Nino phenomenon.

THE FOOD STATUS SURVEY OF SAPAT AT TALIFUGO, CONNER, APAYAO

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This study assessed the food security condition of SAPAT PROJECT "Sapat at Masustansyang Pagkain sa Bawat Tahanan" (Sufficient Nutritious Food in Every Household), funded by the United Nation Development Program thru the National Anti-Poverty Commission recipients in Barangay Talifugo, Conner, Apayao. The survey revealed that most of the respondents weree 36- 45 years old and active in farming activities. The mean number of children per family is six and annual income was PhP 5,410.06. About 80% of the respondents had sufficient food on their table and 62% never had cut size meals. However, only 36% can afford to eat a balanced diet containing carbohydrates, protein, vitamins and minerals. All respondents eat rice during breakfast, lunch and dinner. To cope with the scarcity of rice especially during rainy season, 92% of the respondents substitute rice with root crops. Protein sources include chicken, pork, beef, fish and eggs. Most of the respondents eat their viand in combination with vegetables with some meat and fish. There are 23 commonly consumed vegetables in Talifugo, Conner, Apayao. The respondents usually consumed leaves, shoots and fruits of the vegetables. Most of these are planted in backyard/farms or bought from market for barter. Seventy percent of the respondents grow vegetables for family consumption and only 36% had enough vegetables for family consumption. Majority did not meet the availability of food in a quantity and quality sufficient to satisfy the dietary needs. The most common diseases are fever, headache, cough, colds, asthma and malaria. The less serious cases are referred to local parademic health workers in the barangay.

EVALUATION OF VEGETABLE, ROOT, AND TUBER (VRT) CONSUMPTION PROMOTION AMONG CHILDREN

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Northern Philippines Root Crops Research and Training Center
Benguet State University, La Trinidad, Benguet

Promotion interventions to improve the consumption of vegetables, roots, and tubers among children were conducted in six municipalities of the Cordillera region. Vegetables, roots, and tubers (VRT) consumption, quality of diet and nutritional status before and after promotion interventions were compared, and the relevance, effectiveness, efficiency and sustainability of the interventions were evaluated. The vegetables, roots, and tubers promotion interventions were relevant in terms of attaining the Philippine government goals of increased per capita intake of vegetables and reduced micronutrient deficiencies. The interventions were partially effective as it increased to 38% the percentage of children eating vegetables, roots and tubers; increased to 98% the adequacy of their vegetables, roots, and tubers intake; and improved diet quality of children in terms of protein, calcium

and vitamin C, including water content. Despite the limited resources, the interventions were efficiently implemented by the participating barangays and schools. However, sustainability of intensified vegetables, roots, and tubers consumption promotion is questionable or dependent on political will.

DEVELOPMENT OF PROCESSING TECHNOLOGIES FOR PANDAN AND LEMON GRASS

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Bicol Region is the second economically depressed region of the country. Albay is one of its six provinces with high percentage of unemployment rate. This project basically aimed to develop products and by-products of pandan and lemongrass which both generate new technologies and provide income sources for Bicolanos, thereby respond to this major unemployment problem. Pandan and lemongrass are locally abundant in Region V. Production of these plants could generate an estimated gross income of ₱270,000.00 per harvest if sold at ₱5.00 per kilogram of lemongrass stalks, and 108,000 kilograms of pandan if sold at ₱3.00 per kilogram could generate an estimated income of ₱324,000.00 per harvest. Moreover, pandan and lemongrass contains medicinal properties. They are both used as diuretic. Pandan is an anti-diabetic plant and leaves can treat skin diseases. Lemongrass is also a stimulant, promotes digestion, reduces fever and relieves menstrual pain and nausea. It is on these social, economic, and health considerations that the researchers conducted this research. An experimental and descriptive-developmental methods of research was employed. Matured pandan and lemongrass were subjected to juice extraction producing a sixty-two percent (62%) juice recovery for pandan samples and seventy-two percent (72%) for lemongrass. The extracted juices were processed into a ready-to-drink and granulated herbal drinks. The meal waste was made into powdered food seasoning and flavorings. Several recipes were prepared seasoned and/or flavored with pandan, lemongrass and its combination such as chicken braised with lemon grass, hamonadong pata flavored with pandan and lemon grass juice extract, puto and cookies flavored with pandan juice extract, Italian pork chop and chicken liver seasoned with pandan and lemon grass combo juice extract and others. Results showed that the produced ready-to-drink and granulated herbal drinks from pandan, lemon grass and its combination, and the different prepared recipes were highly acceptable.

MINDORO BANNER FOOD PRODUCT DEVELOPMENT: ACCEPTABILITY OF COOKIES MADE FROM VARYING PROPORTIONS OF WILD YAM (*Dioscorea villosa*) FLOUR

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As an initial endeavor to develop a Mindoro banner product, “nami” or wild yam (*Dioscorea villosa*) was used. This crop is a staple food of the Mangyans of Mindoro. The study was conducted to determine the acceptability of cookies with varying proportions of “Nami” flour. Treatment levels were T_0 (control, 100% wheat flour), T_1 (75% wheat flour + 25% “Nami” flour); T_2 (50% wheat flour + 50% “Nami” flour), T_3 (75% wheat flour + 25% “Nami” flour) and T_4 (100% “Nami” flour). Products were rated by 75 evaluators as to taste, color, aroma, and texture using Hedonic Rating Scale. Weighted mean, standard deviation, ANOVA and LSD were used. Comparable acceptability was found between “nami” cookies and the commercial product. However, the use of 100% “nami” flour got significantly low taste. The use of 50% and 100% “nami” significantly reduced color acceptability. There was no significant effect on aroma, but texture was significantly reduced. “Nami” flour can be used in the preparation of cookies but other ingredients should be added to improve texture and taste. The use of quality indicators that would not rely on sensory evaluation was recommended for more reliable results. Nutritional and chemical content must also be evaluated.

