MMSU Science and Technology Journal
Vol. 3 No. 2 | July-December 2013

ISSN: 2012 0060

CORRELATES OF FOOD SAFETY PRACTICES OF THE CHICHACORN INDUSTRY IN ILOCOS NORTE

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Abstract

The National Economic Development Authority-Development Bank of the Philippines-Mariano Marcos State University (NEDA-DBP-MMSU) Project (2007) survey revealed that not one of the Ilocos Norte food processors could approximate Good Manufacturing Practices (GMP), a basic food safety program required by the Bureau of Food and Drugs (BFAD). The Ilocos Norte chichacorn industry is not an exemption. Thus, this study determined the factors affecting the adoption and implementation of food safety program in the said industry.

Fourteen chichacorn owners and ten workers located in Paoay, Solsona, Pinili, and Dingras served as respondents of the study. Majority of the chichacorn establishments were categorized as micro enterprises based on the number of workers. Owners' production areas were mostly extension of their houses. Product processing was still based on accustomed production practices using minimal equipment available. Not all processors are registered with regulatory agencies as some operate without BFAD registration, which is a basic requirement of all food establishments based on P.D. 856 (Sanitation Code of the Philippines).

Moreover, owners and workers had a moderate knowledge level on food safety. However, their beliefs and work behavior on food safety practices were highly favorable. The environmental condition in their production plant though was moderately favorable. Meanwhile, their level of compliance with food safety practices during production was low.

The respondents' personal characteristics are significantly related to their work behavior, but not with their food safety practices. In contrast, respondents' knowledge belief and environmental condition are highly significant to their existing food safety practices. Additionally, the respondents are knowledgeable about some food safety practices, but the condition of their processing plants and the existing practices of the workers run counter to what they know and believe in.

Keywords: food safety, chichacorn, industry

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Introduction

Food safety has been gaining increased attention lately because of increasing cases of food-borne illnesses worldwide due to globalization, production efficiency techniques, and uncertainty surrounding existing and emerging food-borne risks, as well as the public interest in microbial food safety and dietary concerns.

According to the Food and Agriculture Organization-World Health Organization (FAO-WHO) Philippine report, some processors are faced with difficulties for food safety program compliance such as Good Manufacturing Practices (GMP) particularly small-and- medium-enterprise plants. This finding is parallel with the benchmark survey results conducted by Abadilla et al (2007) that none of the food processing establishments in Ilocos Norte would comply with GMP. The Ilocos Norte chichacorn industry is not an exemption.

The chichacorn industry in Ilocos Norte is one of the major food processors under the snacks category. It has been noted by the Department of Trade and Industry (DTI) as among the promising industries in the country as it has already penetrated foreign markets where there are Filipino communities such as those in Cyprus, Australia, and Saudi Arabia. In 2007, it had $14,400 export sales, which is on top of the P14.005 million domestic sales (Valdez, 2007). However, despite the tremendous success of the industry, it was observed by Abadilla et al (2007) that none of the chichacorn producers in the province could approximate GMP standards, the basic food safety required by BFAD. Results of the same study showed that the Total Plate Counts (TPC) of the samples from the chichacorn processors were from 1700 to 3600 cfu/g, which was higher than the maximum level of 10cfu/g. TPC manifests proper food safety implementation in the food processing sector (http//:foodoregonstate.edu.html-accessed 08/22/2006).

According to the FAO-WHO country report of Ramos and Oblepias along with local and national studies conducted by Albano (2004), Nieto-Montenegro et. al. (2006), McArthur et.al (2006), Hine et. al., Altekruse et al (1995), Knabel (1995), Pradish (1999) and Wilcock et al (2003), many factors affect compliance in putting food safety programs in place. This trend is attributed to socio-economic factors, technical knowledge, behavioral change, as well as managers' and workers' values among others.

The absence of proper and effective food safety control causes production losses and public confidence in the food industry; thus, it is necessary to maintain the safety and quality of food being produced by the food industries. A comprehensive control procedure in the food chain should be in place to ensure safe and high quality foods. One of this control procedure is the GMP – the basic food safety program.

Considering that the chichacorn industry is a promising snack industry in Ilocos Norte, proper and effective food safety control should be in place. However, due to the absence of a study ensuring proper food safety practices and production of quality chichacorn, this study was undertaken. Generally, this inquiry documented the existing food safety practices of the chichacorn industry, and determined the factors related to the same in chichacorn processing.

Specifically, it identified the respondents' personal and business profile; their knowledge level on food safety practices; their beliefs and work behavior on food safety; the environmental condition of their processing plant; their chichacorn production safety practices; the relationship between food production safety practices followed in the chichacorn industry; and the relationship between the respondents' personal characteristics, knowledge, beliefs, work behavior, environmental condition of the processing plants, and their food safety practices.

Methodology

Locale of the study. Ilocos Norte is known for its agricultural crops such as garlic, onion, rice, corn, and other cash crops. Being a corn producer, the province is famous for its processed corn called chichacorn. This study was conducted in all towns of Ilocos Norte where chichacorn producers operate such as Paoay, Solsona, Pinili, and Dingras.

Research design. The study used a combination of descriptive and relationship research designs. The descriptive dimension focused on the respondents' personal and business profile. Meanwhile, the relationship aspect looked into the interplay between the respondents' personal and business profile, knowledge, beliefs, work behavior as well as their respective manufacturing plant's environmental condition and their food safety practices.

The 14 owner-and 10 worker-respondents came from the chichacorn producers in Paoay, Pinili, Dingras, and Solsona. The workers interviewed were those who have been involved in the industry for at least one year and had knowledge on the entire production process. Complete enumeration of the manufacturers was considered because their size was manageable.

Interview instrument and administration. An interview schedule determined the respondents' personal and business profile, level of knowledge, beliefs, work behavior, environmental condition, and the existing food production safety practices.

Items were constructed based on the provisions of the CFR-Code of Federal Regulations Title 21 Part 110-Current Good Manufacturing Practice in Manufacturing, Packaging or Holding Human Food, PNS/BFAD 23:2010-Recommen- ded Code of Practice of the Processing and Handling of Fried Corn Snacks (Chichacorn) and the observed manufacturers' processing practices.

Data sets on knowledge level, beliefs, and work behavior were gathered through an interview schedule. Follow up questions were asked to let the respondents elaborate their responses. Meanwhile, data on the environmental condition of the manufacturers were based on the researchers' observations.

Data analysis. Frequency counts, percentages, and means were used in analyzing the data. Using SPSS 14.0 by Windows 2005 (SPSS, Inc.), Pearson r correlation coefficient determined the relationship between the food safety practices and the respondents' personal characteristics, knowledge, attitude towards food safety practices, beliefs on food safety, and the environmental conditions in their chichacorn processing plants.

Levels of knowledge, beliefs, work behavior, and environmental conditions were determined using score ranges based on the number of items per parameter equally distributed in a three-descriptive level category.

The level of knowledge was determined using a 20-item true or false test. Means of the respondents' scores were computed, which were further categorized as follows: high (14-20), moderate (7-13), and low (0-6).

Beliefs, work behaviors, and environmental conditions were determined using a 15-item compliance checklist. Mean scores were computed and categorized into three: favorable (11-15), moderately favorable (6-10), and unfavorable (0-5).

Results and Discussion

Respondents' Personal and Business Profile

Table 1 shows the respondents' demographic and business profile such as age, gender, educational attainment, number of years in the business, and seminars or training programs.

Age. The highest frequency of respondents included those who belonged to the 46-60 range. This means that the chichacorn industry work force is generally middle aged.

Gender. A big majority (67%) of the respondents were females and they were primarily responsible in sorting corn kernels, washing boiled corn, and packaging. On the other hand, the males who comprised the rest of the respondents did the drying, boiling, washing, frying, as well as storing raw and semi-processed and processed corn. These findings suggest that females dominate the work force and lighter tasks are done by them while heavier tasks are accomplished by the males.

Educational attainment. Almost all (96%) of the respondents had formal schooling, while one (4%) did not have. The respondents started and completed elementary (33%), high school (38%), college (4%) and vocational and graduate studies (4%). This trend means that the industry accommodates work force whose educational background cuts across all levels.

Number of years in the business. Half of the respondents had been working in the chichacorn industry for about ten years, while only a few (8%) had been in the business for at least 20 years.

Seminars/Training programs attended. The respondents attended seminars and training programs on current Good Manufacturing Practices (cGMP) (42%), food preparation (21%), sanitation (8%), and Hazard Analysis Critical Control Point (HACCP) (4%). However, almost one of three never had a chance to participate in any of the same activities.

Respondents' Knowledge on Food Safety

cGMP. A big majority of the respondents were knowledgeable on cGMP as a food safety program required by BFAD for food establishments, which is a joint concern of the government, the industry, and the consumers (Table 2a).

Table 1. Personal and business profile of the respondents (n=24).

PROFILE	FREQUENCY	PERCENTAGE
Age		
<30	6	25
31-45	5	21
46-60	8	33
>60	5	21
Mean	46	
Gender		
Female	16	67
Male	8	33
Educational Attainment		
Elementary	8	33
High School	9	38
Vocational	1	4
College	4	17
Graduate Studies	1	4
No Formal Education	1	4
No. of Years in the Business		
<10	12	50
11-20	10	42
>20	2	8
Mean	11	
Seminars/Training Programs Attended*		
Current Good Manufacturing Practices	10	42
(cGMP)	5	21
Food Preparation	2	8
Sanitation	1	4
Hazard Analysis Critical Control Point	7	29
(HACCP)		
None		

*Multiple Responses

Personal hygiene practices. The respondents were knowledgeable on personal hygiene practices such as wearing of apron (93%), washing of hands properly (71%), and assigning supervisors to ensure food safety compliance (58%). However, only about one-third of them (36%) knew that food handlers were major sources of food -borne diseases. In addition, they acknowledged that pests, mice, and cockroaches are other sources of food-borne diseases.

Processing plant facility, design, and sanitation practices. Respondents were knowledgeable on the provision of properly-designed processing establishments and sanitation practices. These include proper storage of ingredients and equipment that could help prevent food from contamination that

Table 2a. Knowledge of the respondents on food safety.

FOOD SAFETY DIMENSION	KNOWLEDGEABLE		NOT KNOWLEDGEABLE	
	Freq.	%	Freq.	%
cGMP				
Food safety is the concern of the government, industry and consumers	18	75	6	25
cGMP is the basic food safety requirement of the BFAD	15	63	9	37
Personal Hygiene Practices				
Wearing of hairnet during production prevents contamination	23	93	1	7
Washing of hands in a dipper would cause microbial contamination	17	71	7	29
Assigning of supervisors is necessary to comply with food safety practices in the food processing plant	14	58	10	42
Considering food personnel as one major source of foodborne diseases	11	36	13	54
Processing Plant Facility, Design and Sanitation Practices	23	93	1	7
Storing of Ingredients, food and chemicals in separate labelled container				
Being aware of soil, air, and water as contaminants	23	93	1	7
Piling sacks in flat form is the best storage practice for raw materials	21	87	3	13
Pathogenic microorganisms causes illness	19	79	5	21
Using of water and soap followed by chlorine solution is the best way to clean counters and other surfaces that come in contact with food	16	67	8	33

Table 2a continued...

FOOD SAFETY DIMENSION	KNOWLEDGEABLE		NOT KNOWLEDGEABLE	
	Freq.	%	Freq.	%
Designing food processing establishment properly for adequate mobility of equipment during production, maintenance and sanitation	14	58	10	42
Sanitizing all food contact surfaces as frequent as necessary	14	58	10	42
Providing separate storage for raw and ready to eat food to prevent cross contamination	13	54	11	46
Providing slopping floor type should be provided in the chichacorn processing plant	11	46	13	54
Production and Processing				
Inspecting corn kernels before receiving is a priority measure for delivered corn kernels	18	75	6	25
Improperly storing of corn kernels causes mold growth that produces aflatoxin	11	46	13	54
Hot smoking oil produces free radicals	5	21	19	79
Analysis of Finished Products				
Analyzing finished goods should be part of routine check before product is released for shipment	4	17	20	83

could come from soil, air, and water. Proper storage could also prevent growth of microorganisms, which the respondents know could cause illness. Majority (67%) of the respondents knew that water and soap, followed by chlorine solution are the best materials for cleaning counters and other contact surfaces. However, it was observed that most respondents used water and soap alone in cleaning contact surfaces and equipment. Sanitizing was rarely done in the plant.

Production and processing. A big majority (75%) of the respondents knew that corn kernels should be inspected first before these are received to ensure quality processing. Particularly, corn kernels should be free from insect infestation and varietal mixture. Less than half (46%) of the respondents knew that if the corn is not properly stored, molds that produce aflatoxin might grow. Only one-fifth (21%) of the respondents knew that substances like free radicals could be formed in hot smoking oil. When the oil reaches its smoke point, further heating would lead to oil disintegration, which produces substances that could cause illness such as cancer.

Analysis of finished products. Less than a fifth (17%) of the respondents knew that analyzing finished goods should be a part of the routine check before the product is released for selling or shipment. However, it was observed that product analysis was not usually done by the processors.

On the whole, the respondents were moderately knowledgeable ($\dot{x}$=12) on food safety. This implies that the respondents have just enough knowledge on the food safety dimensions, which could be attributed to their exposure and involvement in the different food safety programs. However, in order to ensure that the respondents will be able to gain more knowledge on food safety, there should be a constant exposure to training programs and seminars.

Respondents' Beliefs on Food Safety

Beliefs of the respondents on food safety were determined based on a 15-item test on food safety. Although majority (75%) of the respondents believed that knowledge and skills in the chichacorn production are needed for the success of the business, all of them agreed that chichacorn owners and workers need to undergo proper training on food handling to reduce the incidence of foodborne illnesses. Likewise, they believed that aside from dogs, cats, and birds as

Table 2b. Respondents' knowledge level on food safety in the chichacorn industry in Ilocos Norte.

KNOWLEDGE LEVEL	RANGE OF SCORE	FREQUENCY	PERCENTAGE
High	14-20	12	50
Moderate	7-13	11	46
Low	0-6	1	4
Mean	**12**		
Descriptive Interpretation	**Moderate**		

sources of contaminants, food handlers could contaminate their products in many ways. Proper handling and food production processes are important in producing quality chichacorn and in reducing risk of diseases like cancer.

In the production process, respondents believed that inspecting raw materials conducted even those from trusted sources ensures quality. The respondents believed that if they have cough, the product could be contaminated. They also believed that scratching one's head and touching one's face (54%), as well as harboring of dust during drying (42%) could affect product quality. However, majority of the respondents believed that the dust accumulated while drying can be removed during washing, and that cooking surely kills microorganisms.

Respondents asserted that water alone is not enough to clean their equipment, and that boiled corn remains should be removed from the boiling pot. Tables and food contact surfaces should be cleaned as frequent as necessary. Almost all (92%) of the respondents believed that microorganisms harbor on wood. However, it was observed that most of the tables used specially during packaging are made of wood.

Although the respondents had moderate knowledge on food safety, they had a highly favorable belief on food safety practices in chichacorn production. This implies that despite moderate knowledge level, the respondents are guided by their food safety practices based on a set of beliefs. What is important to them is that their products are clean and safe.

Respondents' Work Behavior

Respondents were given a 15-item test on food safety emphasizing on behavior related to personal hygiene, processing, and product safety.

Personal hygiene. Almost all (92%) of the respondents said that they followed food safety rules as models for the workers. Respondents' behavior on the practice of proper personal hygiene shows that almost all of the respondents took a bath before going to work,

Table 3a. Respondents' belief on food safety in the chichacorn industry.

INDICATOR STATEMENT	FAVORABLE		UNFAVORABLE	
	Freq.	%	Freq.	%
• Right knowledge in food handling can reduce the incidence of foodborne illness	24	100	-	-
• Possible contamination occurs when food is accidentally coughed on	24	100	-	-
• Water alone is inadequate to clean equipment and utensils	24	100	-	-
• It is a must for chichacorn owners and workers to receive appropriate training in food handling	22	92	2	8
• Food handler can be a source of contamination	22	92	2	8

Table 3a continued...