CONSUMPTION OF FISH-SHELL PRODUCTS IN APAYAO

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Fish plays a very important role in the daily life of many Iyapayaos, particularly the poor. It is the main source of animal protein in their diet. The study was conducted to determine consumption of fish-shell in Apayao. Descriptive survey involving a total of 115 respondents was used with questionnaire and interviews as data gathering tools. Fresh fish is the type of fish products usually sold to market and is most preferred by the consumers. In terms of the methods of preservation, majority used the sun dried method. Fish products were usually sold in the market and housewives were the majority involved in the house to house selling of fish-shell products. Tilapia is the most preferred kind of aquatic products frequently preferred for home consumption and the consumer respondents greatly consider the freshness and quality and even the price in buying fish-shell products. Sinursur is the most preferred indigenous cook of fish; fresh form and sun dried fishes are the best selling products. To protect the freshwater resources of the province particularly the fish-shell species, there should be a stronger program and advocacy on sustainable use of resources

DEVELOPMENT OF KATMON FRUIT (*Dellenia philippinensis*) AS BASE SEASONING MIX

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This research is focused on the development and acceptability of Katmon fruit (*Dellenia philippinensis*) as base seasoning mix. Experimental method was used in deseeding the katmon fruits. Katmon powder was produced through drying, deseeding, milling and packing/storing in a foil packaging material. For every 2500 grams of fresh Katmon fruits, an average of 255 g. or 10.2 g. or 10.4 % of dried flour was generated. A moisture loss of 2240.4 g. or 89.6 % was observed. The Katmon powder recovered a light brown fine fibrous and has been mixed with other ingredients to produce seasoning mix. Of the three replications conducted the base seasoning mix with ingredients of 45g of Katmon powder, 3g iodized salt, 1.45 sugar, 0.5 msg and 0.05 citric acid were rated as extremely as like to taste. Based on acceptability level, trial 1 was rated as extremely like as to flavor and much like as to texture, odor and color, respectively. Sensory evaluation was done by the panelist using standard score sheets. Acceptability factors such as taste, texture, odor and color were included among the choices. Results were obtained across prepared viands which is "sinigang na baboy" in Katmon mix indicating the evident taste and odor of the katmon base seasoning mix. The researchers observed correct cooking methods/ techniques in the addition of the developed seasoning mix in the prepared viands. The accepted ones were then standardized. The researchers concluded that katmon fruit are potential for the preparation of base seasoning mix and accepted among consumers and as per laboratory test conducted by the FNRI 2009 and DOST 2010.The shelf-life is highly recommended for the developed product to compete with the other commercial base seasoning mixes. Further research is still needed to address other gaps revealed by the research.

DEVELOPMENT AND ACCEPTABILITY OF AN ENRICHED LUBI -LUBI (*FICUS PSEUDOPALMA*) NOODLES

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This research is focused on the development and acceptability of an enriched lubi-lubi (*Ficus pseudopalma)* noodles utilizing its puree as indigenous ingredients. Noodles were developed and enriched using lubi lubi leaves. The level of acceptability was determined to find out the degree of acceptance of the noodles among consumers. Experimental method was used by extracting the puree of lubi lubi leaves and used as flavor and packed/stored in polyethylene bag. Of the three trials conducted,

the enriched lubi-lubi noodles with ingredients of 250 g of Lubi lubi leaves puree, 325 g APF, 10 g salt, 150 g eggs and 2 g vegetable oil, 187.5 water was rated much acceptable. Based on acceptability level, trial 2 was rated as much acceptable as to taste and color and acceptable as to texture and odor. Sensory evaluation was done by the panelist using standard score sheets. Acceptability factors such as color, texture, flavor and odor were included among the choices. Results were obtained across prepared products, indicating the evident taste and aroma of lubi-lubi leaves through varied degree depending upon the quantity of puree used. The researchers observed correct mixing methods or techniques used flavorings and other materials that nicely blended with lubi-lubi puree as suggested by evaluators; the accepted ones were then standardized. The researchers concluded that lubi-lubi leaves are potential flavoring in the preparation of enriched lubi-lubi noodles and accepted among consumers. The proximate analysis of the developed enriched noodles in terms of moisture content, ash content, fiber content, protein content, fat content, carbohydrate content and shelf-life is highly recommended for the developed product to compete with the other commercial veggie noodles. Further research is still needed to address other gaps revealed by the research.

DIFFERENT LEVELS OF FRUIT EXTRACT IN JAMBOLAN WINE MAKING

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This study aimed to determine the alcohol content of jambolan wine with different levels of fruit extract. There were four treatments prepared in this study, each replicated three times. All the mixtures were fermented for two weeks. After fermentation, the mixtures were pasteurized. Samples from each pasteurized mixtures were placed in sterilized bottles and were brought to DOST for analysis. Based on the DOST analysis, T_1 has an alcohol content of 6.46%, T_2 - 5.035%, T_3 - 4.84% and T_4 - 3.81 %. The researchers concluded that the greater the level of fruit extract, the lesser is the alcohol content of the wine. And as the amount of extract increases, the alcohol content decreases. The best mixture in making jambolan wine is 2liter fruit extract + 2 cups brown sugar + 2 teaspoon yeast. The researchers come up with the recommendation that a sensory test should be made to confirm the findings of this study.

FISH AND SHELL POSTHARVEST PRODUCTION IN APAYAO

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The study was conducted to determine the indigenous processing of fish and shell in Apayao. It was also conducted to produce fish and shell food products. Results showed that the most common dishes for freshwater fish and shell fishes include *abraw*, *sinursuran* and *sagket*. The natives costumarily cook fish and shell fishes with added hot chili. This reflects the Apayao's inclination to hot and spicy foods. *Abraw* is a combination of grated coconut flesh with added *agatol/*crablets and *agurong*. All three are made to ferment overnight and cooked the following day with coconut milk and hot chili. *Sinursuran* refers to fishes cooked in bamboo internodes with salt and hot pepper. The content is crushed using a *"sursur"* or a long stick. *Sagket* making can be applied to meat or fishes which employs the practice of allowing the fish or meat's flesh to develop a rotten odor and is later cooked with salt and hot pepper. Moreover, it was found that all freshwater and shell fishes available in Apayao can be made into fish- and shell-based flakes, noodles, burgers, sauces, soups, breads and crackers, fish bone soups, kropek, canned/bottled/tetra packed fish and shells, and other nutritious fish and shell food products. However, it is recommended that more studies be made to establish the process flow of making these products without compromising the quality of the output. It is recommended that further studies should be made regarding the indigenous processing of freshwater and shell fishes to include shelf–life analysis and nutritional content evaluation on the products. More experiments on other products should be conducted to explore the potentials of the food products.

BUROLICIOUS PROJECT: ITS PROCESSING, PACKAGING, COMMERCIALIZATION AND PROJECT IMPLEMENTATION

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This study aimed to (1) standardize the process and formula of fermented rice-fish (dalag) mixture; (2) analyze the nutrients, sensory test, shelf life, microbial properties for food safety and (3) improve the socio-economic status of the buro producers. This study is designed to make the product retain its delicious taste however eliminating the undesirable odor. The improved processing of buro revealed that ginisang burong dalag packed in 8 oz. glass jar with a maximum net weight of 240 grams has a minimum processing time at 100ºC for 44 minutes starting from thermal processing temperature at 37.8ºC. The improved burong dalag has 24-26% salt content lower than original and 18-21 days of fermentation. The commercial sterility test resulted in negative traces of harmful aerobic and anaerobic bacteria, when cultured in malt extract and acid product test broth. It has low mold and yeast count as compared to other fermented manufactured goods. The improved product is delicious, nutritious and with pleasant odor. It has passed the 365 days shelf life test. In its entirety, burong dalag is acceptable and has export quality. Market pilot test disclosed that standard preparation of 3 kilos has 36.26% return of investment for cooked buro and 48.26% if raw. It also increased employment of 3-4 laborers per producer. At present the researchers trained 23 female producers in three barangays and one model cooperator. The processed burong dalag has potential innovation into a large profitable industry. The burolicious project implementation have social impact on (1) high quality of food safety, (2) amplified sales; (3) improved socio-economic status of buro makers; (4) boosted the morale of women (5) increased employment rate; (6) revival of the old culture on buro making which originated from the town; and (7) increased the revenue of the town.

EFFECT OF VACUUM PACKAGING ON KEEPING QUALITY OF SMOKED FISH

Myrna C. Bigueja[1]*and Christine C. Bigueja*[2]
Partido State University[1], Bicol University[2]

Smoked fish are almost as perishable as fresh fish. To preserve smoked fish for a longer time, it should be kept at 0ºC. The experiment was conducted to improve the keeping quality of smoked fish. The study aimed to determine the effect of vacuum packaging material on some selected fillet and whole and gutted smoke fish, such as: milk fish bangus *(Chanos chanos)*, round scad *(Sardinella longiceps*), tilapia *(Oreochromis niloticus)*, and stored at room temperature and cold storage at 4 $\pm$ ^{0}C for 12 weeks. Packaging materials increases storage period, however, the shelf life of whole and gutted smoked fish is shorter than filleted fish. Products that were kept in cold storage had stable quality up to 24 weeks. Furthermore, sensorial analysis showed no significance difference up to 15 days for under-vacuum packaging conditions at cold storage temperature. On the other hand, fillet tuna and tilapia has longer storage life than fillet milk fish bangus and round scad. In conclusion, vacuum packaging materials could improve some quality aspects and increase the shelf-life. Hence, it is recommended that smoked products should be packed in vacuum packaging materials.

PHYSICAL, CHEMICALANDRETURN OF INVESTMENT ANALYSIS OF BOTTLED TILAPIA (*Oreochromis niloticus*) IN COCONUT (*Cocos nucifera*) SAUCE

Myrna C. Bigueja[1] *and Christine C. Bigueja*[2]
Partido State University[1], Bicol University[2]

An experiment was conducted to evaluate the physical, chemical attributes of bottled tilapia (*Oreochromisniloticus*) in coconut sauce. Likewise, return of investment was calculated to determine the profitability and viability of the product. Result of the sensory evaluation showed that the best proportion of the ingredients in making the Bottled Tilapiai n Coconut Sauce were 160 grams tilapia fish, 1 cup coconut milk, 1 tsp ginger (sliced), ½ tsp garlic (chopped), 1 stalk lemon grass, ¼ tsp salt,

¼ tsp kalamansi juice, 3-4 whole black pepper. The product has proximate chemical content of 95.97 ash; 43.23 carbohydrate; 16.50 fats; 27.5 moisture and 12.77 protein. Furthermore, the product also met the requirements for commercial sterility, for not having any growth of organism under various condition of the test. For the undiscounted measures of profitability, the project showed a high return of investment of 194% and a short payback of 1months. The Benefit Cost Ratio of the project was greater than 1 at a computed B/C ration of 2.7indicating that the project is viable. It is recommended that Bottled Tilapia in Coconut Sauce recipe may be improved and may be developed with different variations. Shelf life of the product may also be determined in the future investigation. Laboratory analysis may be conducted on the peroxide value of the product.

TAXONOMY OF FRESHWATER FISHES AND MOLLUSKS IN THE PROVINCE OF ABRA

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Fishes and shells are widely distributed in the freshwater bodies of the province of Abra. This study covers the taxonomy of freshwater fishes and shells in the province of Abra. It is aimed at furnishing information on the identification, nomenclature, characteristics and etymology, growth and development and ecological status and importance of fishes and shells found in the province of Abra. Collection of different species of fishes and shells was done in all the tributaries of the Abra rivers system. Fishes and shells were transferred to the laboratory for further identification, classification and characterization. Sixteen (16) species of fishes and seven (7) species of shells belonging to 21 genera were classified and identified namely; Fishes - *Clarias batrachus linn, Oreochromis sp., Anguilla marmorata,Cyprinus carpio, Zenarchopterus dispar,* Cestreaus plicatilis ,Opicephalus striatus, *Glossogobius giuris* , *Awaousgrammepomus, Awaousocellaris, Bunakapinguis, Sicyopterus micrurus, Anguillidae sp* . *Rhyacichthys aspro,*Gambusia affinis, *Anguillidae sp.* and Shells - *Pyganodon sp.* Glochidium sp. *Melanoides sp., Melanoides sp., Physa sp., Viviparus sp.,Pomacea canaliculata*. Etymology of the nomenclature was derived from their taxonomic morphology. Although there were similar morphological characters observed among fishes and shells collected, variation on the external and internal morphological characteristics, size and coloration was also reflected. Growth and development was done during wet and dry seasons. Some are all year round. Longevity ranges from 1-47 years. Most of these species were found in riffles and pools of the rivers and found to be ecologically threatened. These species are economically important as human food.