INDICATOR STATEMENT	FAVORABLE		UNFAVORABLE	
	Freq.	%	Freq.	%
• Wooden utensils are not safe in processing	22	92	2	8
• Presence of pets in the production can cause food contamination	21	88	3	12
• Properly prepared chichacorn keeps customers from illness such as cancer	21	88	3	12
• Knowledge and skills in chichacorn production is sufficient for business success	18	75	6	25
• Cooking is a sure way to kill microorganisms	18	75	6	25
• Dust harbored during drying does not affect product quality	14	58	10	42
• Scratching of the head or touching the face while producing chichacorn does not affect the quality of the product	11	46	13	54
• Cleaning of tables and other food contact surfaces is done only when needed	8	33	16	67
• It is okay if fragment of boiled corn remains in the cooking pot, anyway, contaminants will be destroyed during boiling	7	29	17	71
• Inspection of corn delivered kernels is not necessary before accepting them from trusted sources	2	8	22	92

Table 3b. Level of the respondents' belief on food safety in the chichacorn industry in Ilocos Norte.

BELIEF LEVEL	RANGE OF SCORE	FREQUENCY	PERCENTAGE
Highly Favorable	11-15	15	63
Moderately Favorable	6-10	9	37
Unfavorable	0-5	-	-
Mean	**11**		
Descriptive Interpretation	**Highly Favorable**		

removed their jewelry before working (83%), and cleaned their fingernails before handling anything to prevent contamination (79%). Others (79%) also stressed that they would not report to work if they have illnesses or wounds in their hands.

Processing and product safety. Cleanliness and product safety during processing were also practiced in the plant. All of the respondents said that they put all things in their proper places and properly clean equipment used before and after processing. They do not also smoke during processing. More than half (54%) indicated that they wear an apron and hairnet during processing and majority (62%) used proper footwear inside the plant.

Generally, respondents' level of work behavior in producing chichacorn was highly desirable (Table 4b). This implies that the respondents behave in such a way that enables them to produce safe products.

Environmental Condition of the Manufacturing Plants

All owners had their own production areas; majority of which were extension of their houses while others were built as

Table 4a. Food safety work behavior of the respondents' in the chichacorn industry.

INDICATOR STATEMENT	PRACTICED		DID NOT PRACTICE	
	Freq.	%	Freq.	%
Personal Hygiene				
• Follow food safety rules to be a model for the workers	22	92	2	8
• Take a bath before going to work	22	92	2	8
• Remove jewelry before working	20	83	4	17
• Give attention to the cleanliness of fingernails.	19	79	5	21
• Work even despite of having fever or wounds in hands	19	79	5	21
Processing and Product Safety				
• Place things in designated areas.	24	100	0	0
• See to it that the equipment is clean before and after using	24	100	0	0
• Avoid cigarette smoking during production	24	100	0	0
• Make sure that the production area is clean	23	96	1	4
• Prepare food in sanitary way even if there is a rush order	23	96	1	4
• Clean and wash the drying area after use	22	92	2	8
• Eat while working at the production area	20	83	4	17
• Cook chichacorn with the health of the consumers in mind	19	79	5	21
• Use different footwear inside and outside the processing plant	15	62	9	38

separate units. Half of the owners had sufficient space for their equipment, production, maintenance, and sanitation activities (Table 5a).

Inside the processing plant. All processing plants had accessible toilet facilities and floors that are always kept dry especially after production. Almost all were provided with ventilation and lights. Likewise, most of the chichacorn processing plants had sufficient water supply for adequate sanitary measures to meet the processing and cleaning needs and employees' sanitary requirements.

Additionally, most processing plants had storage rooms for raw materials, semi-processed and processed corn, equipment, and packaging. Others had storage rooms containing different items.

Majority (57%) of the processing plants were screened for protection from pests specially on areas used for storage and packaging. Cooking and washing were done in an open area in the processing plant, therefore giving proper ventilation and lighting during processing. It was observed that some of the owners had their cooking areas where boiling was done under a tree. All of them had sufficient water to use during processing, which usually came from treated deep wells.

Signage for instructions, reminders, and warning signs were available in two processing plants. Half of the respondents provided trash receptacles with cover within the processing plant.

Outside the processing plant. All of the processors had waste disposal areas, which were usually dug pit or septic tanks. Grass or weeds were observed to be abundant in the surroundings of the majority (65%) of the processing plants, as well as in places where boiled corn was dried. The respondents did not consider it as an alarming hazard. It should be noted that weeds and grasses are possible breeding grounds for pests and pathogenic microorganisms.

It was observed that a big majority (71%) of the plants had no stagnant water around their premises. Water that was usually collected around the production area came from the washings used for boiling corn. During rainy seasons, producers from Paoay encountered problems on water and mud within the premises of their plants. This also affected safety of the water source, since it was only drilled. According to one of the respondents in Paoay, there was a time (in year 2008) when he stopped producing chichacorn due to the floods. That was so, because the product would be affected by the quality of water supply. Indeed, chichacorn processing needs sufficient amount of safe water specially in boiling and washing of corn kernels.

Table 4b. Level of respondents' work

BEHAVIOR LEVEL	RANGE OF SCORE	FREQUENCY	PERCENTAGE
Highly Desirable	11-15	20	83
Moderately Desirable	6-10	4	17
Undesirable	0-5	-	-
Mean	**13**		
Descriptive Interpretation	**Highly Desirable**		

Table 5a. Environmental condition of the processing plant of the chichacorn industry (n=14).

INDICATOR STATEMENT	Complied		Not Complied	
	Freq.	%	Freq.	%
Inside the Processing Plant				
• Accessible toilet facilities are maintained in sanitary conditions	14	100	-	-
• Floors are kept dry after production	14	100	-	-
• Proper ventilation and lights are provided	13	92	1	8
• Sufficient water supply of adequate sanitary measures and sufficient temperature to meet the needs for processing and cleaning and employees' sanitary requirement	12	85	2	15
• Provision for separate storage room for equipment	11	79	3	21
• Provision for separate storage room for raw materials	11	79	3	21
• Provision for separate storage room for semi-processed/processed kernels	11	79	3	21
• Provision for separate room for packaging	10	71	4	29
• Doors are kept closed	9	64	5	36
• Absence of pets around and inside processing plant	9	64	5	36
• Provision of hand washing station with sufficient water, soap and towel in the production area	9	64	5	36
• Provision of adequate screening or protection against pest	8	57	6	43
• Provision of trash receptacle with cover	7	50	7	50
• Provision of sufficient space for equipment, production, maintenance and sanitation activities	7	50	7	50
• Provision of exhaust fans	2	14	12	86
• Provision for signage for information and reminders to personnel	2	14	12	86
Outside the Processing Plant				
• Provision of waste disposal area outside the plant	14	100	-	-
• No standing/stagnant water around plant premises	10	71	4	29
• Roads and park yards are free from dirt and mud	9	64	5	36
• No weeds/tall grasses around plant premises	5	35	9	65

It was observed that some (36%) plants were located near dirty and muddy roads and park yards. Another problem encountered by the producers was uncemented roads, which produced dust whenever vehicles passed by the processing plant. However, the Paoay producers remedied that problem by cementing the roads going to their production area through the help of the LGU. The Pinili producers were still being burdened with such a dilemma, especially so that their drying area was near the road.

In some processing plants, pets, especially dogs and cats, could enter freely because their production areas were not enclosed. One of the respondents had a cattle shade which was near their cooking, packaging and storage area. According to WHO, animal wastes could be a source of E. coli, a pathogenic microorganism that could be hazardous to health when food has been contaminated with it through cross-contamination during food preparation and use of contaminated surfaces and kitchen utensils.

On the whole, the environmental condition of the processing plant was found to be moderately favorable with a mean score of 13. This implies that the owners met the required environmental conditions of their processing plants, which are conducive for producing chichacorn safely.

Respondents' Processing Practices

Table 6a presents the respondents' practices in processing chichacorn. They were grouped into seven major activities, namely: inspection, storage, boiling, drying, frying, addition of flavoring and packaging (Figure 1).

Inspection. Corn kernels used for processing were bought from local farmers. When these were delivered, respondents ensured the cleanliness and suitability of the materials for processing. Based on the enumerated practices, size of the kernels and possible insect infestation were the basis for inspection. Corn kernel moisture content is considered by majority (58%) of the respondents; however, a big majority (79%) of them evaluated corn kernel based on the acceptable moisture through visual inspection rather than using a moisture meter.

Table 5b. Level of environmental condition of the processing plant of the chichacorn industry.

LEVEL OF ENVIRONMENTAL CONDITION	RANGE	FREQUENCY	PERCENTAGE
Highly Favorable	14-20	14	58
Moderately Favorable	7-13	8	34
Unfavorable	0-6	2	8
Mean	**13**		
Descriptive Interpretation	**Moderately Favorable**		

Storage. Availability of corn kernel was seasonal. As such, processors were forced to store large volume of raw materials during peak season. Good practice of proper storage should be observed to minimize insect infestation, cross contamination, and moisture absorption. The respondents properly stored corn by using sacks lined with plastic bags. These sacks were filed on platforms by most (88%) of the respondents, which was parallel to the result of their knowledge on the best storage practice of raw materials. On the other hand, majority (60%) had exclusive rooms for raw materials storage.

Boiling. Corn is boiled twice. Prior to boiling, corn kernels were washed as practiced by majority (67%) of the respondents. The first boiling was done to peel off the corn kernels' pericarp using

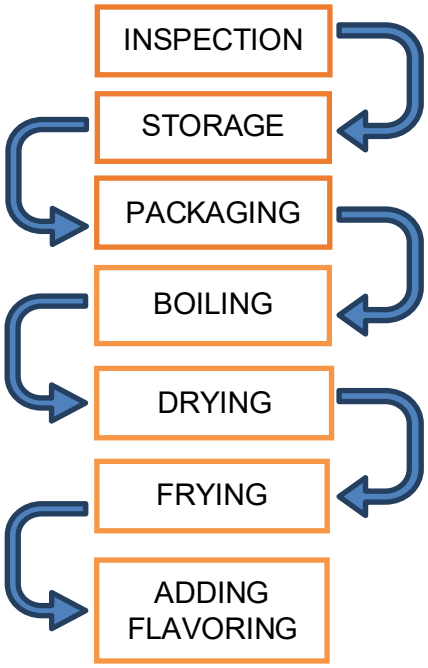

Fig1. Flowchart of chichacorn processing

Table 6a. Respondents' food safety practices in the chichacorn industry in Ilocos

INDICATOR STATEMENT	PRACTICED		DID NOT PRACTICE	
	Freq.	%	Freq.	%
Inspection				
Corn kernels are inspected based on moisture content	14	58	10	42
The moisture content is determined through a moisture meter	5	21	19	79
The moisture content acceptable to corn is 14-16%	-	-	24	100
Storage				
Storage containers are filed on platforms	21	88	3	12
There is provision for separate room during storage	16	67	8	33
Sealed container is used in storing corn kernels	-	-	24	100
Boiling				
Corn kernels are washed before boiling	16	67	8	33
Amount of added lime is according to GMP	0	0	24	100
Completeness of washing is determined through litmus or chemical tests	-	-	24	100

Table 6a continued...

INDICATOR STATEMENT	PRACTICED		DID NOT PRACTICE	
	Freq.	%	Freq.	%
Drying				
Drying facilities are cleaned, washed and sanitized	21	88	3	12
Mechanical dryer is used for drying corn kernels	2	10	22	90
Endpoint f drying is determined through moisture content	-	-	24	100
Frying				
Vegetable oil is used for frying	24	100	-	-
Frying oil temperature is maintained at 375°F	2	10	22	90
Frying endpoint is determined with moisture content of 3%	-	-	24	100
Mixing of Additives and Flavorings				
Drying facilities are cleaned, washed and sanitized	24	100	-	-
Flavorings And additives are mixed right after frying	22	92	2	8
Flavorings and additives are mixed through a mixing equipment	5	21	19	79
Packaging				
Packed fried corn is sealed with an electric sealer	20	83	4	17
Product is packed in designated packaging room.	9	38	15	62
Table used in packaging is made of stainless steel	-	-	24	100

lye solution. Lye or sodium hydroxide was widely used for peeling of fruits and vegetables. According to CODEX, acceptable amount of lye used in processing should be in accordance with GMP, or a standard set by the manufacturers, which would be effective for its particular use. It was observed that respondents used varying amounts of lye solution when boiling corn. Each producer had his/her own proportion of lye per kilogram of corn. The second boiling was done after the pericarp was removed in order to soften the corn kernel.

After each boiling, the corn kernels were washed under running water to remove the pericarp as well as the lye added. It was observed that respondents did not employ tests to determine if the washed corn was lye-free.

Drying of boiled corn. Washed boiled corn was dried immediately to prepare it for frying. This was also done to prevent spoilage, bacterial infestation, and mold growth. Prior to drying, activities to prepare drying equipment were done by most (88%) of the respondents such as cleaning/washing/sanitizing and inspecting for possible hazardous elements.

Almost all (90%) of the respondents used improvised drying equipment, which was made up of galvanized iron or bamboo slots lined with plastic net. They were built in an open area located at the side or back of their house or processing plant. On the other hand, only few (10%) of the respondents used mechanical dryer.

Solar drying usually takes three to four days, while mechanical drying takes just hours to dry corn kernels. The boiled products are susceptible to microbial pathogenic growth when exposed in an open air since water activity is increased, thus, time and temperature controls are required to assure product safety. The endpoint of drying is usually based on the color and texture of the kernels.

Frying. Vegetable oil should be used in frying corn as set by BFAD standards in chichacorn production. It was observed that all of the respondents complied with this requirement. During frying, the oil was maintained at 375°F to prevent oil deterioration; hence, quality fried corn was produced. Only two (10%) of the respondents monitored the temperature of cooking oil during frying while others relied on the smoking point of the oil.

The best practice to determine if corn kernels were properly fried is to have a 3% moisture content (BFAD, Draft Standards for Fried Corn Snacks); however, no one practiced it. The quality of fried corn kernels was only determined by their color and texture (crunchiness) when they float.

Mixing of additives and flavorings. In order to enhance the taste of the corn, all of the manufacturers added garlic, salt, MSG, flavorings for product variation such as cheese, barbeque, spicy/sweet, and spicy. Prior to mixing, all of the respondents cleaned, washed, and sanitized the mixing facilities or equipment. Almost all (92%) of the respondents mixed additives and flavorings right after frying, while the rest (8%) mixed them after cooling. Only few (21%) owned and used a mechanical mixer for additives and flavors.

Packaging. Flavored fried corns are packed after attaining the desired temperature. Packaging protects the product from airborne contamination and moisture pick-up, as well as controls water activity (a_w); hence, it prevents the growth of undesirable microorganisms.

Only few (38%) of the respondents had a room exclusively used for packaging. Majority (62%) packed inside their house or in an available area within the plant. The recommended table should be made of stainless steel; however, none of the respondents had such table. Most (83%) of the respondents used impulse or bond sealer for packaging.

On the whole, Table 6b indicates low level of food safety practices (7), which implies that some food safety requirements were not properly followed by chichacorn producers in Ilocos Norte.

Correlation of Variables and Food Safety Practices

Respondents' Characteristics

Table 7 shows that age, educational attainment, years in the business and

seminars/training programs attended are not significantly correlated to their food safety practices.

Factors of Safety Practices

The correlation between the four factors of food safety and the existing food production safety practices of chichacorn shows that knowledge (r=0.671), belief (r=0.551), and environmental condition of the processing plant (r=0.753) were highly significant, while work behavior (r=0.413) was only significant at 0.05 level of significance (Table 7). This means that food safety was practiced if the workers know these, believe in their importance, act accordingly, and work in a well-equipped and maintained environment.

A review done by Wilcock et al (2003) on food safety issues revealed that if people knew or learned that their current practices are unsafe, they are willing to change such. Therefore, it is important to educate food handlers regarding the positive outcomes of safety practices in food production to reduce foodborne diseases, to keep a clean working environment, and to reduce the spread of microorganisms via processing protocols.