MAPPING OF POTENTIAL FISH AND SHELL PRODUCTION AREAS IN APAYAO

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This study was conducted to identify and map out the habitats of the different endemic fish and shell species in various rivers in the province of Apayao. Specifically, it aimed to describe the specific habitat of fish-shell of the freshwater ecosystem in the province and identify the production areas of fish-shell. Field survey in the different rivers in Apayao were conducted and maps of existing habitats of the different endemic fish and shell species in various rivers in Apayao were generated using Autocad. The four (4) major watersheds of Apayao Province; namely, Apayao-Abulug Watershed, Zumigue-Ziwanan Watershed, Nabuangan-Barren Watershed, and Cabicungan Watershed, show that Apayao Province is rich in water resources. Biophysical and chemical parameters measured in the 18 sampling stations established in upstream, midstream and downstream locations fall within the standard set by DENR for unpolluted rivers. Endemic fish and shell species abound in the rivers in Apayao. The data collected from the sampling stations were summarized in ten (10) geographical maps and overlay maps for clarity. Other maps show the location of the sampling stations in relation to the barangays in the different municipalities of Apayao. The information generated from the study provided insight on the location of fisher folk, fish and shell resources available and fishing practices.

PROBIOTICS AS CONTROL FOR LUMINESCENT VIBRIOSIS IN MUD CRAB (*Scylla serrata Forsskal,* **1775) LARVAL REARING**

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Luminescent vibriosis caused by *Vibrio harveyi* is a common disease problem in mud crab (*Scylla serrata*) larval rearing. The use of antibiotics to treat vibriosis in mud crab larvae is not apparently viable due to drug resistant vibrios. The use of commercial probiotics to control luminescent vibriosis has been identified as a promising approach. Three experiments were individually carried out to determine the survival rate of mud crab larvae treated with three different commercial probiotics that were inoculated in the rearing water used to rear mud crab larvae. To determine the effect of commercial probiotics on heterotrophic count, presumptive *vibrio c*ount, yellow colony-forming *Vibrio* count, green colony-forming *Vibrio* count and luminous *Vibrio* count, rearing water and mud crab larvae samples were collected, spread-plated and counted on nutrient agar plates with 1.5% NaCl and thiosulfate-citrate bile salt agar plates, respectively. Water quality parameters were also monitored to determine the effects of probiotics on the level of salinity, temperature, dissolved oxygen, pH, ammonia and nitrite. Further, the survival rate of probiotic treated and untreated mud crab zoea larvae were determined through immersion challenge with *V. harveyi*. Addition of commercial probiotics in the rearing water did not significantly reduce LVC in the rearing water and mud crab larvae compared with the control. However, these probiotics significantly improved water quality as indicated by marked reduction in ammonia and nitrite levels. In addition, probiotic treated mud crab larvae challenged with *V. harveyi*, resulted in higher survival rates indicating that application of commercial probiotics during mud crab larval rearing is a strategy to control unwarranted outbreaks of luminescent vibriosis in mud crab larval rearing.

SPECIES DIVERSITY OF TWO SELECTED FRESHWATER ECOSYSTEMS OF ABRA

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The study was conducted to determine the species diversity of two selected freshwater ecosystems of Abra in terms of; presence of macroflora and macrofauna found in Lagayan and Lagangilang River ecosystems; occurrence and distribution of macrospecies present in Lagayan and Lagangilang River ecosystems; compare the species diversity indices of the Lagayan and Lagangilang River ecosystems;assess the quality of water of the rivers ecosystems based on the presence of biological indicators; identify the relationship of the fishing activities of fishermen to the observed data. The researcher collected the macroflora and macrofauna of the two freshwater ecosystems along the banks of the river by using mosquito nets. The species were identified and classified according to the Linnanean system of classification.Frequency and relative frequency were used to determine the occurrence and species diversity of the two sites. Different diversity indices (Shannon-Weiner,Simpson, Margalef's were used to compare the species diversity of the two freshwater ecosystems. The water quality of the ecosystems was determined by the presence or absence of the different biological indicators. Chi square was used to show the relationship of the fishing activities of fishermen and the observed data of the researcher.

BEHAVIORS OF "IGON" NATIVE CHICKEN (*Gallus gallus domesticus*) RAISED IN CONFINEMENT

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The traditional raising of native chicken is familiar and most commonly practiced in rural backyards in the Bicol Region. The native chickens are just loosely free to roam around and trees served as their perches at night. This backyard production yield low volume of products and results in the inconsistency of the product output in the market (Chang, FAO 2002). Igon is the type of native chicken found in the 2nd and 3rd district of Albay. It is very popular in the locality especially to fighting cock aficionados due to its strength and hardiness. Other management systems such as confinements must be tried in order to increase its production; hence, this study was conducted to analyze the behavioral activities of "Igon" native chicken raised in confinement such as feeding and drinking, mating and laying, sitting/nesting and mothering ability and other behavior encountered of "Igon" native chicken raised in confinement. The behavioral results that were gathered showed that superiority among the rooster and hens was observed during eating, drinking, and mating by means of pecking. Igon rooster and hens eat (65-95g)/day and (45-75g)/day) more amount of feeds during rainy days and drink less amount of water (130-350ml) and (50-90ml)/day, respectively. Nine to nineteen days after mating hens were observed to look for nest. Two hens tried to share the same nest at the same time during laying and nesting. Laying time was 1-2 minutes when eggs popped out the cloacae of the hen. Sitting hens left their nest 1 to 3 times a day to eat, drink and dust bath. Hatching time of eggs set was after 20-22 days. The temperature of nest varies from 35.8oC, 38.2oC and 40oC for flat, curve and slightly deep, fit and deep curve, with 60%, 94%, and 70% hatchability, respectively. Mothering ability was observed by driving away their chicks in one corner of the pens by way of opening their wings to cover their chicks and fight approaching chickens near them. Social or range behavior was usually observed while eating, drinking, pecking of grasses in the roaming area and relaxing while cleaning their feathers and dust bathing. Other behavior observed was cannibalism of hens for chicks fallen from the nest to the ground.