A research done on Australia's consumer awareness, knowledge, and attitude toward food safety issues revealed that respondents who recalled seeing, hearing or reading information about food safety tend to have better food safety practices than those who had no recall of food safety messages or information (http://www.health.vic.gov.au/foodsafety/research/food_safety_knowledge.htm2/5/2009). However, studies done by the Research Triangle Institute International revealed that teaching the recommended safe food handling is sufficient. Motivation to follow the food safety recommendations should be given so that the food handlers may understand the risk of unsafe food handling, hence, warrants extra

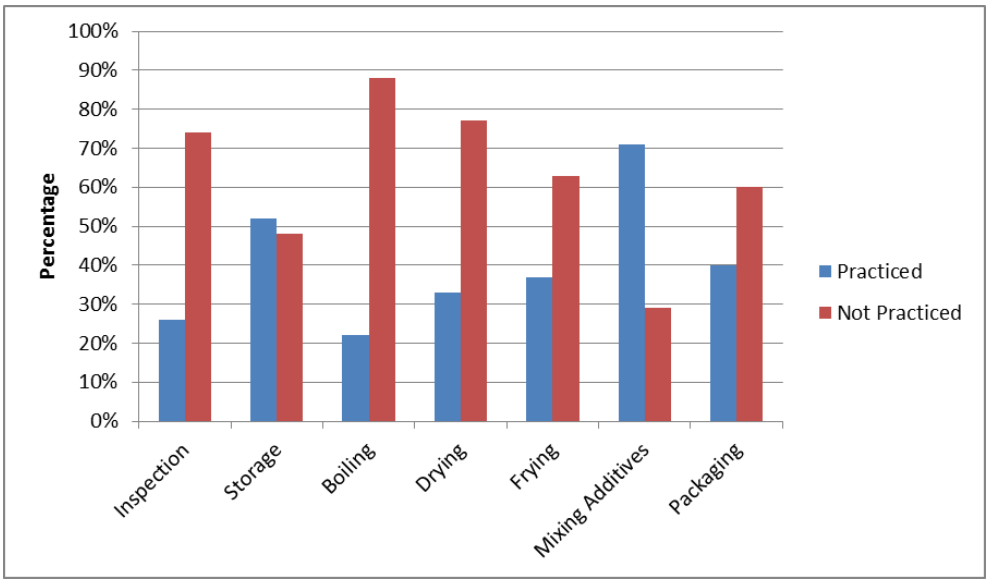

Fig. 2. Respondents' food safety practices in producing chichacorn

precaution. This was suggested because those studies revealed that despite the respondents' knowledge on the proper thing to do, i.e. washing of hands with soap and water after handling raw foods, only few respondents actually practiced it (http://www.mewswise.com/articles/ view/533347-11/09/2008). Another study revealed that food handlers do not practice safe food handling due to their limited knowledge on the "how to's" in making food safe to eat (Wilcock et al 2003).

Studies on of consumers' behavior towards food safety show that the willingness to change behavior is determined by attitudes and beliefs. This means that in order to implement the food safety practices, the people should have positive attitudes and beliefs toward food safety, which leads them to take action (application). In order to change, the person has to realize that his/her current practices endangers his/her health and that taking action (positive application) has a strong likelihood of reducing it. Furthermore, if positive attitude for change is absent, expected action that would lead to change will not happen. This would therefore explain the low level of the existing food safety practices of the chichacorn industry.

Conclusions and Recommendations

Half of the respondents had already been working in the chichacorn industry

Table 6b. Respondents' level of food safety practices in processing chichacorn in Ilocos Norte.

KNOWLEDGE LEVEL	SCORE RANGE	FREQUENCY	PERCENTAGE
High	15-20	-	-
Moderate	8-14	8	63
Low	0-7	18	37
Mean	**7**		
Descriptive Interpretation	**Low**		

Table 7. Correlates of food safety practices among chichacorn processors in Ilocos Norte.

VARIABLE	COEFFICIENT
Respondents' Characteristics	
Age	-0.388^{ns}
Educational attainment	-0.082^{ns}
Years in the business	-0.225^{ns}
Seminars/training programs attended	0.222^{ns}
Factors of Food Safety Practices	
Knowledge	0.671**
Belief	0.551**
Work behavior	0.413*
Environmental condition	0.753**

for 10 years, while some had been in the industry for more than 20 years. Most of the workers were middle aged, majority were females, and almost all had attended formal schooling. They had likewise attended seminars and training programs that are related to food safety and food preparation such as cGMP and HACCP.

Owners and workers had moderate knowledge level on food safety, which could be attributed from their exposure to training programs and seminar sponsored by government agencies such as the DOST and FNRI. Majority of them were aware that GMP is a food safety program required by BFAD for food establishments and were knowledgeable on personal hygiene, importance of properly designed establishments, production and process controls. However, they were not well aware of some food safety concepts and their effects on the production of safe food. Insufficient implementation of GMP with regard to equipment and facilities was due to limited capital.

The respondents' beliefs on food safety practices were highly favorable. Majority of the respondents acknowledged that training programs on proper food safety practices contributed to the success of their business. They also recognized the importance of personal hygiene, good health, proper equipment, sanitary environment, and regular inspection to develop quality products. In addition, the respondents had a highly favorable work behavior in relation to steps followed in chichacorn production.

Based on observation, the environmental condition of the chichacorn processing plants was moderately favorable. However, there were insufficient storage rooms for raw materials, semi-processed corn, equipment, and packaging utilities. Although all had their own facilities for cooking and washing, disposal areas were usually dug pits or septic tanks and the smell of the wastes posed a threat to the environment. Grass or weeds were found around the processing plants. Most have dusty roads and parking lots nearby. During rainy seasons, some plants were flooded.

Level of compliance with food safety practices during the production was low, because respondents claimed they were not aware of some technical requirements such as the proper moisture content for raw and cooked corn, the right amount of time to spend, the proper temperature maintained in frying. Some did not have their own equipment for drying, mixing and packaging. Additionally, production processes were still manual and traditional.

There was no observed relationship of the respondents' personal characteristics such as age, educational attainment, years in the business, as well as number of seminars or training programs attended and their food safety practices. On the other hand, knowledge, beliefs, work behavior, and environmental condition of the plants had positively significant relationship with existing practices of food safety in chichacorn production.

In light of the findings, the following recommendations are forwarded:

The owners and workers in the chichacorn industry should continually attend training programs and seminars related to food safety to enhance their knowledge, beliefs, and attitudes toward food safety practices.

To ensure product quality, process standardization should be undertaken based on the Philippine National Standard for Fried Corn and Codex Alimentarius to address critical control points and address low level food safety practice.

The owners should comply with the provisions of the environmental condition processing plant as provided in the GMP to ensure product safety and quality in every facet of the product process flow.

Acknowledgement

The researchers would like to thank the leader and staff of the MMSU-NEDA-DBP Project for their support in conducting this research; colleagues who in one way or another shared wisdom and insight for the improvement of the research; all owners and workers of the chichacorn establishments for opening their doors and allowing us to gather important data needed; and above all, God Almighty for orchestrating all things to make this research a success.

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MMSU Science and Technology Journal
Vol. 3 No. 2 | July-December 2013

ISSN: 2012 0060

GROWTH AND YIELD OF SWEET SORGHUM (*Sorghum bicolor* L.) AS AFFECTED BY THE DIFFERENT LEVELS OF BIO-SLUDGE

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Abstract

A study on the utilization of bio-sludge as organic fertilizer for sweet sorghum was conducted from October 2010 to April 2011 at the MMSU Experimental Station, Batac City, Ilocos Norte. It evaluated the potentials of bio-sludge as a source of organic fertilizer for sweet sorghum. The experiment was laid out in Randomized Complete Block Design with three replications. The treatments used were: T1 – control, no fertilizer application, T2 – recommended rate (RR) of inorganic fertilizer (80-30-30, NPK kg ha-1), T3 – recommended rate (RR) of bio-sludge (BS) (3.5 t ha-1), T4 – T2 + 25% RR of BS, T5–T2 + 50% RR of BS, and T6 – T2 + 75% RR of BS. Meanwhile, the parameters used to assess the effects of the treatments were plant height, stalk, panicle length diameter and length, grain yield ha-1, stalk weight, juice yield ha-1, juice sweetness, and bagasse weight.

Significant results were obtained in all the parameters measured except for the sugar content. Height, stalk, and panicle length, stalk and bagasse weight, and the juice yield of plants fertilized with the RR of inorganic alone (80-30-30, NPK kg ha-1) and with the addition of 25, 50 and 75% RR of BS were significantly higher than those applied with the RR of BS alone and the untreated ones while bigger stalk diameter resulted from the combination of higher amount of bio-sludge (50 or 75% RRBS) and inorganic fertilizer. Grain yield also increased by 35% when sweet sorghum was fertilized with the combination of higher amount of bio-sludge (50 or 75%) and inorganic fertili- zer; however, values were comparable with those applied with inorganic alone. Overall, using inorganic fertilizer at a rate of 80-30-30 kg NPK ha-1 was sufficient to improve the growth and yield of sweet sorghum. In addition, higher ROI was obtained in the same treatment. Although the application of bio-sludge did not contribute to the growth and yield of sweet sorghum, soil fertility was improved as manifested by the increase in %OM, %N, P and K.

Keywords: *Bio-sludge, organic fertilizer, soil fertility, grain yield, juice yield*

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Introduction

Replenishing the cultivated fields with nutrients and soil improving-materials ensures sustained soil fertility and ample harvests. This is mainly achieved by applying commercial fertilizers. Fertilizer is a substance added to soil to improve plant growth and yield. It replaces the chemical components that are taken from the soil by growing plants. It is also designed to improve the growing potential of soil and can create a better growing environment than natural soil. Moreover, it can be tailored to suit the type of crop that is being grown (http:// www.madehow.com).

According to Abd El-Aziz (2007), supply plant needs and improve the physical and chemical characteristics of soil such as its pH and structure. There is usually a dramatic improvement in both quantity and quality of plant growth when appropriate fertilizers are added. In Manahay's (2010) study on Tubang-bakod, all seedlings applied with commercial organic fertilizer survived unlike those of the unfertilized ones.

However, with the increasing cost of commercial fertilizers, the government has been spending million of dollars on imported inorganic fertilizers (Gicana, 1999; Gonzales, et al 2003). This is the reason why the prices of inorganic fertilizers in the local agricultural outlets are affected by the US dollar-PhP exchange rates, which consequently affect farmers' productivity.

As such, alternative approaches such as re-using of nutrients and soil-improving products from decomposed plants, and even from human excreta have been considered (Jonsson et al, 2004).

Human food contains considerable amounts of nutrients originating from plants. Only minute amounts of the plant nutrients are absorbed by and retained in the growing human body - the remainder leaving the body as excreta. The products of ecological sanitation, urine and feces, are in many ways well suited for use as fertilizers. The fertilizing effect of urine, just as that of chemical fertilizers is greater if the soil contains at least some organic matter. Urine is nutrient rich and feces are high in organic matter (Jonsson et al, 2004).

Schonning and Stenstrom (2004) reported that the conversion of human manure to humus is known as thermophilic (hot) composting, which involves the cultivation of heat-loving microorganisms in the composting process. These orga- nisms, which include bacteria and fungi, create an environment in the compost that destroys disease organisms in human manure, converting into a user-friendly, pleasant-smelling humus for food gardens.

Rich in nutrients, decomposed human manure is a valuable soil amendment that helps maintain fertility and increase crop yields. Compost provides a multitude of benefits. Humus in composts stabilizes the soil, reduces erosion, improves water-holding capacity and soil structure, and creates air spaces in the soil. Likewise, humus chelates some heavy metals and other contaminants and can act as a nutrient storehouse that slowly releases nutrients to plants (Schonning, et al, 2004).

Bio-sludge or human waste/excreta collected from septic tanks or sewage plants is a mixture of solid and liquid sediments. The rapid growing human

population everywhere is inevitably creating problems due to the proper disposal of this potential pollutant. If not properly disposed, these wastes will contaminate not only the rivers but also the ground water table, which is an essential natural resource to humans.

In the Philippines, there are only few known service providers in collecting wastes from septic tanks, which do not even have the state-of-the-art sewage treatment plant that can fully process the waste into useful materials like organic fertilizers.

Applying sewage sludge to agricultural land has been widely practiced, especially in non-food crops through the years. Its utilization does not only complement the crop farming sector to increase crop productivity, but it also addresses the environmental concern for the proper disposal of bio-sludge by evaluating of its potentials as organic fertilizer to biofuel crops such as sweet sorghum. Additionally, using bio-sludge will minimize the country's dependence on imported oil-based fertilizers, because it is already available. Thus, a study was conducted to evaluate the potential of bio-sludge as source of organic fertilizer for sweet sorghum. Specifically, it determined the optimum levels of bio-sludge and inorganic fertilizer to increase grain and juice yield of sweet sorghum and assessed the economics of producing sweet sorghum using different fertilizer treatments.

Methodology

Locale of the study. The study was conducted at the MMSU Experimental Station, City of Batac, Ilocos Norte from October 2010 to April 2011. The area is a typical upland previously planted with rice and corn. The experimental area covers 1,332 sq m. The plot size was 17.5 sq m.

Research design and treatments. The experiment was laid out in Randomized Complete Block Design with three replications (Plate 1). The fertilizer treatments used were: T_1 – Control (No fertilizer application); T_2 – Recommended rate (RR) of inorganic fertilizer (80-30-30 NPK kg ha^{-1}); T_3 – RR of Bio-sludge (BS) (3.5 t ha^{-1}); T_4 – T2 + 25% RR BS; T_5 – T2 + 50 % RR BS; and T_6 – T2 + 75% RR BS. The inorganic fertilizer recommended rate of 80-30-30 NPK ha^{-1} or combined complete fertilizer (375 g $plot^{-1}$) and urea fertilizer (195 g $plot^{-1}$). Sweet sorghum variety SPV 422 was used.

Management Practices

Soil analysis. Composite soil samples were gathered from the experimental area before planting and after the removal of the standing crop. The soil samples were brought to the Department of Agriculture, Provincial Office, Laoag City for soil texture, pH, % OM, %N, P, and K analysis.

Application of treatments. The organic fertilizer treatments in T3, T4, T5, and T6 and complete fertilizer in T2, T4, T5, and T6 were applied as basal. The organic (bio-sludge) and complete fertilizers were applied in powdered form and were placed within the furrows before planting the sweet sorghum seeds. The urea fertilizer, on the other hand, was side dressed at 45 days after planting (DAP).

Care and maintenance. The experimental area was prepared thoroughly by plowing it twice to eradicate the emerging weeds and harrowed to

Plate 1. Experimental set-up showing the different treatments and panicles

pulverize the soil in time for planting. Furrows were set 70 cm apart and 15 cm deep. The seeds were sown via drilling. Overhead irrigation was done after planting to enhance germination. At the early vegetative growth stage (first six weeks), the plants were irrigated bimonthly, and weekly thereafter, especially during the panicle initiation up to seed maturity. Weeding was done monthly to avoid competition for moisture, nutrient, and solar radiation.

Data Gathering Procedure

Agronomic characteristics. Measurement of plant height, diameter and length of stalk was done at maturity period after cutting the sweet sorghum plants. Plant height was measured 0.50 cm above the ground to the panicle tip. The length of stalk was also measured after separating the panicle.

Yield and yield components. The panicle length and the stalk weight plot-1 were measured immediately after cutting the sweet sorghum plants while the bagasse weight and juice yield were measured separately after milling or extracting the juice using a portable cane mill. The grain yield plot-1 was weighed after threshing.

Percentage of sugar content. Using a refractometer, the brix reading of the sweet sorghum juice was obtained from the stalk.

Data Analysis. The various data sets gathered were subjected to analysis of variance for RCBD. Treatment means of parameters that showed significant results were compared using the Duncans' Multiple Range Test (DMRT) at 5% level of significance.

Results and Discussion

Soil Analysis

Table 1 shows the soil analysis results before applying the fertilizer treatments and after removing the sweet sorghum in the field. The soil texture before fertilizer application and after harvesting was heavy containing 55% clay, 30% silt, and 15% sand. There was a change in soil pH from slightly acidic to slightly alkaline (pH value ranged from 7.15 – 7.83), which according to Hoanh and Natividad (1987), is considered favorable for growing most plants. The %OM, %N, P (ppm) and K (ppm) contents were moderately increased by the application of RR of inorganic fertilizers (2.29, 0.093%, 27.19 ppm and 498.33 ppm, respectively). Meanwhile, those fertilizer treatments combined with bio-sludge include the following: RR inorganic + 25% RR BS (2.00%, 0.1%, 15.85 ppm and 478.30 ppm, respectively), RR inorganic + 50% RR BS (1.52%, 0.076%, 11.92 ppm and 464.47 ppm, respectively), and RR inorganic + 75% RR BS (1.44%, 0.072%, 18.90 ppm and 454.46 ppm, respectively). The treatment with no fertilizer and pure bio-sludge application did not increase the %OM (0.02%) and %N (0.006%) of the soil. The OM and P levels in all the treatments were deficient because they were below the adequate levels of 5% and 30 ppm respectively (Committee on Soil Fertility Management, 1999).

Agronomic Characteristics

Results revealed that the height of the sweet sorghum plants, their stalk length and diameter, as well as panicle length were significantly influenced by the different levels of bio sludge and inorganic fertilizer treatments (Table 2). Specifically, those plants applied with the recommended rate (RR) of inorganic fertilizer (80-30-30 kg NPK ha^{-1}) were the tallest (211.10 cm). However, comparable results were noted in treatments added with 25%, 50%, and 75% RRBS with similar values of 204.58, 210.85, and 210.82 cm, respectively. These were followed by plants applied with the RRBS (190.23 cm).

Table 1. Soil analysis before the application of treatments and after the removal of sweet sorghum in the field. MMSU, Batac, Ilocos Norte.

TREATMENT	TEXTURE	pH	OM,%	%N	P,ppm	K,ppm
Initial	Heavy	6.89	0.045	0.022	Trace	306.00
No Fertilizer	Heavy	7.68	0.02	0.006	2.79	374.34
RR Inorganic Fertilizer (80 -30-30)	Heavy	7.70	2.29	0.093	27.19	498.33
RR Bio-Sludge	Heavy	7.83	0.016	0.000	2.79	364.47
RR Inorganic + 25% RR Bio-Sludge	Heavy	7.28	2.00	0.100	15.85	478.30
RR Inorganic + 50% RR Bio-Sludge	Heavy	7.73	1.52	0.076	11.92	464.47
RR Inorganic + 75% RR Bio-Sludge	Heavy	7.15	1.44	0.072	18.90	454.46

Meanwhile, the unfertilized plants were the shortest (177.93 cm). On the other hand, the longest stalks at maturity period were exhibited by plants fertilized with the RR of inorganic + 50 % RR BS (179.88), but comparable lengths were obtained from those treated with RR inorganic + 75% RR BS (179.67 cm), RR inorganic fertilizer (179.15 cm) alone, and RR inorganic + 25% RR BS (173.75 cm). The shortest stalks were similarly recorded from the unfertilized plants (153.82 cm).

These results imply that plant height and stalk length of sweet sorghum were enhanced by applying the RR of inorganic fertilizer alone. This was manifested by the significantly shorter plants and stalks produced, which were exclusively applied with bio-sludge. Organic fertilizers may contain available nutrients, however, these may be released slowly and thus, did not immediately increase the height and stalk length of sweet sorghum. This corroborates with the findings of Legaspi and Malab (2013) on the delayed response of Tugui to organic fertilizer. After the conversion period on the first cropping year, the organic fertilizer effects were observed.

In terms of stalk diameter, sweet sorghum plants fertilized with the RR inorganic + 75% RRBS had the biggest stalk diameter (1.44 cm). The result, however, is comparable to those plants fertilized with the RR inorganic + 50% RR BS (1.37 cm). This was followed by the plants applied with the RR inorganic + 25% RR BS (1.36 cm), RR inorganic (1.35 cm), and RR BS (1.29 cm). The lowest stalk diameter was noted from the unfertilized plants. The results indicate that the addition of 50 to 75% of the RR BS to the RR inorganic fertilizer proved beneficial and met the nutrient requirement needed to increase the stalk diameter of sweet sorghum.

Table 2. Agronomic characteristics of sweet sorghum as affected by different bio-sludge levels and inorganic fertilizer treatments.

TREATMENT	PLANT HEIGHT (cm)	LENGTH OF STALK (cm)	DIAMETER OF STALK (cm)
	**	**	**
No Fertilizer	177.93^{c}	153.82^{c}	1.24^{d}
RR Inorganic Fertilizer (80-30-30)	211.10^{a}	179.15^{a}	1.35^{bc}
RR Bio-Sludge	190.23^{b}	164.38^{b}	1.29^{cd}
RR Inorganic + 25% RR Bio-Sludge	204.58^{a}	173.75^{ab}	1.36^{b}
RR Inorganic + 50% RR Bio-Sludge	210.85^{a}	179.88^{a}	1.37^{ab}
RR Inorganic + 75% RR Bio-Sludge	210.82^{a}	179.67^{a}	1.44^{a}
CV (%)	3.00	3.00	2.80

Means marked with the same letter within each column are not significantly different at 5% level of significance.

Panicle Length, Grain Yield, Stalk and Bagasse Weight and Juice Yield

Highly significant effects of the different levels of bio-sludge and inorganic fertilizer treatments were noted on the panicle length, grain yield (t ha-1), stalk and bagasse weight, and the juice yield (li ha-1) of sweet sorghum (Table 3). Plants fertilized with the RR inorganic + 75% RR BS had the longest panicles (32.60 cm) and consequently had the highest grain yield (14.78 t ha-1). Nevertheless, the result did not significantly vary from those plants fertilized with the same inorganic fertilizer level (31.95 cm and 13.22 t ha-1, respectively) and those added with 50% RR BS (31.65 cm and 13.53 t ha-1, respectively). The shortest panicles and lowest grain yield were exhibited by the unfertilized plants (24.12 cm and 9.19 t ha-1, respectively) and those treated with the RR BS alone (24.85 cm and 9.56 t ha-1, respectively).

Similarly, the stalk and bagasse weight of sweet sorghum were heaviest when fertilized with the RR inorganic + 75% RRBS (24.95 and 18.79 t ha-1, respectively). However, these were not significantly different from plants fertilized with RR inorganic plus 25% (24.00 and 18.50 t ha-1, respectively), 50% (24.19 and 18.15 t ha-1, respectively) and those applied with the RR inorganic fertilizer alone (22.95 and 16.96 t ha-1, respectively). The plants fertilized with the RR BS alone and those which were not applied with fertilizer generally registered the lowest values. The same trend was observed on the juice yield (L ha-1) of sweet sorghum. The highest juice yield (6,165.71 L ha-1) was produced by the plants applied with the RR inorganic + 75% RR BS. Comparable results, though, were obtained from plants fertilized with RR inorganic alone (5,992.38 L ha-1), and those which were added with 50% (6,041.90 li ha-1), and 25% RR BS (5,497 L ha-1).

It can be inferred from the results that the sweet sorghum panicle length, grain and stalk yield, bagasse weight, and juice yield were slightly increased by adding bio -sludge to the inorganic fertilizer applied. The results further imply that applying RR inorganic fertilizer alone (80-30-30 kg NPK ha-1) is enough to increase stalk yield, bagasse weight, and juice yield of sweet sorghum considering the comparable results and the costs incurred with the addition of the different bio-sludge levels. The findings are consistent with the previous results on agronomic characteristics, which further support the contention that organic fertilizer nutrients are released slowly. As such, they have not been fully utilized by the plants within the duration of the study. According to Silva (2011), the organic matter applied to the soil has to be mineralized or broken down by microorganisms first and its nutrients released to the soil as ions; thus, nutrients derived from organic fertilizer sources are not readily available to plants compared to the nutrients from soluble synthetic fertilizers.

Percentage Sugar (^{O}Brix)

The percent sugar content of sweet sorghum juice was not significantly affect-ted by the different bio-sludge levels and inorganic fertilizer treatments used (Table 4). Numerically, however, the sugar content of sweet sorghum juice ranges from 16.50 to 19.67%. The highest numerical value was obtained from those treated with the RR inorganic + 50 % RRBS while the lowest was recorded from the unfertilized plants.

Table 3. Stalk yield, bagasse weight, juice yield, and grain yield of sweet sorghum as affected by different levels of bio-sludge and inorganic fertilizer treatments. MMSU, Batac, Ilocos Norte.

TREATMENT	PANICLE LENGTH (cm)	STALK YIELD (t ha^{-1})	WEIGHT OF BAGASSE (t ha^{-1})	JUICE YIELD (li ha^{-1})	GRAIN YIELD (t ha^{-1})
	**	**	**	**	**
No Fertilizer	24.12^{b}	14.76^{b}	11.00^{b}	3763.81^{b}	9.19^{c}
RR Inorganic Fertilizer (80-30-30)	31.95^{a}	22.95^{a}	16.96^{a}	5992.38^{a}	13.22^{ab}
RR Bio-Sludge (RRBS)	24.85^{b}	13.24^{b}	8.86^{b}	4382.85^{b}	9.56^{c}
RR Inorganic + 25% RRBS	31.81^{a}	24.00^{a}	18.50^{a}	5497.14^{a}	12.60^{b}
RR Inorganic + 50% RRBS	31.65^{a}	24.19^{a}	18.15^{a}	6041.90^{a}	13.53^{ab}
RR Inorganic + 75% RRBS	32.60^{a}	24.95^{a}	18.79^{a}	6165.71^{a}	14.78^{a}
CV (%)	3.10	5.60	8.10	9.90	7.30

Means marked with the same letter within each column are not significantly different at 5% level of significance.

Cost and Return Analysis

The estimated cost and return analysis of a 1-ha sweet sorghum using different levels of bio-sludge and inorganic fertilizer is shown in Table 5. As expected, the control or the unfertilized plants incurred the lowest expenditure (₱51, 950.00), while those plants applied with the RR inorganic + 75% RR BS had the highest expenditure (₱73, 429.00) due to the expenses incurred in purchasing the inorganic fertilizer and bio-sludge. The higher cost of production, however, was compensated by the higher gross income (₱320, 550.00) and net return (₱247, 121.00) brought about by the increased seed and stalk yield obtained from those applied with the RR inorganic + 75% RR BS. The utilization of the RR inorganic fertilizer in sweet sorghum production, however, would realize a profitable gain of 376.50% in return for every peso invested. This is higher by 39.96 % than the RR inorganic + 75% RR BS, by 49.78% than the inorganic + 25 % RR BS, by 50.36% than the inorganic + 50% RR BS, by 94.29% than the control, and by 186.31% than the inorganic + 25% RR BS.

Conclusions and Recommendations

Results revealed that sweet sorghum plant height, stalk length and diameter, and panicle length were influenced by the fertilizer treatments. Plant height, stalk, and panicle length were increased when plants were fertilized with the RR of inorganic fertilizer of 80-30-30 kg NPK ha-1 (211.10 cm) and by adding 75 (210.82 cm), 50 (210.85cm) and 25%

Table 5. Cost and return analysis of a 1-ha sweet sorghum farm, using different bio-sludge levels and inorganic fertilizers.

ITEM	TREATMENT					
	No Fertilizer	RR Inorganic (80-30-30 NPK ha^{-1})	RRBS (3.5 t ha^{-1})	RR Inorganic + 25% RRBS	RR Inorganic + 50 % RRBS	RR Inorganic + 75% RRBS
Materials						
1. Seeds	900.00	900.00	900.00	900.00	900.00	900.00
2. Fertilizer						
Complete		4,494.00		4,494.00	4,494.00	4,494.00
Urea		2,860.00		2,860.00	2,860.00	2,860.00
Bio-sludge			17,500.00	4,375.00	8,750.00	13,125.00
3. Gasoline & oil	29,000.00	29,000.00	29,000.00	29,000.00	29,000.00	29,000.00
Labor (Man-day)						
1. Land preparation	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00
2. Irrigation	5,250.00	5,250.00	5,250.00	5,250.00	5,250.00	5,250.00
3. Application of fertilizer		1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
4. Weeding	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
5. Harvesting/Threshing	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00
Rental						
1. Water pump	800.00	800.00	800.00	800.00	800.00	800.00
2. Land	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
Total Production Cost	**51,950.00**	**60,304.00**	**70,450.00**	**64,679.00**	**69,054.00**	**73,429.00**
Income from Seeds@20 kg^{-1}	183,800.00	264,400.00	191,200.00	252,000.00	270,600.00	295,600.00
Income from Stalk@1 kg^{-1}	14,760.00	22,950.00	13,240.00	24,000.00	24,190.00	24,950.00
Gross Income	**198,560.00**	**287,350.00**	**204,440.00**	**276,000.00**	**294,270.00**	**320,550.00**
NET INCOME	**146,610.00**	**227,046.00**	**133,990.00**	**211,321.00**	**225,216.00**	**247,121.00**
ROI (%)	**282.21**	**376.50**	**190.19**	**326.72**	**326.14**	**336.54**

Complete fertilizer=₱1,059 bag^{-1}, Urea=₱1,100 bag^{-1}, Bio-sludge= ₱250 bag^{-1}, Seeds=₱150 kg^{-1}, Man-day = ₱250 day^{-1}

(204.58cm) of the RR BS. On the other hand, the biggest plant stalk diameter was obtained by adding 75% RR BS (1.44 cm); how- ever, that is comparable with those added with 50 % RRBS (1.37 cm).

Stalk and bagasse weight, and juice yield were consistently increased by applying the RR inorganic + 75% RRBS. However, comparable results on these parameters were obtained by the adding 25 to 50% RR BS and by applying the RR of the inorganic fertilizer alone. The highest grain yield was likewise produced by sweet sorghum plants applied with the combination of RR inorganic + 75% RR BS. That was not significantly different though from those plants added with 50% RR BS and those applied with RR inorganic fertilizer alone. No significant effect of the fertilizer treatments was noted on the percentage sugar content of sweet sorghum juice. The highest production cost was incurred by using RR inorganic + 75% RRBS, however, this was compensated by the higher gross income and net return obtained. Exclusively applying RR inorganic alone in sweet sorghum production would realize a higher profitable amount in return for every peso invested.

Based on the results, applying RR inorganic fertilizer alone at a rate of 80-30 -30 kg NPK ha-1 is sufficient to improve the growth characteristics and to increase stalk, grain, and juice yield of sweet sorghum. Although bigger stalk diameter resulted from the combination of higher amount of bio-sludge and organic fertili- zer, this did not significantly increase the juice and grain yield as compared to the plants applied with RR inorganic fertilizer alone. However, the effects of bio-sludge application in improving soil fertility as manifested by the increase in %OM, %N, P and K are indispensable. It is then suggested that higher amounts/rates of bio-sludge fertilizer be evaluated.

Acknowledgement

The researchers wish to thank all those who in one way or another became instrumental in the completion of this research work.

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MMSU Science and Technology Journal
Vol. 3 No. 2 | July-December 2013

ISSN: 2012 0060

MMSU GRADUATES' EMPLOYABILITY STATUS AND POTENTIALS

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Abstract

Through the years, the Mariano Marcos State University has become a comprehensive university by offering a number of science curricula. Since 1978, the university has awarded around 40,000 degrees, diplomas, and certificates; hence a study on the employability status and potentials of graduates is needed to have an anchor for curricular relevance.

This survey determined the graduates' demographic profile, formal and non -formal training programs attended after college and employment distribution. It also assessed the programs with the best potential for initial earning.

Five hundred randomly-selected graduates served as respondents. They represented the different programs offered by the various academic units of the university. Some of them graduated with honors and hurdled professional board examinations.

Almost a quarter of the employed finished teacher education. Majority of the graduates who were employed locally had starting salaries ranging from Php 5,000 to Php 10,000. However, graduates of nursing and engineering who were employed abroad received higher initial salaries than their locally-employed counterparts. A big majority of the graduates were employed, while the others (8.8%) were not due to inadequate job opportunities. At least a quarter of those employed waited for less than a month to six months after graduation before they were hired. Moreover, majority considered their communication skills learned in college as the most useful in their jobs.

The presence of landline phones among the graduates and their regional origin determined their employability. Additionally, academic factors, such as honors received, as well as professional examinations passed and ratings, were other determinants of graduates' employability.

Tracer studies for the various degree programs should be conducted and analyzed separately to obtain specific results. Likewise, an emphasis on graduates' appropriate occupational positions and placements and reasons of unemployment should be considered.

Keywords: *graduates' employability, employability status, graduates' potential*

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Introduction

In developing countries, Kimani (2002) reported that many higher education institutions (HEIs) have not been producing the types of skilled personnel needed by the work place. Consequently, unemployment has been increasing among college graduates due to the serious mismatch between HEI priorities and those of the labor market.

The Philippines as a developing country faces challenges having been beset for decades with structurally-high unemployment and underemployment rates. The unemployment rate in the Philippines was last reported at 7 percent in July of 2012, 21% of which includes college graduates [BLES, September 2012, cited in Benezuela-de Ocampo et al (2012)].

Higher education policy issues include expanding student enrolment in institutions of higher learning and encouraging private sector groups and individuals to establish and run institutions of higher education. The policy also includes curri- cular emphasis on programs that are geared toward responding to the changing world of science and technology and the corresponding ever-changing needs of the people, their government, industry, business and the surrounding environment in general. Institutions of higher education are then required to review their curricula to meet current and future needs, as well as the traditional subjects and incorporate further training programs (Kajage, 2003).