GERMPLASM COLLECTION OF FORAGE CROPS FOR SMALL RUMINANT PRODUCTION

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The study was conducted to establish germplasms collection area of forage crops for small ruminant production. Specifically, it was intended to collect germplasm of forage crops in small ruminant production; maintain germplasm of forage crops for conservation purposes. Four types of forage crops collected: grasses, legumes, trees and other crops. These were planted in the experimental area at DA- ROS, Luna, Apayao. Germplasm collection was established at ASC, Luna Campus. The collected germplasms were maintained *ex situ*. A total of 26 forage crops were collected for the establishment of small ranch production under Agroforestry project. The germplasms were collected from variety of sources and donors. In the light of the findings, the following are forwarded as recommendation: Collect other germplasms of forage crops for the small ruminants production; explore other potential legume, grass and tree forage for small ruminant production considering the wide ecological and biodiverse species of crops in the province.

Poster Presentation

CLIMATE CHANGE ADAPTIVE CULTURE TECHNOLOGY FOR LETTUCE PRODUCTION

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In response with the pertinent provisions of the 2009 Climate Change Act of the Philippines (R.A. No. 929) an experimental research relevant to climate change had been conducted using lettuce as the experimental unit. The technology involved a process by means of constructing the experimental set ups and cultivating of lettuce. The first set up involved construction of a bed-like structure made of bamboos. The other set up was a garden plot with the same dimensions as that of the bed-like structure. Lettuce were grown on both experimental set ups using organic fertilizers and urea as treatments. A completely randomized design was followed in this experiment replicated three times. In the first experimental set up, lettuce seedlings were planted in polyethelene bags each bag planted with one seedling. The plot as the other set up was also planted with lettuce seedlings. Results showed that lettuce grown in polyethelene bags grew faster and healthier as compared with lettuce grown in plot. Lettuce in polyethelene bags were also produced year round.

UTILIZATION OF CHICKEN CROP AS SAUSAGE CASING

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Sausage or “longganisa”, an excellent source of proteins and vitamins, is a convenient food made from different kinds of meat which may be packed in natural or artificial casings. To add value to waste products particularly the internal organ - crop in chicken dressing plants and develop a unique product in support to the commercialization of the native chicken industry in the Bicol region, the use of crops as casing was explored and the sensory quality and acceptability of the chicken crop as casing for chicken sausage was determined. The study conducted from February 10- March 5, 2010 at the Institute of Graduate Studies, Central Luzon State University, Munoz, Nueva Ecija used the Completely randomized design with dried crop and frozen crop as treatments replicated three times. The attributes appearance, odor, flavor, tenderness and general acceptability were evaluated by ten panelists. Significant differences ($P \leq 0.05$) were noted in the appearance, odor, flavor and general acceptability with the frozen crop having a better score. After one week storage in the refrigerator, odor and flavor were significantly different ($P \leq 0.05$) with those stuffed in frozen crops having a higher score. Both products were comparable in terms of appearance and general acceptability. Cost of production of one piece of crop sausage was P8.73. Freezing the crops is recommended than drying due to the increase in time and labor spent in drying. Use of crop as casing would be very suitable for specialty products using native chicken meat in place of broilers. The author recommends further study on crops as casing material using other poultry species and the development of specialty products (native chicken or rabbit meat as raw material) with crops as casing material.

DEVELOPING THE MINIMUM REQUIREMENTS OF PRODUCTION FUNCTION FOR OPTIMUM PRODUCTIVITY OF BICOL UNIVERSITY

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This study was conducted to develop the minimum requirements of production function for optimum productivity of Bicol University. Selected colleges of Bicol University include the Bicol University College of Agriculture and Forestry; Bicol University Polangui Campus and Bicol University College of Industrial Technology. The study focused on the production projects funded by the University that generated funds intended to supplement institutional maintenance and operating

expenses. To generate the data needed, the researcher utilized the normative descriptive survey using questionnaire with self-rating scale, checklists, and interview. Data were analyzed using range, averages, percentages,cross-tabulation, and graphical presentation. For the study of congruency and validation of relationships, the Kruskal-Wallis *H*-test was used. Based from the findings of this study, the following conclusions include: (1) All the respondents considered the internal productivity factors to contribute to the production function of Bicol University although the level of contribution vary from moderate to much contribution; (2) The degree of controllability of the productivity factors likewise vary from least controllable to moderately controllable; (3) Among the problematic factors, people was the most problematic for top management, plant and equipment for middle management and students with addition of organization and systems for students; (4) The differences in the perceptions of the respondents and colleges to the internal productivity factors' level of contribution, degree of controllability and as problem areas were all significant; and, (5) The Kurosawa model based on structure of work hours can be used to determine workers' efficiency and productivity. The following recommendations are presented: (1) Adoption by Bicol University of the proposed minimum requirements of production function for optimum productivity developed from this study; (2) The existing production projects must not be treated as support only to instruction, research and extension but rather as full scale commercial enterprise; (3) Small-scale projects should be expanded to a medium-scale enterprise; (4) Bicol University must undertake an innovative measure to initiate a comprehensive development plan specific for production function; (5) Bicol University must institutionalize the implementing rules and regulations governing production function, and lastly, (6) Bicol University must make an effort and representation to appropriate institutions/entities and/or government development agencies for the creation of Regular Fund classification specific for production function which should be included in the General Appropriations Act (GAA).