These findings from various HEIs point out the importance of tracer studies to be continuously conducted to surface benchmark information needed in curricular revisions and offerings and to monitor the graduates' whereabouts and performance. Hence, this research traced graduates of the Mariano Marcos State University (MMSU), their employability, and the factors that affect their performance.

Increase in curricular offerings and with the improvement in the quality of instruction in MMSU, the number of grad- uates had remarkably increased. As such, the institution continues to followup and trace its graduates' whereabouts and monitor their performance. Moreover, the institution's accreditation of its various curricular offerings demands a comprehensive tracer study among graduates.

Being one of the institutions of higher education in Region 1, MMSU considers tracer studies of graduates as important tools for institutional development especially now that the world of work is changing rapidly. With this inquiry, the institution can get a systematic feedback from former students, their working conditions, and their retrospective assessment of their course of study. Through tracer stu- dies, the quality of higher education and its relevance and usefulness to the career achievement of graduates can be holistically appraised (Jamil, 2004).

Among specific concerns of this study are the following: a) demographic profile of graduates; b) distribution of graduates in various companies/organizations; c) programs with highest potential for highest initial earning; d) types of graduates that are most employable; e) waiting time; f) competencies learned in college and academic experiences; and g) factors of graduates' employability.

Methodology

Sampling procedure. This research adopted the descriptive-survey method. Data sets of 2001-2004 graduates from the institution were obtained from the records of both Alumni Relations and Registrar's offices. The master list of graduates per degree program together with their year of graduation was prepared as basis for sampling. Five hundred randomly selected graduates from 11 program clusters served as respondents.

Research instrument. This research utilized the instrument prescribed by the Commission of Higher Education (CHED) – Graduate Tracer Study Program. The instrument include the following areas:

A. General information
B. Educational background
C. Training programs/Advance studies attended after college
D. Employment data

The instrument was a product of a series of seminar-workshops conducted

Table 1. Distribution of the graduates based on their program clusters.

PROGRAM CLUSTER	2000-2001		2001-2002		2002-2003		2003-2004		Total	
	N	n	N	n	N	n	N	n	N	n
Teacher Education	282	24	287	31	366	39	331	30	1266	124
Social Science in Philosophy					6	1	7	1	13	2
Natural Science & Mathematics	52	6	75	9	55	15	83	18	265	48
Business Economics & Mgt.	252	18	222	22	216	27	254	33	944	100
Communication Arts & Languages					18	1	16	2	34	3
Home Economics, Nutrition & Dietetics	48	2	29	1	40	1	22	2	139	6
Engineering	135	15	144	22	153	10	111	12	543	59
Health & Allied Sciences	99	4	185	18	184	16	207	17	585	55
Journalism & Mass Comm.	6	1	10	1	9	1	15	1	40	4
Agric., Forestry, Fisheries & Vet. Med.	94	10	128	11	144	22	120	14	486	57
Industrial Tech. & Related Tech.	182	14	124	10	108	13	105	5	520	42
TOTAL	**1150**	**94**	**1204**	**125**	**1210**	**146**	**1271**	**135**	**4835**	**500**

by CHED and participated in by representatives from various state universities and colleges of the country.

Data gathering procedure. Standard survey instruments or questionnaires were mailed to the respondents' addresses based on records of the alumni and registrar's office. Respondents were given enough time to accomplish the instruments and were requested to return them to the Alumni Relations Office. Respondents who were not able to return the completed instruments were personally visited in their homes and work places to retrieve the instruments or to interview them. For long distances, landline and mobile phones were utilized in communicating with concerned respondents. In cases where the original target respondents changed address and status (use of family name due to marriage) and could hardly be located, they were randomly replaced with more accessible graduates.

Data treatment and analysis. Frequency counts and percentages were used to analyze the descriptive data. In addition, correlation analysis was employed in determining the employability factors against personal and academic background of the graduates.

Results and Discussion

Demographic Profile of the Graduates

Personal characteristics. The personal characteristics of the graduates are shown in Tables 2a to 2e. Almost all (480 or 96%) the respondents are from Region I and only a few from other areas. Majority (317 or 63.40%) of the graduates are females. Most of them (408 or 81.60%) are single while some are married and single parents.

Contact details of the graduates such as their email addresses together with their landline and mobile phones were also determined (Tables 2f to 2h). Generally, majority of the graduates (289 or 57.8%) were not netizens, but most of them (423 or 85%) were mobile phones users.

Table 2a. Region of origin and location of the graduates (n=500).

REGION OF ORIGIN	FREQUENCY	PERCENT	RANK
1	480	96.0	**1**
2	14	2.8	**2**
4	1	0.2	**5**
CAR	**2**	0.4	**4**
NCR	3	0.6	**3**
Total	**500**	**100**	

Table 2b. Residence of the graduates (n=500).

LOCATION OF RESIDENCE	FREQUENCY	PERCENT	RANK
City	112	**22**	**2**
Municipality	388	**78**	**1**
Total	**500**	**100**	

Table 2c. Gender of the graduates (n=500).

GENDER	FREQUENCY	PERCENT	RANK
Male	183	36.6	**2**
Female	317	63.4	**1**
Total	**500**	**100**	

Table 2d. Civil status of the graduates (n=500).

CIVIL STATUS	FREQUENCY	PERCENT	RANK
Single	408	81.6	**1**
Married	88	17.6	**2**
Single Parent	1	0.2	**4**
Not Indicated	3	0.6	**3**
Total	**500**	**100**	

Table 2e. Age-range of the graduates (n=500).

AGE	FREQUENCY	PERCENT	RANK
Below 20	1	0.2	8
21-22 yrs. old	9	1.8	5.5
23-34 yrs. old	199	39.8	2
25-26 yrs .old	216	43.2	1
27-28 yrs. old	48	9.6	3
29-30 yrs. old	9	1.8	5.5
Above 30	8	1.6	7
Not indicated	10	2	4
Total	**500**	**100**	

Educational background. As shown in Table 3, the samples comprised of almost a quarter of teacher education graduates (124 or 24.8%), as well as business economics and management graduates (100 or 20%). The others were under the engineering (59 or 11.8%), agriculture, forestry and fisheries (57 or 11.4%), nursing (55 or 11%), natural science and mathematics (48 or 9.6%), industrial technology and related technology (42 or 8.4%), home economics and nutrition (6 or 1.2%), journalism and mass communication (4 or 0.8%), communication arts and languages (3 or 0.6%) and social science and philosophy (2 or 0.4%) programs.

Reasons for taking the course. Table 4 shows that the most number of graduates (176 or 35.20%) pursued their degree programs due to the prospect for immediate employment, while the least had (16 or 3.20%) no particular choice prior to their first enrolment.

Table 2f. Graduates with and without e-mail accounts (n=500).

EMAIL	FREQUENCY	PERCENT	RANK
With	211	42	2
Without	289	58	1
Total	**500**	**100**	

Table 2g. Graduates with and without landline phones (n=500).

LANDLINE	FREQUENCY	PERCENT	RANK
With	162	32	2
Without	338	68	1
Total	**500**	**100**	

Table 2h. Graduate with and without mobile phones (n=500).

MOBILE	FREQUENCY	PERCENT	RANK
With	423	85	1
Without	77	15	2
Total	**500**	**100**	

Table 3. Number of graduates under the various clusters (n=500).

PROGRAM CLUSTER	FREQUENCY	PERCENT
Teacher Education	124	24.8
Business Economics & Mgmt.	100	20.0
Engineering	59	11.8
Agric., Forestry, Fisheries & Vet. Med.	57	11.4
Health & Allied Sciences	55	11.0
Natural Science & Mathematics	48	9.6
Industrial Tech. & Related Tech.	42	8.4
Home Economics, Nutrition & Dietetics	6	1.2
Journalism & Mass Comm.	4	0.8
Communication Arts & Languages	3	0.6
Social Science in Philosophy	2	0.4
Total	500	100

Training programs or advance studies taken after college. As shown in Table 5, the highest number of the graduates (99 or 19.8%) got involved in other employment-related training programs. Others went into further or advance studies (51 or 10.20%) after graduation. Among them are those who pursued programs in the natural sciences and mathematics (9 or 18.75%), home economics and dietetics (1 or 16.67%), teacher education, (21 or 16.94%) and

Table 4. Reasons of graduates for pursuing their respective degree programs (n=500)*.

REASON FOR TAKING THE COURSE	PROGRAM CLUSTER																																			
	Teacher Educ.			Business Economics & Management			Engineering			Agricultural, Forestry, Fisheries & Vet.Med.			Health & Allied Sciences			Natural Science & Mathematics			Industrial Tech. & Rel. Tech.			Home Economics, Nutrition & Dietetics			Journalism & Mass Communication			Communication Arts & Lang.			Social Science & Philosophy			TOTAL		
	(n=124)*			(n=100)*			(n=59)*			(n=57)*			(n=55)*			(n=48)*			(n=42)*			(n=6)*			(n=4)*			(n=3)*			(n=2)*					
	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R
High grades in the course or subject area(s) related to the course	38	30.65	4.5	27	27	5.5	12	20.34	5.5	8	14.06	8	4	7.27	11.5	12	25	7	13	31	3	1	16.67	8	2	50	6							117	23.4	6
Good grades in high school	29	23.38	7	31	31	3	12	20.34	5.5	6	10.53	10	7	12.73	7	19	39.58	2	15	35.7	2	1	16.67	8	1	25	10							121	24.2	5
Influence of parents or relatives	42	33.87	2	31	31	3	13	22.03	3.5	15	26.32	4	17	30.91	1	15	31.25	4	8	19.1	7.5	2	33.33	4.5							1	50	2	144	28.8	2
Peer Influence	17	13.71	12	15	15	11	6	10.17	10	5	8.77	12	6	10.91	9.5	4	8.33	11.5	4	9.52	11				1	25	10				1	50	2	59	11.8	12
Inspired by a role model	38	30.65	4.5	14	14	12	9	15.25	7.5	7	12.28	9	7	12.73	7	5	10.42	10	8	19.1	7.5	2	33.33	4.5	2	50	6							92	18.4	9
Strong passion for the profession	39	31.45	3	27	27	5.5	19	32.2	1.5	14	24.56	5	7	12.73	7	21	43.75	1	9	21.4	4.5	1	16.67	8	4	100	1	2	66.67	1.5				143	28.6	3.5
Prospect for immediate employment	30	24.19	6	54	54	1	19	32.2	1.5	24	42.11	2	12	21.82	3	13	27.08	5.5	17	40.5	1	3	50	2.5	2	50	6	2	66.67	1.5				176	35.2	1
Status or prestige of the profession	25	20.16	8	19	19	9	8	13.56	9	11	19.3	6.5	11	20	4	8	16.67	8	5	11.9	10	1	16.67	8	2	50	6							90	18	10
Availability of course offering in chosen institution	22	17.74	9.5	22	22	8	4	6.78	12	19	33.33	3	6	10.91	9.5	7	14.58	9	8	19.1	7.5	3	50	2.5	3	75	2.5	1	33.33	4				95	19	8
Prospect of career advancement	22	17.74	9.5	24	24	7	13	22.03	3.5	11	19.3	6.5	10	18.18	5	17	35.42	3	8	19.1	7.5	1	16.67	8	3	75	2.5							109	21.8	7
Affordability for the family	44	35.48	1	31	31	3	5	8.47	11	29	50.88	1	4	7.27	11.5	13	27.08	5.5	9	21.4	4.5	4	66.67	1	2	50	6	1	33.33	4	1	50	2	143	28.6	3.5
Prospect of attractive compensation	17	13.71	12	16	16	10	9	15.25	7.5	3	5.26	13	13	23.64	2	4	8.33	11.5	3	7.14	12				1	25	10	1	33.33	4				67	13.4	11
No particular choice or no better idea				4	4	13	3	5.08	13	5	8.77	12	2	3.64	13				2	4.76	13													16	3.2	13

* Multiple responses

Table 5. Training programs or advance studies taken by the graduates after completing their college degrees (n=500)*.

TRAINING OR ADVANCE STUDY TAKEN AFTER COLLEGE	PROGRAM CLUSTER																																
	Teacher Educ.			Business Economics & Management			Engineering			Natural Science & Mathematics			Agricultural, Forestry, Fisheries & Vet.Med.			Health & Allied Sciences			Industrial Tech. & Rel. Tech.			Home Economics, Nutrition & Dietetics			Journalism & Mass Communication			Communication Arts & Lang.			TOTAL		
	(n=124)*			(n=100)*			(n=59)*			(n=57)*			(n=55)*			(n=48)*			(n=42)*			(n=6)*			(n=4)*			(n=3)*					
	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R
Advance Studies or Graduate Program	21	16.9	1	15	15	1	2	3.39	3.5	9	18.8	1	0	0		2	3.64	3	1	2.38	1	1	16.7	1	0	0		0	0		51	10.2	1
Post Baccalaureate or Prof. Certificate Program	1	0.81	4	0	0		2	3.39	3.5	3	6.25	2	0	0		3	5.45	1	0	0		0			0	0		0	0		9	1.8	4
Short Term Intensive Prof. Dev. Seminar	2	1.61	3	2	2	3	3	5.08	2	0	0		2	3.51	1	2	3.64	3	5	11.9	2.5	0			0	0		0	0		16	3.2	3
Short Term Prof. Related Training	6	4.84	2	5	5	2	6	10.2	1	1	2.08	3	0	0		2	3.64	3	5	11.9	2.5	0			0	0		1	33.33	1	26	5.2	2
Other Work Related Trainings	32			5			14			9			8			16			12			0			0			3					
Number. of other work related trainings																																	
0 to 1	8	6.45	1.5	5			2	3.39	2	6	12.5	1	4	7.02	1	4	7.27	2	6	14.29	1							3	100	1	38	7.6	1
2 to 3	8	6.45	1.5	0			6	10.2	1	1	2.08	2	2	3.51	2	6	10.9	1	3	7.14	2							0			26	5.2	2
3 to 4	1	0.81	3.5	0			0	0		0		–	0			0			0									0			1	0.2	3.5
5 to 6	1	0.81	3.5	0			0	0		0		–	0			0			0									0			1	0.2	3.5

* Multiple responses

business, economics and management (15 or 15.0%).

Additionally, there were few graduates who had short-term professional related training (9 or 5.20%), short-term intensive professional development seminar (16 or 3.20%), and post-baccalaureate programs (9 or 1.80%).

Reasons for pursuing advance studies. As shown in Table 6, a big majority of the graduates (129 or 72%) took advance studies for professional advancement and a little less than a greater of them mentioned (46 or 26%) that security and promotion were secondary reason for them to pursue further studies.

Honors/Awards received. Table 7 shows that out of the 500 respondents, only few of them received academic and other awards. Among which are as follows: cum laude (12 or 2.40%); dean's list (4 or 0.80%); magna cum laude (2 or 0.40%); with academic distinction (1 or 0.20%); and others got SILAW and athletic awards.

Professional examinations passed. The number of graduates who passed the various professional exams taken from 2001 to 2004 (Table 8). It is interesting to note that all graduates of accountancy, chemical engineering, and mechanical engineering passed their board exams. Likewise, almost all civil engineering graduates (94%) passed their board exam. Similarly, most of the graduates in nursing (89%); electronics and communication engineering (83%); electrical engineering (80%); and pharmacy and teacher education (75%) made it to their various professional examinations. For graduates of physical therapy (71%) and chemistry (67%), a big majority of them passed their respective exams. However, a little less than 28% of agriculture graduates passed and the rest have not taken the board exam yet.

Distribution of Employed Graduates in Various Companies/Organizations

As shown in Table 9, educational institutions comprised the bulk of employers (117 or 23%) of MMSU graduates. Those were followed by

Table 6. Reasons of graduates for pursuing advance studies (n=500)*.

	PROGRAM CLUSTER																										
REASON FOR PURSUING ADVANCE STUDIES	Teacher Educ.			Business Economics & Management			Engineering			Agricultural, Forestry, Fisheries & Vet.Med.			Health & Allied Sciences			Natural Science & Mathematics			Industrial Tech. & Rel. Tech.			Home Economics, Nutrition & Dietetics			TOTAL		
	(n=124)*			(n=100)*			(n=59)*			(n=57)*			(n=55)*			(n=48)*			(n=42)*			(n=6)*					
	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R
For promotion	24	19	2	7	7	2	4	6.8	2	0	0		1	1.81	3	4	8.3	2	5	11.9	2	1	16.7	1.5	45	9	2
For prof. dev.	43	35	1	19	19	1	17	29	1	6	10.5	1	22	40	1	10	21	1	11	26.2	1	1	16.7	1.5	128	26	1
Others	1	0.8	3										1	1.82	2				1	2.38	3				3	0.6	3

* Multiple responses

Table 7. Honors and awards received by the graduates (n=500)*.