HEALTH REMEDIATION AND THE USE OF MEDICINAL FLORA BY DEAGANONS OF DIMASALANG, MASBATE, PHILIPPINES: A DOCUMENTARY

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Deagan Island is one island component of Barangay Mancaraguit, Dimasalang, Masbate. It is a 257 hectare island, occupied by fishing and farming community, with tenurial rights granted under the Comprehensive Agrarian Reform Program (CARP) (ARC Development Plan). Fishing is the frontline livelihood of the growing communities of Deagan and the adjoining islands. Traditional knowledge on health in Deagan Island is very rich. Selected household members of the island disclosed some fertility-related and health care issues affecting most of the households. There is no available Health Center in the island so medical and health needs are rarely attended to, except for those who can afford to go to the health center in the town proper for check-ups. Absence of health workers and the geographical isolation of the island make sanitation monitoring and transport of emergency cases difficult and childbirth risky. Propagation of medicinal plants for health remediation is basically observed in every household. The use of medicinal plants is common in first aid remedies for common illnesses, like colds, fever and flu. Among the common herbs which some of the residents propagate are *lakadbulan*, *artamesa*, *oregano,herba buena*, *labnog* and *noni* plants. *Hilots* are local means in which the community depend from whenever somebody is ill. These are the six (6) quack doctors whom the locals call as *parahoyop* who are always ready to administer their craft to those who are infirmed. Their rituals ranged from the use of various leaves, bark of trees, eggs and essential oils accompanied by the prayers or *oracion* which the *parahoyop* does. Although, most of them do not accept any payment for their services, the residents sometimes give them donations in the form of small cash or in kind. Majority of the ones being brought to them for treatment are those who suffer from muscle pains, sprains, constipation, gas pain, headaches, fever and flu and the headache due to the so-called usog or sibang. Some of them also undertake circumcision of the male youth using a sharp *labaha* as implement with rubbing alcohol and guava leaves as antiseptic.

***BURIRING* (FAMILY *Tetraodontidae*) FISHERIES: PROSPECTS FOR ALTERNATIVE TOURISM OF DIMASALANG, MASBATE, PHILIPPINES**

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Buriring is a unique fisheries of Bicol, particularly of Dimasalang, Masbate. *Buriring* is a local name of juveniles of distinct species of a pufferfish, belonging to Family Tetraodontidae. The duration of its occurrence in the Naro Bay is very short (four to five weeks only); however, the capture of juveniles is in large quantity. Three distinct species are observable based on distinct physical markings; however, there is a need to establish the taxonomy of these species. It is important however to stress that the three variants are traditionally eaten by most people of Dimasalang as exotic food. The 2006 season had an approximate production of 2,200 metric tones with a conservative economic value of P44 million pesos. A Buriring fishery in Dimasalang is rich in traditional knowledge. A variety of menu can be prepared out of *buriring*. The very popular is soup (in Cebu) and a variety of menu for buriring's liver and flesh known locally as *linabog* (in Dimasalang). The presence of *buriring* is not a good phenomenon to some. Some fishers were annoyed by *buriring*, since it severely reduces their income during its season. It was noted from the accounts of people that some severely affected sectors resort to rituals to drive-away *buriring*. This was reportedly done by wrapping some *burirings* in a black cloth and burry this in a local cemetery through a simple ritual. It was claimed to be effective, because for sometime, *buriring* disappeared for almost five years not too long ago. With such unique fishery in Dimasalang, the trend of holding festivals as promotional strategy of local government units, *buriring* can be a good material. It could introduce Dimasalang to the world as haven of *buriring*. Capitalizing on the unique characters and limits of *buriring*, a local festivity can be conducted annually, especially during season of the fish. In the essence, the festival would result to more detailed understanding of the fish and its ecology. At times when the supply is scarce, as an expected dynamics of any fish population under exploitation, the activity can be channeled to resource limit awareness and environmental management advocacies.

PREVALENCE OF *Paragonimussp.* METACERCARIAE INFECTION IN FRESHWATER CRAB, *Sundathelpusa philippina*, FOUND ALONG BRGY. PUTING SAPA CREEK IN SORSOGON, PHILIPPINES

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Freshwater crabs, *Sundathelpusa philippina*, the second intermediate host of the lung fluke, *Paragonimus sp.* were collected froma creek in Barangay Puting Sapa, Juban, Sorsogon, and were examined microscopically for the presence of metacercariae in the gills, pericardial tissues, gonadal tissues, and leg muscles. There were 61 crabs examined: 31 males and 30 females, and 26 juveniles and 35 adults. Male crabs had significantly higher metacercarial load (mean 92) compared to females (mean: 80). Mature adult crabs had significantly higher level of infection (mean: 105) compared to the juveniles (mean: 68). Comparative mean metacercarial load distribution in different body tissues showed the highest in gills at mean of 58.9, and followed by pericardial tissues with 15.9, gonadal tissues with 12.8, and leg muscles with 1.4. Using the ANOVA and validated by Duncan's and Tukey Kramer's tests, a significant difference (p=0.05) in the metacercarial load in gills and in leg muscle metacercarial load between adult crabs and juvenile crabs was noted; while insignificantly different between the genders. In the pericardial tissues and gonadal tissues, the metacercarial load showed no remarkable difference between adults and juveniles as well as sexes.

DISTRIBUTION AND ABUNDANCE OF FRESH WATER CRAB (*SUNDATHELPUSA PHILIPPINA)* INHABITING A CREEK IN BARANGAY PUTING SAPA, JUBAN SORSOGON

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The study was conducted to determine the distribution and species abundance of the freshwater crabs in the locality of Brgy. Puting Sapa Juban, Sorsogon. The 239 crabs collected from two sampling stations, Ilawod and Iraya covering an area of 250 square meters per station were all identified as *Sundathelpusa philippina*.The crabs pooled from the two stations consisted of 115 females and 124 males with a relative density of 0.460 and 0.496, respectively. Male juveniles (n=51) had higher relative density (0.204) compared to 29 female juveniles (0.116). Adult and juvenile sex ratios were 1:1 and 1:2 (male vs. females), respectively. In both stations, though differences in weight and body length between sexes in both adult and juveniles were insignificant, this was significant between stages of development/growth. Biomass difference between the two stations (Ilawod: n=136 & 0.087g; Iraya: n=103 & 0.086g) is insignificant.

THE ECOLOGICAL VULNERABILITY OF BIO-PHYSICAL QUALITY OF THE COASTAL WATERS OF BACON DISTRICT, SORSOGON CITY, PHILIPPINES

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The coastal waters of Bacon District, Sorsogon City characteristically supports more production of the marine organisms because of the diverse plankton community and good water physical characteristics. There were twenty-one different species of phytoplanktons and eight species of zooplanktons identified and taxonomically classified. The phytoplanktons identified belonged to six phyla – Bacillariophyta, Ochrophyta, Ciliophora, Dinophyseae, Prasinophyta and Cyanobacteria. *Amphisolenia bidentata* is the most abundant of the phytoplankton species and *Acanthocyclops robustus* is the most abundant zooplankton. San Juan has the most diverse plankton community, and the abundance of phytoplanktons in the area supports more production of marine organisms, since planktons are indicators of a healthy and productive sea. The physical characteristics of the sea water surrounding Bacon District such as salinity, pH, temperature, turbidity and conductivity complied with the standards set by DENR-EMB in DAO-34. Normal growth of aquatic bios-systems are observed and is likewise favored by the water quality, however, this marine habitat is so fragile that any alterations to this aquatic environment including the observed optimum condition of such environment will render them unfavorable for both aquatic organism and to the inhabitants residing the island. There is a need to sustain the management of the marine sanctuary in the area so that the richness of the marine resources is maintained. While there is the presence of mariculture in the area, there should be constant counter monitoring of the water quality for environmental safeguarding.

THE COASTAL FISHERIES PRODUCTION OF BACON DISTRICT, SORSOGON CITY, PHILIPPINES

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The capture fisheries of Bacon District is a multigear type which harvests various species of mainly coastal and oceanic pelagics and hard bottom demersal fishes. Fishing dynamics is strongly affected by the interplay of northeast and southwest monsoon. Peak fishing operations happen in February, when the northeast monsoon weakened, up to June, prior to the onset of the southwest monsoon. Bulk of the fishing trips and 64% of the municipal fisheries production of the district is

generated during this period. The fishing gears have diversified from 20 types in 1998 to 33 at the present time. The increase in gear types and units signal increasing fishing intensity and scarcer resources, hence fishers modify their gears to enhance catching efficiency. Fishers disclose that they devote longer fishing times and generate smaller catch during the present time. Decrease of catch rate was noted to range from 20-65% using rough baselines in 1998. Species shift from big oceanic pelagics to smaller coastal pelagics and demersals and shortened fish availability (season) were also evidently noted. The fishing gears are mostly simple and municipal types, dominated by handlines of several variants. Seven units of commercial fishing gear (ring net) are present and contribute 19% to the coastal fisheries production of the district. Fifty three percent of the 2156.8 mt total fisheries production estimate for 2009 is contributed by handlines. More than 80% of this total production is contributed by Sto. Nino, San Juan, Caricaran and Poblacion. The remaining are shared by the other 14 barangays, having Bato (3.5%) and Buenavista (3.8%) leading the pack of minor contributors. The approximately 1200 fishers are unevenly distributed along the 32.48 kilometer coastline, with an average density of 34.73 fishers per kilometer coastline. The total annual fisheries production they generate, conservatively estimated at P130 million (PhP) surprisingly exceeded the total economic revenue generated by the 1400 hectares of irrigated and unirrigated rice farmlands. With this information at hand, investments to wider interventions for fisheries development and management would have stronger economic and social justification.

THE ECOLOGICAL HABITATS OF BACON DISTRICT, SORSOGON CITY, PHILIPPINES

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The ecological habitats of the coastal area of Bacon District, Sorsogon City were assessed of their status. Standard sampling techniques were used to generate data that were needed to come up with comprehensive statements regarding the present state of the identified habitats. Line intercept method was used to survey the existing coral reefs. Line quadrat method was used to assess the seagrass/seaweed beds while line plot method was used to evaluate the community structure of the mangrove habitat. Fish visual census was employed to asses the diversity and biomass of coral reef fishes. Corals were found to be thriving along the entire coastal zone of the district but noted to very extensive in barangays Osiao, Sto. Niño, San Juan, Caricaran, Sawanga and Buenavista. The status of the coral reefs in the said areas ranged from poor to good live coral cover. Overall mean percentage live coral cover was 40.28% in the whole sampling area indicating a fair live coral cover condition. The reduction in live coral condition can be attributed to both anthropogenic and natural causes. Thirty six species of coral reef fishes were identified in the coral reef stations with varying biomass estimates of 112 to 308 kg/hectare. Nine species of seagrasses and four species of seaweeds were identified and they were observed to be extensively thriving in the sampling areas. The species *Syringodium isoetifolium* appeared to be the dominant species of seagrass. This was followed by *Thalassia hemprichii* with *Halophila minor* as the least. Among the seaweeds the species *Halimeda cylindracea* was dominant. Ten species of mangrove species were identified alongside with another three associated species. *Avicennia marina* was present in all the sampling sites. Cutting of mangrove trees was observed in most of the sampling stations. Level of perturbation was estimated at level three. The different ecological habitats evaluated were important life support systems for the existing fishery in the area especially for the gleaning of macro-invertebrates.

SOCIO-ECONOMICS OF BACON DISTRICT COASTAL COMMUNITIES, BACON DISTRICT, SORSOGON CITY, PHILIPPINES

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An assessment of the socio-economics of the coastal communities was undertaken as component of the Rapid Resource and Social Assessment of Bacon District. It intended to provide detailed update of the status of the social and economic well-being of the district coastal dwellers for CRM and other interventions for the district's fisheries development and management. The fisherfolks of Bacon District are original Bacongnons, mostly catholics, have an average residency of 23 years and majority are elementary and high school graduates. The mean household size is 6.45 members. They have been fishing on an average of 24.17 years, and presently exert fishing intensities of 10.15 months per year, 3.19 weeks/month, 4.93 days/week and 1.43 times/day. Many households commonly owned manual or motorized banca. Mesh sizes of nets are suited for the target species. Hooks used by fishers are homemade. Most of these municipal fishing gears are assembled locally using locally-available materials. Most of smaller fishes were caught by fish nets and the fish corral. Per catch, the volume ranged from 3-5 kilograms per fishing trip (one trip per day). Marketable sizes costs PhP 70.00 per kilogram, however, 80% of the catch is allotted for domestic consumption, 10% is shared with companions and/or relatives and the remaining quantity is sold. Fisher folks are aware of the existence of illegal fishing practices in the coastal waters of Bacon District with illegal fishing perpetrators are people from outside of their barangay and rely on the local government unit (LGU) as the one responsible in stopping illegal fishing. Women play crucial role in both community development at Bacon District or in the fishing activities. Women's activities in the barangay are focused much on socio-civic and livelihood activities and involvements include marketing of fish catch and fish processing. The coastline along the Bacon District has been naturally and ecologically contoured and is considered a recreational and ecotourism area due to the quality beaches.. Bacon District fisher folks have positive perceptions of conservation of coastal resources. They are open to the realities for a need towards better future direction of conservation and management of coastal resources. Fishing is their way of life and the same needs to be nurtured.