HONORS OR AWARDS RECEIVED	PROGRAM CLUSTER																							
	Teacher Educ.			Business Economics & Management			Engineering			Agricultural, Forestry, Fisheries & Vet.Med.			Health & Allied Sciences			Home Economics Nutrition & Dietetics			Communication Arts & Lang.			TOTAL		
	(n=124)*			(n=100)*			(n=59)*			(n=57)*			(n=55)*			(n=6)*			(n=3)*					
	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R
Magna Cum Laude	2	1.61	3.5																			2	0.4	4
Cum Laude	6	4.84	1	4	4	1	1	1.69	2							1	1.7	1				12	2.4	1
With Academic Distinction				1	1	2																1	0.2	5
Dean's List Award	2	1.61	3.5							1	1.75	2	1	1.81	2							4	0.8	3
Other Awards	5	4.03	2				1	1.69	2	1	1.75	2	1	1.81	2				1	33.33	1	9	1.8	2

*Multiple responses

Table 8. Percentage of graduates who passed in various professional exams

PROGRAM DISCIPLINE WITH BOARD EXAM	NO. OF GRADUATES	NO. OF PASSERS	PERCENT
Teacher Education	124		75
LET-Elementary		26	21
LET- Secondary		67	54
Natural Science & Mathematics			
Chemistry	3	2	67
Business Economics & Mgt.			
Accountancy	3	3	100
Engineering			
Chem. Engineering	5	5	100
Civil Engineering	18	17	94
Electrical Engineering	5	4	80
Electronics & Comm. Engineering	12	10	83
Mechanical Engineering	2	2	100
Health & Allied Sciences			
Nursing	36	32	89
Pharmacy	12	9	75
Physical Therapy	7	5	71
Agric., Forestry, Fisheries & Vet. Med.			
Agricultural Engineering	8	4	50
Agriculture	43	12	28

companies/organizations/groups/ establishments under health and social work; transport, storage and communication; agriculture, hunting and forestry; financial intermediation; construction; hotels and restaurant; other community, social and personal services; wholesale and retail trade, personal and household goods; real estate renting and business activities; public administration and defense, compulsory social security; manufacturing; private household with employed persons; electricity; and recreational and cultural services.

The number of companies/ organizations where graduates were distributed was indicated by the presence of employed graduates in the listed companies in Table 9. Graduates of business economics and management were mostly deployed in 13 companies like: financial intermediation (22%), hotels & restaurants (9%), real estate (8%), social and personal service activities (8%), wholesale retail trade (7%), transport, storage and communication (7%), public administration and defense (5%), education (4%), agriculture, hunting & forestry (3%), manufacturing (2%), construction (2%), recreational & cultural services establishments (2%); and private households (1%). Graduates of journalism and mass communication were deployed in just one company (educational organization).

Programs with the Potential for Highest Initial Earning

Table 10 presents the various programs with the potential for highest initial earning.

Majority (51.4%) of the graduates from the various program clusters received initial salaries from Php 5,000 to Php 10,000. These are graduates of journalism and mass communication; industrial technology and related technology; agriculture, forestry, and fisheries; business economics and management; teacher education; home economics, nutrition and dietetics; health and allied science; communication arts and languages; natural sciences and mathematics and engineering. However, nursing and engineering graduates received as initial salary of at least P20,000 due to their employment abroad (Table 11c).

Employability of Graduates

Table 11a shows the graduates' employability. A big majority of them (379 or 75.80%) were employed. Meanwhile, almost one out of ten (44 or 8.80 %) were unemployed when the study was conducted.

A little more than 15% includes those who have never been employed. Almost similar unemployment rate (8%) was obtained in the tracer study of Polytechnic University of the Philippines - Quezon City by Verona (2013). However, the incidence of unemployment was found very low (about 1-3 percent) based on the findings of Al-Samarrai and Bennell (2003).

High employment rate could be attributed to the graduates' commendable performance in various professional exams (Table 8), honors received (Table 7) and training programs or advance studies taken (Table 5). These conditions served as basic foundation for them to apply for a job. Moreover, similar results were obtained from a tracer study of The Lyceum University of the Philippines-Batangas (Valdez, 2012). While

Table 9. Distribution of employed graduates in various companies and organizations (n=500)*.

COMPANY/ ORGANIZATION	PROGRAM CLUSTER																																			
	Teacher Educ.			Business Economics & Management			Engineering			Agricultural, Forestry, Fisheries & Vet.Med.			Health & Allied Sciences			Natural Science & Mathematics			Industrial Tech. & Rel. Tech.			Home Economics, Nutrition & Dietetics			Journalism & Mass Communication			Communication Arts & Lang.			Social Science & Philosophy			TOTAL		
	(n=124)*			(n=100)*			(n=59)*			(n=57)*			(n=55)*			(n=48)*			(n=42)*			(n=6)*			(n=4)*			(n=3)*			(n=2)*					
	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R
Agriculture, Hunting & Forestry	1	0.81	12.5	3	3	11	2	3.39	7.5	16	28.07	2				2	4.17	4.5																24	4.8	5
Fishing																																				
Mining & Quarrying																																				
Manufacturing				2	2	13	5	8.47	4.5	1	1.75	9.5							1	2.38	11	1	16.67	3.5										10	2	14
Electricity	2	1.61	10				2	3.39	7.5							1	2.08	9																5	1	16
Construction	1	0.81	12.5	2	2	13	17	28.81	1										1	2.38	11													21	4.2	7
Wholesale & Retail Trade; Repair of Motor Vehicles, Motorcycle & Personal and Household Goods	4	3.23	6.5	7	7	7	2	3.39	7.5	1	1.75	9.5				1	2.08	9	3	7.14	5													18	3.6	10
Hotels and Restaurants	4	3.23	6.5	9	9	3				1	1.75	9.5	1	1.82	6	2	4.17	4.5	3	7.14	5													20	4	8
Transport, Storage & Communication	4	3.23	6.5	7	7	7	10	16.95	3	1	1.75	9.5	1	1.82	6	2	4.17	4.5	1	2.38	11													26	5.2	4
Financial Intermediation				22	22	1	1	1.69	11										1	2.38	11													23	4.6	6
Real Estate, Renting & Business Activities	2	1.61	10	8	8	5				1	1.75	9.5	1	1.82	6	1	2.08	9	2	4.76	8													16	3.2	11.5
Public Administration & Defense; Compulsory Social Security				5	5	8										1	2.08	9	5	11.9	2													11	2.2	13
Education	68	58.8	1	4	4	9	5	8.47	4.5	6	10.53	3	12	21.8	2	12	25	2	4	9.52	3	2	33.33	1.5	3	75	1	1	33.33	2				117	23	2
Health & Social Work	2	1.61	10							4	7.02	4	30	54.6	1	2	4.17	4.5	3	7.14	5	1	16.67	3.5										42	8.4	3
Other Community, Social and Personal Service Activities	5	4.03	4	8	8	5	1	1.69	11	1	1.75	9.5	1	1.82	6				2	4.76	8							1	33.33	2				19	3.8	9
Private Households w/ Employed Persons	4	3.23	6.5	1	1	15				3	5.26	5.5																						8	1.6	15
Extra-Territorial Organizations & Bodies																																				
Reacreational & Cultural Services Establishments				2	2	13	1	1.69	11																									3	0.6	17
Not Applicable	22	17.7	2	17	17	2	11	18.64	2	19	33.33	1	8	14.6	3	23	47.9	1	15	35.71	1	2	33.33	1.5	1	25	2	1	33.33	2	2	100	1	121	24	1
Not Indicated	5	4.04	3	3	3	11	2	3.39	7.5	3	5.26	5.5	1	1.82	6	1	2.08	9	1	2.38	11													16	3.2	11.5

*Multiple responses

Table 10. Initial salary range received by the graduates in their first job (n=500)*.

SALARY RANGE	PROGRAM CLUSTER																																			
	Teacher Educ.			Business Economics & Management			Engineering			Agricultural, Forestry, Fisheries & Vet.Med.			Health & Allied Sciences			Natural Science & Mathematics			Industrial Tech. & Rel. Tech.			Home Economics, Nutrition & Dietetics			Journalism & Mass Communication			Communication Arts & Lang.			Social Science & Philosophy			TOTAL		
	(n=124)*			(n=100)*			(n=59)*			(n=57)*			(n=55)*			(n=48)*			(n=42)*			(n=6)*			(n=4)*			(n=3)*			(n=2)*					
	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R
Below P5,000	2	1.61	4.5	1	1	6.5																												3	0.6	8
P5,000 to less than P10,000	69	55.65	1	63	63	1	12	20.34	2	37	64.91	1	27	49.09	1	14	29.17	2	28	66.67	1	3	50	1	3	75	1	1	33.33	2				257	51.4	1
P10,000 to less than P15,000	37	29.84	2	24	24	2	33	55.93	1	4	7.02	3	17	30.91	2	12	25	3	8	19.05	2				1	25	2	1	33.33	2				137	27.4	2
P15,000 to less than P20,000	1	0.81	6.5	2	2	4	2	3.39	5.5	2	3.51	4	1	1.82	4.5							1	16.67	3										9	1.8	4
P20,000 to less than P25,000	2	1.61	4.5	1	1	6.5				1	1.75	5	2	3.64	3																			6	1.2	5
P25,000 and above				1	1	6.5	3	5.08	4				1	1.82	4.5																			5	1	6
Not Applicable	12	9.68	3	7	7	3	7	11.86	3	13	22.81	2				22	45.83	1	6	14.29	3	2	33.33	2				1	33.33	2	2	100	1	79	15.8	3
Not Indicated	1	0.81	6.5	1	1	6.5	2	3.39	5.5																									4	0.8	7

*Multiple responses

intellectual, communication and interpersonal skills, competencies, and work-related values learned by graduates and deve- loped while schooling were considered as the most important factor related to employability.

As likewise presented in Table 11a, most graduates in the health and allied sciences (85%), teacher education (83%), business economics and management (82%), and engineering (81%) were more employable than their counterparts in the other disciplines.

Table 11b shows that more than one-third (35%) of the graduates landed as professionals in their own fields of specialization. Others were employed as service workers and shop/market sales workers (13.4%), clerks (12.2%), technicians and associate professionals (8.2%). Only a few landed as laborers and unskilled workers, farmers, forestry workers, and fishermen.

As majority of graduates were locally employed, some graduates of home economics, nutrition and dietetics (16.67%), health and allied sciences (7.27%), agriculture, forestry and fisheries (5.28%), engineering (5.08%) and teacher education (3.23%) worked abroad. This suggests the presence of opportunities outside the country which enabled the graduates to receive higher initial salary (Table 10).

Table 11a. Employability of graduates under the various program disciplines.

PROGRAM CLUSTER	EMPLOYABILITY								
	EMPLOYED (N=379)			UNEMPLOYED (N=44)			NEVER BEEN EMPLOYED (N=77)		
	F	%	Rank	F	%	Rank	F	%	Rank
Teacher Education	103	83	2	9	7	5.5	12	10	8.5
Business Economics & Management	82	82	3	11	11	3	7	7	10
Engineering	48	81	4	4	7	5.5	7	12	7
Agricultural, Forestry, Fisheries & Vet. Med.	38	67	7	6	10	4	13	23	5
Health & Allied Sciences	47	85	1	3	5	7	5	10	8.5
Natural Science & Mathematics	25	52	10	1	2	8	22	46	2
Industrial Tech. & Related Tech.	27	64	9	9	22	2	6	14	6
Home Economics, Nutrition & Dietetics	4	67	7				2	33	3.5
Journalism & Mass Communication	3	75	5	1	25	1			
Communication Arts& Languages	2	67	7				1	33	3.5
Social Science & Philosophy							2	100	1

Table 11b. Occupation of graduates under the various programs/disciplines

OCCUPATION	PROGRAM CLUSTER																																
	Teacher Educ.			Business Economics & Management			Engineering			Agricultural, Forestry, Fisheries & Vet.Med.			Health & Allied Sciences			Natural Science & Mathematics			Industrial Tech. & Rel. Tech.			Home Economics, Nutrition & Dietetics			Journalism & Mass Communication			Communication Arts & Lang.			TOTAL		
	(n=103)*			(n=82)*			(n=48)*			(n=38)*			(n=47)*			(n=25)*			(n=27)*			(n=4)*			(n=3)*			(n=2)*					
	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R
Professionals	71	57.26	2	17	17	5	35	59.3	2	5	8.77	6	42	76.4	2	12	25	3	5	11.9	5.5	1	16.7	3.5	1	25	3.5	1	33.33	3	190	35	2
Technicians and Associate Professionals	3	2.42	6.5	12	12	6	7	11.9	4	11	19.33	3	1	1.82	6	1	2.08	6	6	14.29	4										41	8.2	8
Clerks	10	8.06	5	27	27	3	1	1.69	6	8	14.04	4.5	1	1.82	6	6	12.5	4.5	5	11.9	5.5	2	33.3	2	1	25	3.5	1	33.33	3	61	12.2	6
Service Workers and Shop and Market Sales Workers	16	12.9	4	22	22	2	5	8.47	5	8	14.04	4.5	2	3.64	4	6	12.5	4.5	8	19.05	3										67	13.4	5
Farmers, Forestry Workers and Fishermen										2	3.51	8																			2	0.4	9.5
Trades and Related Workers				1	1	8.5							1	1.82	6																2	0.4	9.5
Plant and Machine Operators and Assemblers				1	1	8.5													1	2.38	7												
Laborers and Unskilled Workers	3	2.42	6.5	1	1	8.5				2	3.51	8										1	16.7	3.5							7	1.4	4
Special Occupation				1	1	8.5				2	3.51	8							2	4.76	6				1	25	3.5				6	1.2	7
Employed	103	83.06	1	82	82	1	48	81.4	1	38	66.67	1	47	85.5	1	25	52.08	1	27	64.29	1	4	66.7	1	3	75	1	2	66.67	1	379	75.8	1

The various reasons behind the unemployment of 121 (24.2%) graduates are presented in Table 11d. More than one-third of them (45 or 34.09 %) said that there was no job opportunity for them. Other reasons stated by the other unemployed graduates include the following: on-going application for overseas work, termination of contract from previous employment and resignation from work.

Waiting Time

Table 12 shows the waiting time of graduates before they were able to land a job. Generally, MMSU graduates waited for as short as less than a month to as long as 4 years or more to find a job. Unlike other business school of private universities, graduates waited no more than 6 months before landing a job (De Ocampo, 2009).

Table 11c. Place of work of employed graduates

PROGRAM CLUSTER	PLACE OF WORK					
	Local			Abroad		
	F	%	Rank	F	%	Rank
Business Economics & Management	80	80	1	1	1.00	6
Teacher Education	98	79.03	2	4	3.23	5
Health & Allied Sciences	43	78.18	3	4	7.27	2
Journalism & Mass Communication	3	75.00	4			
Engineering	44	74.50	5	3	5.08	4
Communication Arts& Languages	2	66.67	6			
Social Science & Philosophy						
Industrial Tech. & Related Tech.	27	64.29	7			
Agricultural, Forestry, Fisheries & Vet Med	35	61.40	8	3	5.26	3
Home Economics, Nutrition & Dietetics	3	50.00	10	1	16.67	1

Table 11d. Reasons of graduates' unemployment (n=121)*.

REASON	FREQUENCY	PERCENT	RANK
No job opportunity	51	38.64	1
Lack of work experience	21	15.91	2
Advance or further study	20	15.15	3
Family concern and decided not to find a job	13	9.85	4
Applying abroad	12	9.09	5
Health-related reasons	8	6.06	6
Did not look for a job	5	3.79	7
Did not pass board exam	2	1.52	9

However, considering the waiting time of graduates under the various programs, it was observed that graduates of teacher education (42 or 34%), engineering (15 or 25%), journalism and mass communication (2 or 50%) and agriculture, forestry and fisheries (15 or 26%) waited for less than a month to get employed. Meanwhile graduates of the natural sciences and mathematics (8 or 17%), business economics and management (29 or 29%), communication arts and languages (1 or 33%), home economics, nutrition & dietetics (2 or 33%), health and allied sciences (20 or 37%) and industrial technology and related fields (7 or 17%) waited for one to six months to land their first job.

Academic Experiences or Competencies Learned in College

Majority (252 or 50.4%) of graduates found communication skills as the most useful competency learned in college and entrepreneurial skills as the least.

It is clear from the results that the competencies acquired by the graduates in the course of their degree programs differed from one to another (Table 13). Graduates of teacher education (74 or 58%), business economics and management (64 or 64%), communication arts and languages (2 or 66.67%), engineering (24 or 41%), health and allied sciences (37 or 67%), agriculture, forestry and fisheries (20 or 35%) and industrial technology and related technologies (16 or 38%) found communication skills to be the most useful in their present jobs. On the other hand, graduates (2 or 100%) found human relations and critical thinking skills to be the most useful.

Graduates of natural sciences and mathematics (12 or 25%) found critical thinking to be most useful. Similarly, graduates of home economics, nutrition and dietetics (2 or 33.33%) found communication skills and human relations to be equally important while graduates of journalism and mass communication (3 or 75%) indicated communication skills and knowledge in information technology as the two most important skills acquired during college. This result concurs with Kaijae's findings (1996) that graduates found competencies/skills and knowledge acquired during college are relatively useful in their work.

Determinants of Graduates' Employability

In addition to the factors that determine graduates' employability, the following determinant factors were considered: personal, academic and graduates' professional skills (Tables 14, 15 and 16).

Based on the findings, among the graduates' personal background such as presence of landline phone and region of origin were found to be significant determinants of graduates' employability. Graduates with landline phones and are urban residents led to the immediate access to job employment opportunities. Similarly, most of the graduates were employed in urban areas within their region since more jobs applicable to their degree were readily available in the area (Nyanzi et al, 2006).

In terms of academic factors, honors received, professional examinations passed and ratings were significant determinants of graduates' employability. The high correlation between academic factors and employability indicated better

Table 12. Waiting time of graduates before their first employment (n=500).

WAITING TIME	PROGRAM CLUSTER																																			
	Teacher Educ.			Business Economics & Management			Engineering			Agricultural, Forestry, Fisheries & Vet.Med.			Health & Allied Sciences			Natural Science & Mathematics			Industrial Tech. & Rel. Tech.			Home Economics, Nutrition & Dietetics			Journalism & Mass Communication			Communication Arts & Lang.			Social Science & Philosophy			TOTAL		
	(n=124)*			(n=100)*			(n=59)*			(n=57)*			(n=55)*			(n=48)*			(n=42)*			(n=6)*			(n=4)*			(n=3)*			(n=2)*					
	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R
Less than a month	42	33.9	1	26	26	2	15	25.42	1	15	26.32	1	17	30.9	2	7	14.6	3	6	14.3	3.5				2	50	1							130	26	1
1 to 6 months	22	17.7	2	29	29	1	11	18.64	3	10	17.54	3.5	20	36.4	1	8	16.7	2	7	16.7	2	2	33.3	1.5	1	25	2.5	1	33.33	2				111	22	2
7 to 11 months	8	6.45	6	9	9	5	9	15.25	4	3	5.26	5	2	3.64	4.5	2	4.17	6	1	2.38	7							1	33.33	2				35	7	6
1 yr. to less than 2 yrs.	12	9.68	4.5	11	11	4	3	5.08	6	2	3.51	7	2	3.64	4.5	4	8.33	4	5	11.9	5	1	16.7	3.5										4	8	5
2 yrs. to less than 3 yrs	4	3.23	7	1	1	7	1	1.69	7	2	3.51	7	1	1.82	6.5	1	2.08	7.5																10	2	7
3 yrs. to less than 4 yrs.	2	1.61	8							2	3.51	7	1	1.82	6.5				2	4.76	6	1	16.7	3.5										8	1.6	8
Others (4 yrs. above)	1	0.81	9													1	2.08	7.5																2	0.4	9
Not Applicable	12	9.68	4.5	7	7	6	7	11.86	5	13	22.81	2				22	45.8	1	6	14.3	3.5	2	33.3	1.5				1	33.33	2	2	100	1	77	15	4
Not Indicated	21	16.9	3	17	17	3	13	22.03	2	10	17.54	3.5	7	12.7	3	3	6.25	5	15	35.7	1				1	25	2.5							87	17	3

Table 13. Competencies/ Skills learned by graduates after college (n=500)*.

COMPETENCIES/SKILLS	PROGRAM CLUSTER																																			
	Teacher Educ.			Business Economics & Management			Engineering			Agricultural, Forestry, Fisheries & Vet.Med.			Health & Allied Sciences			Natural Science & Mathematics			Industrial Tech. & Rel.Tech.			Home Economics, Nutrition & Dietetics			Journalism & Mass Communication			Communication Arts & Lang.			Social Science & Philosophy			TOTAL		
	(n=124)*			(n=100)*			(n=59)*			(n=57)*			(n=55)*			(n=48)*			(n=42)*			(n=6)*			(n=4)*			(n=3)*			(n=2)*					
	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R	F	%	R
Communication	72	58.06	1	64	64	1	24	40.68	1	20	35.09	1	37	67.27	1	11	22.92	2.5	16	38.1	1.5	2	33.33	1.5	3	75	1.5	2	66.67	1	1	50	3.5	252	50.4	1
Human Relations	70	56.45	2	60	60	2	22	37.29	2.5	19	33.33	2	35	63.63	2	10	20.83	4	16	38.1	1.5	2	33.33	1.5	2	50	3.5	1	33.33	3	2	100	1.5	239	47.8	2
Entrepreneurial	26	20.97	6	26	26	6	5	8.47	6	11	19.29	6	11	20	6	0			8	19.05	4	0			0			0			0			87	17.4	6
Information Technology	40	32.26	5	34	34	5	16	27.12	5	14	24.56	3	18	32.72	5	8	16.67	5	15	35.71	3	0			3	75	1.5	0			1	50	3.5	149	29.8	5
Problem-Solving	51	41.13	3	40	40	3.5	22	37.29	2.5	11	19.29	6	28	50.91	4	11	22.9	2.5	6	14.29	6	0			1	25	5	1	33.33	3	0			171	34.2	4
Critical Thinking	48	38.71	4	40	40	3.5	20	33.9	4	12	21.05	4	31	56.36	3	12	25	1	7	16.67	5	0			2	50	3.5	1	33.33	3	2	100	1.5	175	35	3

*Multiple responses

Table 14. Personal factors affecting the graduates' employability.

	PERSONAL FACTOR								
	Presence of Email	**Presence of Land-line Phone**	**Presence of Mobile Phone**	**Civil Status**	**Sex**	**Age**	**Region of Origin**	**Prov-ince**	**Loca-tion of Resi-dence**
EMPLOYA-BILITY	.010^{ns}	.102*	-.008^{ns}	-.031^{ns}	-.080^{ns}	.012^{ns}	-1.00*	-.098^{ns}	-.024^{ns}

*Correlation is significant at the 0.05 level (2-tailed)

Table 15. Academic factors affecting the graduates' employability.

	ACADEMIC FACTOR					
	Degree	**College**	**Year Graduated**	**Honors/ Awards Received**	**Professional Examination Passed**	**Rating**
EMPLOYABILITY	-.014^{ns}	.068^{ns}	-.082^{ns}	-.121**	-.187**	-.121**

**Correlation is significant at the 0.01 level (2-tailed)

Table 16. Professional skills affecting the graduates' employability

	PROFESSIONAL SKILL						
	Comm'n.	**Problem solving**	**Supervisio n and Manageme nt**	**Planning**	**Innovation, creativity and developmen t**	**Organizi ng**	**Delegating**
EMPLOYABILITY	.034^{ns}	.057^{ns}	.064^{ns}	.072^{ns}	-.026^{ns}	.053^{ns}	.025^{ns}

employment opportunities to graduates who received honors/awards and had high ratings in professional exams.

Aside from the professional skills, no other determining factor was found to influence graduates' employability. This could be due to the fact that professional skills are considered most during employment period.

Conclusions and Recommendations

Most of the graduate-respondents came from programs under teacher education, business economics and management, engineering, agriculture, forestry and fisheries, health and allied sciences, industrial technology, and allied fields. Some received honors and awards, as well as participated in advance training programs. Majority of the graduates were employed in the educational sector. However, most of the employed graduates of business economics and management were distributed/deployed to 13 companies/organization. Most of the employed graduates received initial salaries from Php5,000 to less than Php10,000 a month. However, some engineering and nursing graduates received at least Php 20,000 since they

worked abroad. Graduates took 6 months before they were employed. The respondents indica- ted communication skills as the most useful competency learned in college and entrepreneurial skills as the least.

To attain a better perspective of the employment performance and accomplishment of graduates, tracer studies with emphasis on graduates' appropriate occupational positions and placements and reasons of unemployment should be regularly conducted. In addition, tracer studies for the various degree programs should be done and analyzed separately to obtain specific results considering needs.

Additionally, an enhancement program or pre-employment training program of the university should be considered to improve graduates' competencies and skills to boost graduates' confidence during job interviews and to enhance their employment marketability.

Acknowledgment

Special thanks to the Commission on Higher Education (CHED) for the opportunity given to the institution as part of their research project under the National Graduate Tracer Study (2001-2004) and at the same time the funding support provided for the realization of the research.

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MMSU Science and Technology Journal
Vol. 3 No. 2 | July-December 2013

ISSN: 2012 0060

REDUCING INSECT PEST INCIDENCE IN SOLANACEOUS VEGETABLES THROUGH INTEGRATED PEST MANAGEMENT AND FARMERS' PRACTICES

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Abstract

Three solanaceous vegetable crops - sweet pepper (Capsicum annuum), finger pepper (Capsicum sp), and tomato (Lycopersicon esculentum, S Miller) were at different planting dates using Integrated Pest Management (IPM) and Farmer's Practice (FP) to determine pest incidence and to compare their yield and profitability.

Pest incidence was very high during late planting. Meanwhile, natural enemies incidence was higher during regular planting than either early or late planting. Moreover, pests were higher FP plots, while natural enemies were higher in IPM plots across the planting dates. The most prevalent pest observed both in IPM and FP plots was whitefly (family Aleyrodidae). Curling of leaves upward and downward, which was suspected to be caused by thrips (Thrips palmy Karny) and mites (P. latus Banks) was observed in sweet and finger pepper across all planting dates in both IPM and FP plots; however, its occurrence was only light to moderate under regular planting. Further, damaged tomato fruits caused by fruitworm were more visible during regular planting. Ina addition, the most prevalent natural enemies included various spiders belonging to families Lycosidae and Salticidae, wasp belonging to families Icheumonidae and Brachonidae, as well as Coccinelidae bettles.

Furthermore, sweet pepper yield was higher during regular planting, but it was higher during early planting using IPM. On the other hand, finger pepper yield was comparable across the planting dates, but it was higher in IPM plots. That trend was also evident in producing tomatoes wherein higher yield was obtained in IPM plots that that of the FP plots.

On the whole, the IPM approach is more economical, profitable, and practical that the usual FP. With IPM, pesticide use is minimized; thus, pest resurgence and environmental hazards could be avoided.

Key words: Integrated Pest Management, insect pest, solanaceous, vegetable planting dates natural enemies

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Introduction

Pest occurrence and predominance have varied as climatic conditions change from year to year. As such, most farmers have used a wide range of different chemicals to control various pests. In the Ilocos, farmers usually plant vegetables as part of their cropping system. One of the major constraints in producing quality vegetables is the attack of pests. Using synthetic insecticides has been the farmers' immediate remedy, but the risks of using them has become apparent due to their toxic residues in food, water, and the environment (http://www.foginfor.org). Farmers' relatively inadequate knowledge in implementing proper pest control management practices has aggravated the problem. Most farmers face challenges in dealing with pests affecting their crops.

Lutap and Atis (2003) inquired on the farmers' perceptions of IPM in 10 vegetable-growing towns in Ilocos Norte's rainfed lowland areas. Results revealed that most farmers have been aware and have adopted some cultural practices like crop rotation and, sanitation, yet majority of them were inadequately familiar with IPM. In addition, they relied on pesticides spray at close intervals to control pests and heavily used N fertilizer. The integral shortcomings need to be addressed considering the likelihood of farmers' experiences to pesticide residues. Similarly, consumers could be exposed to pesticide residues when they purchase and consume their produce.

On May 3, 1993, however, Presidential Memorandum Order No. 126, promp- ted the implementation of *Kasaganaan ng Sakahan at Kasakalisan* (KASAKALIKASAN) as the National Integrated Pest Management Program and as the standard approach to crop production and pest management in the country. Through this program, Farmers' Field Schools have been set up all over the country specifically in areas planting vegetables. Results show that a yield increase of 5-10 percent can be obtained via IPM (Training of Trainors for Vegetable IPM, of KASAKALIKASAN, 2003).

Introducing chemicals can change a balanced ecosystem through the destruction of certain species and the dominance of others (sometimes pests themselves). Likewise, pesticides can be ineffective, particularly when pests become resistant to them. Furthermore, pests may survive in situations where the chemicals do not reach pests, are washed off, and are applied untimely during certain pest growth stages (Private Pesticide Applicator Training Manual, 19th edition).

Many of the non-chemical pest control practices and principles in IPM have been followed by farmers, like sanitation, planting time, trap crops, physical barriers, mechanical control, and biological use of resistant varieties. For example, planting dates are changed so that the host is not yet established when the pest is present (Integrated IPM.MSU.edu/download, chapter I pdf, 2015). Weeden, Shelton, and Hoffman (2008) explain that the objective of IPM is to reduce pest populations using multiple tactics. Through such, the chances that a particular pest will adapt to any one of the tactics are minimized. Through the integration of various control methods, the need for chemical control can be aptly reduced. Hence, this study was conducted to determine pest incidence in

sweet pepper, finger pepper, and tomato, following various planting dates, and to compare the yield and economics of producingsolanaceous vegetables planted at different dates using IPM and FP.

Methodology

The study was conducted at the Mariano Marcos State University Experimental farm following the different planting dates for tomato, (Ilocos Red, MMSU Tomato Hybrid 1), sweet pepper (All Season), and finger pepper (Bontoc) based on the survey conducted on farmers growing vegetables in 10 rainfed-lowland areas in Ilocos Norte (Lutap and Atis, 2003). The different planting dates include: early planting (August–September), regular planting (October–November), and late planting (February-March). For each planting date, two approaches were used – the IPM and THEFP. Data sets WERE analyzed separately for each crop using 3x2 factorial in a Randomized Complete Block Design.

Treatments

Planting Schedule	**Planting Dates**
Early Planting: August- September Regular Planting: October- November Late Planting: February- March	August 28, 2006 November 9, 2006 February 7, 2007
Approaches: **<u>Integrated Pest Management (IPM)</u>** **Planting distance:** Sweet pepper: 0.75 m x 0.40 m (All Season Variety) Finger pepper: 0.75 m x 0.40 m (Bontoc) Tomato:1.0 m x 0.40 m (Ilocos Red regular planting) and (MMSU Hybrid 1 -early planting)	**<u>Farmers' Practice (FP)</u>** **Planting distance:** Sweet pepper: 0.75 m x 0.40 m (All Season Variety) Finger pepper: 0.75 m x 0.40 m (Bontoc) Tomato: 1.0 m x 0.40 m (Ilocos Red- regular planting) and (MMSU Hybrid 1-early planting)

Treatments cont….

Fertilization Tomato: 170-130-195 NPK kg/ha +organic fertilizer (30 bags per ha) Sweet & Finger Pepper: 140-50-50 NPK kg/ha + organic fertilizer (30 bags per ha)	**Fertilization** Tomato: 200-190-100 NPK kg/ha Sweet & Finger pepper: 400-150-150 NPK kg/ha
Pest Control Based on observation during the regular field visits and weekly monitoring • Biological control (BT): for tomato fruitworm applied at vegetative, flowering and early fruiting stages • Bait/Attractants (methyl eugenol) for fruitfly applied at early fruiting stage • Yellow and blue sticky traps for aphids, thrips and epilachna beetles • Barrier crop (glutinous corn planted around IPM plots) • Sanitation (rouging) of diseased infected plants • Detergent soap as spray for whitefly and other soft-bodied insect pests attacking finger and sweet pepper	**Pest control (based on calendar spraying)** This is done by: • Weekly spraying of insecticides from vegetative to flowering stages and bi-weekly at fruiting stage. Insecticides used were carbaryl, methomyl, deltamethrin, and profenofos

Population count of insect pests and natural enemies was done weekly on 20 randomly-selected sample plants through visual counting starting three weeks after transplanting. Damaged plants were also recorded using a rating scale. Agronomic, yield, and yield components including cost and return analysis, as well as weather data were also taken during the growing period of the plants.