UTILIZATION OF VERMICOMPOST IN LAHAR-LADEN AREAS AROUND MAYON VOLCANO

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Agriculture is one of the major economic activities in Albay. However, different calamities occur resulting to ecological changes. On November 30, 2006, severe rainfall associated with the passing of super-typhoon Reming triggered lahar flows, landslides and flash floods on the southeastern quadrant of Mayon Volcano. Vast agricultural land had been damaged and deemed one of the worst problems of the residents whose economic life depends on agriculture. A study was conducted to assess the growth and development of bell-shaped pepper (*Capsicum annum* L.) on lahar soil to varying levels of vermicompost. The lahar utilized was collected from lahar-laden area near the 6-kilometer danger zone of Mayon Volcano. Observed values from the study shows that lahar-laden areas can be made productive for agriculture given proper management and appropriate technologies by using organic fertilizer such as vermicompost. Vermicompost is a product of processing organic waste by earthworms. It has dramatic effects on the availability of nutrients, plant germination, growth, flowering, fruiting, and yield of crops. With these, the farmers could use the land destroyed by the lahars in low-lying areas of the volcano while at the same time rehabilitating the immediate surroundings and mitigating also the negative impacts of climate change.

DISASTER RISK REDUCTION THROUGH LAND USE PLANNING IN LAHAR-DEVASTATED FOOTSLOPES OF MAYON VOLCANO IN ALBAY

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Mayon Volcano's lahar deposition continually being pried and loosened by typhoons' heavy rains is constantly altering the landscape in the foot slopes of the volcano. Such a precarious condition necessitates a dynamic land use plan to cope up with the hazards of future events of high intensity typhoons and volcanic eruptions. This study was conducted in Lidong, Sto. Domingo, Albay to formulate an appropriate land use development framework plan for lahar-devastated areas brought about by Typhoon Reming in 2006. The land use development framework planning involved the following activities: A. Environmental assessment of the study site: Spatial extent and physical delineation of the study area; Identification of major land use systems; Ecological profiling (biophysical and socioeconomic), and Integrative analysis. B. Consultative process: Community consultation; and, validation with the community and other stakeholders. Future events of high intensity typhoons and volcanic activities will pose hazards to Lidong and other areas at the footslopes of Mayon Volcano. The land use development framework plan will provide the general guidelines to help mitigate the risks of disaster and maximize the potential use of the land and natural resources.

PEARL FARMING SCIENCE AND TECHNOLOGY PROGRAM OF CASTILLA, SORSOGON, PHILIPPINES

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The research capitalized on the presence of at least three species of pearl producing oysters, one of which is *Pinctada maxima*, popular for its potential to yield south sea pearls. There is the potential of exploring spat collection as possible support activity to the pearl farming program being developed in the area. The 18 species of spats fell under 2 phyla (Mollusca and Arthropoda), distributed to three classes, 10 orders, 10 families and 14 genera. The dominance of several economically important mollusks, specially the pearl producing oysters, namely, *P. maxima*, *P. margaritifera and Pteria penguin and P. colymbus* were indicators of the potential of exploring spat collection as input to nursery technology to support fresh supply of pearl oysters for commercial pearl farming. A promising development of locally-adaptable technology of pearl oyster relaxation was tested in the experimental implantation of round nucleus right in the gonad of recipient oyster. The relaxation protocol utilized locally available plants as relaxant. When compared to the local practice of wedging, PORIT was much simpler and effective. There was 100% survival rate with PORIT while 0% survival rate with the wedging method (experience by local farm practice in Cogon). Also, there were no rejections of the nuclei implanted in PORIT while the owner-technician of the local farm employing the wedging method reported recovery of pearl beads. Pearl farming, as an ecologically-friendly aquaculture practice would sit well with the protection and management of coastal assets of Castilla. The location of the present experimental station, at the eastern periphery of the Malaumauan Island Fish Sanctuary and Marine Reserve (FISAMAR) could be a tool to further enhance the protection and management afforded to the reserve and sanctuary. This an inviting opportunity for local managers to carry-out CRM while integrating eco-friendly aquaculture and FISAMAR management. The ecotourism potential of the pearl farming project in a scenic uninhabited Malaumauan Island, near the FISAMAR is obvious. Several times, the project and the pearl farm venture were featured in broadcast and print media.

FUEL EFFICIENT CHARCOAL STOVE (PATENT NO. 02-2009-000005)

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The research study was primarily aimed to design, construct and evaluate the performance of the Fuel Efficient Charcoal Stove. Patent application to protect the rights of the maker and researcher was also form part of the study. Igneous stones from emitted by Mayon Volcano was selected and used as the secondary materials and used in prolonging heat temperature. The locally available charcoal stove was used to compare the performance of the Fuel Efficient Charcoal Stove. The prototype is patented and awarded by IP Philippines Intellectual property rights and is protected for 7 years. The stove consumes charcoal at the rate of 400 grams for 2 hours; and 3) Heat temperature holds for a while through its secondary materials even charcoals are turned into ashes. The design of Fuel Efficient Charcoal Stove is patentable. Small holes as part of the design with a rectangular shape opening at the lower part helped good circulation to produce more intense heat. About 400 grams of coco charcoal is enough to last for 2 hours to cook food for the family.

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