All other cultural practices like irrigation and weeding were followed to ensure normal plant growth and development.

Results and Discussion

Insect Pests and Natural Enemies

Insect Pests

A. Sweet Pepper

The most common insect pests observed in sweet pepper were white flies that belong to family Aleyrodidae, aphids (Aphididae), and cutworms (S. litura). Significant differences in terms of their incidence was noted among the various planting dates (Table 1). Interaction

effects were noted between the management approaches and the planting dates on the incidence of whiteflies but not of aphids and cutworms. High population of white flies was particularly observed during late planting. Their incidence was higher in FP than those in IPM plots (Figure 1). Aphid colonies were most prevalent during early planting while cutworms were observed during regular planting.

B. Finger Pepper

White flies, aphids, and cutworms were the most common insect pests observed in finger pepper. Significant differences were likewise noted with whiteflies being the most populous across all planting dates and schedule in both IPM and FP plots (Table 2 & Figures 2-4). Moreover, aphid colonies were observed during early and late planting at early

Table 1. Common pests observed in sweet pepper at different planting dates using IPM and FP approaches.

TREATMENT	PEST		
	White Fly	Aphid (Colony)	Cutworm
Treatment			
Planting Date (A)	**	**	**
Early	4.17	5.33a	0.76b
Regular	12.17	2.50b	3.67a
Late	319.83	2.00b	0.71b
Pest Control Approaches (B)	**	ns	ns
IPM	44.22	2.89	1.70
FP	179.89	3.67	1.73
A:B	**	ns	ns
CV (%)	15.27	37.64	14.67

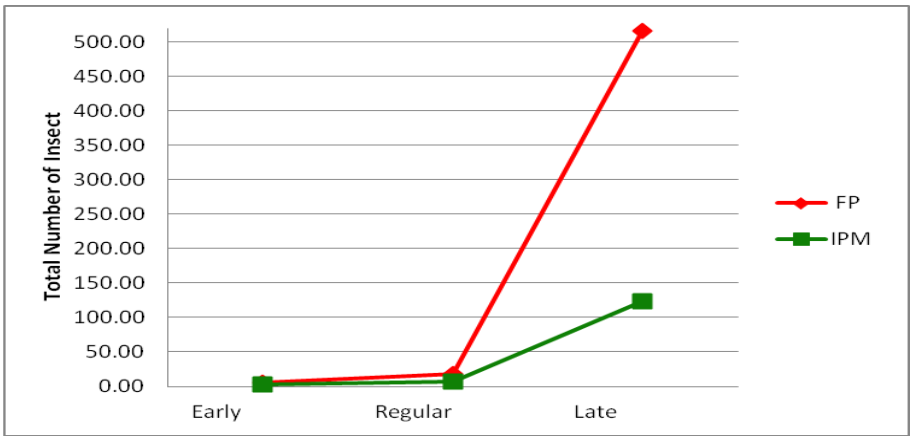

Fig. 1. Interactions effect of the different sweet pepper planting dates and pest control approaches done on whiteflies.

growth stages of the plants but more colonies were noted in IPM plots. Meanwhile, cutworms were exclusively evident during regular planting, but their incidence was negligible.

Additionally, significant interaction was noted between planting dates and approaches, wherein high incidence of whiteflies and aphids was observed during late planting.

Furthermore, leaf curling in pepper was noted in both IPM and FP plots (Figure 5). Curling was more visible during late planting than either during early or regular planting. Higher incidence of leaf curl was observed in FP plots, which can be attributed to the higher whitefly population during late planting in FP plots. Whiteflies are viral-disease vectors whose symptom is leaf curling.

C. Tomato

Incidence of pests and natural enemies on tomato among the different planting dates was only gathered during early and regular planting. Since tomato was planted late, the plants were not able to tolerate the severe infestation of whiteflies that caused leaf curling and drying during the first month of growth. In addition to white flies, Epilachna beetle (*E. vigintioctopunctata* F.), capsid bugs

Table 2. Common pests observed in finger pepper at different planting dates using

	PEST		
	White Fly	Aphid	Cutworm
Planting Date (A)	**	**	**
Early	3.12	2.84	0.76
Regular	3.00	0.71	2.79
Late	432.00	8.00	0.91
Pest Control Approach (B)	**	**	**
IPM	112.75	4.79	1.94
FP	179.33	2.90	1.03
A:B	**	*	**
CV (%)	10.85	24.96	37.03

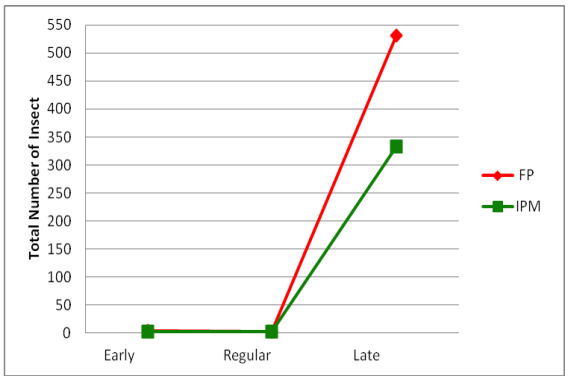

Fig. 2. Interaction effects of the different finger pepper planting dates and pest control approaches on the number of whiteflies.

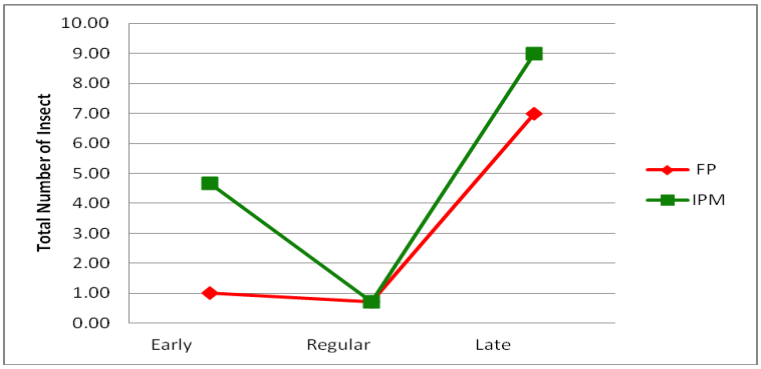

Fig. 3. Interaction effects of the different finger pepper planting dates and pest control approaches on the number of aphid colonies.

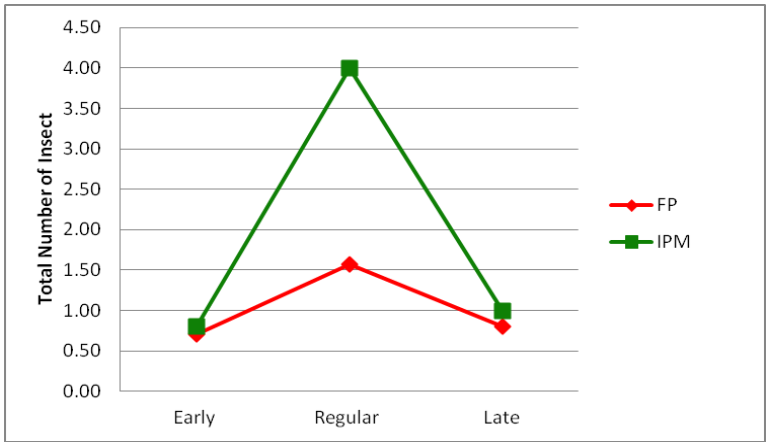

Fig. 4. Interaction effect of the different finger pepper planting dates and pest control approaches on the number of cutworms.

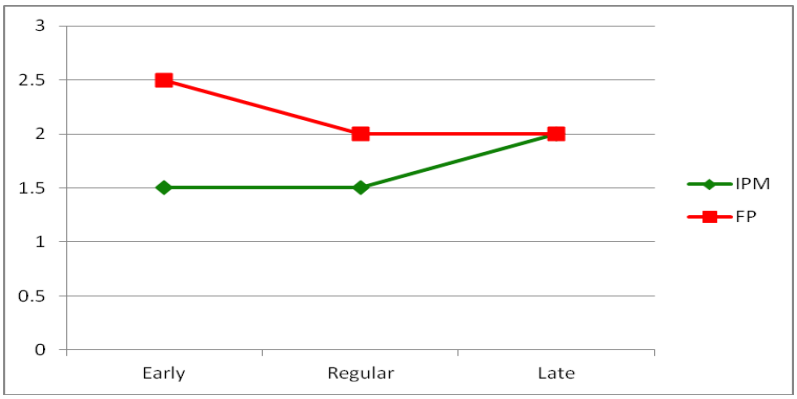

Fig. 5. Leaf curl observed in finger pepper at different planting dates in IPM and FP plots.

(Family *Miridae*), and cutworms (*S. litura*) were the most commonly observed insect pests under early and regular planting schedule. However, significant differences in terms of population were noted across the planting dates in IPM and FP plots. High population of whiteflies and fruitworm was noted under regular in FP plots, while Epilachna was more visible under regular planting in IPM plots. In contrast, capsid bugs were more visible under early planting (Table 3). In terms of the interaction effects, the incidence of pests like whiteflies, fruitworm, and epilachna was affected by planting dates. That trend was evident under regular planting in FP plots (Figures 6-8).

Natural Enemies

Insects, in nature, are plagued by numerous living organisms that feed upon them. These are called natural enemies and are of great value to vegetable growers. Care is needed in allowing them to thrive whenever possible. Many of the natural enemies look like vegetable insect pests; and they should not be mistaken as harmful insects. The most common natural enemies observed in all the crops planted were spiders, coccinelids, and wasps. However, their incidence varied across the different planting dates in IPM and FP plots.

A. Sweet Pepper

Species of spiders belonging to families *Lycosidae* and *Salticidae* were the most commonly observed natural enemies across all the planting dates. Those were followed by coccinelids (*Coccinelidae*); while the least include wasps belonging to families *Broconidae* and *Ichuemonidae* (Table 4 & Figure 9).

The incidence of natural enemies, particularly, coccinelids, was higher in IPM plots than in FP plots.

The common practice of regularly spraying chemicals among farmers could destroy the population of natural enemies, because of their sensitiveness to chemical spray.

Table 3. Common pests observed in tomato at different planting dates using IPM and Farmer's Practice.

	PEST			
	White FlY	Fruit Worm	Capsid Bug	Epilachna Beetle
Planting Date (A)	**	**	**	**
Early	7.00	0.81	13.67a	3.17
Regular	32.34	28.50	4.17b	23.5
Pest Control Approach (B)	**	**	*	**
IPM	6.50	11.79	11.00a	22.00
FP	32.84	17.52	6.83b	4.67
A:B	**	**	ns	**
CV (%)	17.96	15.77	28.65	19.24

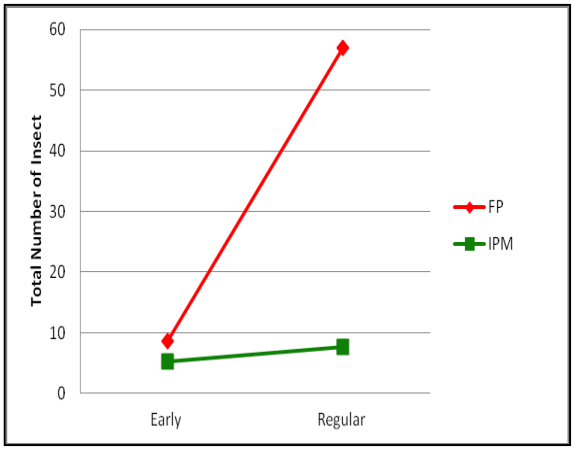

Fig.6. Interaction effects of the different tomato planting dates and pest control approaches on the number of whiteflies.

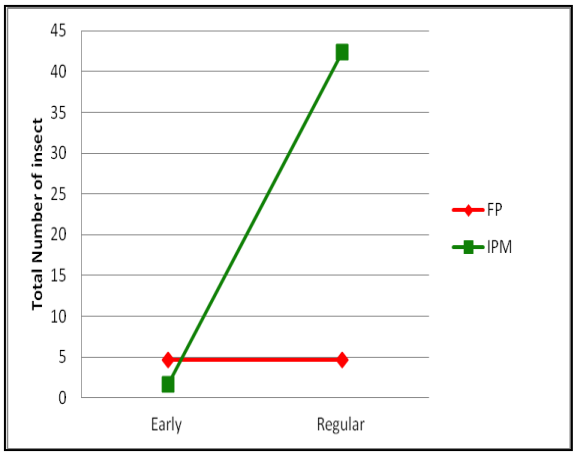

Fig.8. Interaction effects of the different tomato planting dates and pest control approaches on the number of epilachna beetle.

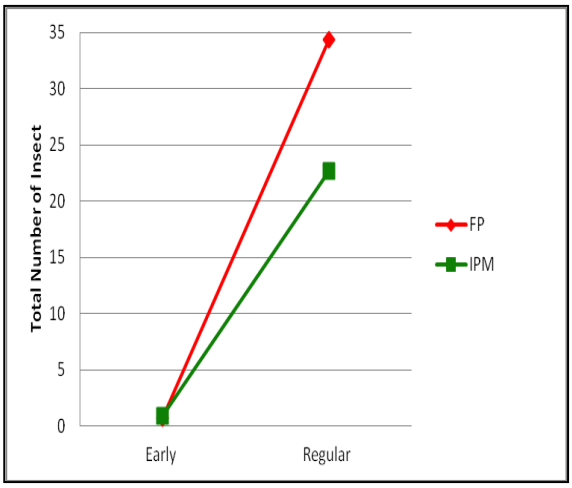

Fig.7. Interaction effects of the different tomato planting dates and pest control approaches on the number of fruit worm.

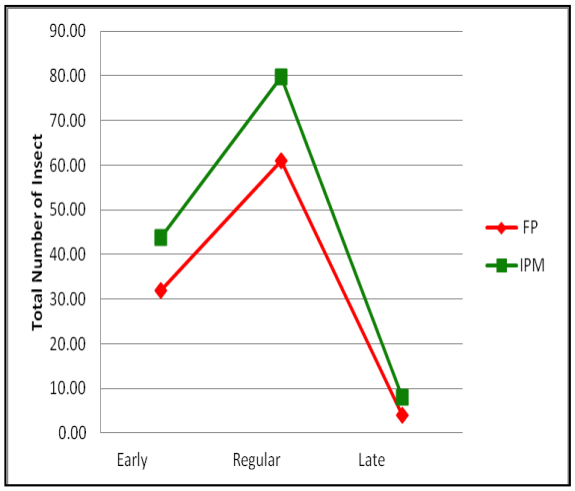

Fig. 9. Interaction effects of the different sweet pepper planting dates and pest control approaches on the number of coccenelid beetles.

B. Finger Pepper

The natural enemies in sweet pepper were the same as those in finger pepper (Table 5). Spiders and coccinelid beetles were the most prevalent natural enemies throughout the growth and development of the crop. Wasp incidence, however, was negligible. In terms of the interaction effects, a higher incidence of natural enemies was likewise observed in IPM plots than in FP plots regardless of planting dates (Figures 10 and11).

Table 4. Incidence of natural enemies in sweet pepper at different planting dates using IPM and FP.

	NATURAL ENEMY		
	Spider	Coccinelid	Wasp
Planting Date(A)	**	**	ns
Early	24.83b	37.83	0.76
Regular	26.50	70.34	2.29
Late	43.50a	6.00	0.72
Pest Control Approach (B)	**	**	ns
IPM	43.00a	43.78	1.57
FP	20.22b	32.33	0.94
A:B	ns	**	ns
CV (%)	24.28	11.21	23.53

Table 5. Incidence of natural enemies in finger pepper at different planting dates using IPM and FP.

	NATURAL ENEMY		
	Spider	Coccinelid beetle	Wasp
Planting Dates (A)	**	**	*
Early	20.00a	35.00	0.93
Regular	15.83a	38.84	1.40
Late	11.33b	5.00	2.19
Approach (B)	**	**	ns
IPM	21.89a	33.78	1.87
FP	9.56b	18.78	1.14
Practices: Planting Dates	ns	**	**
CV (%)	21.96	21.64	15.16

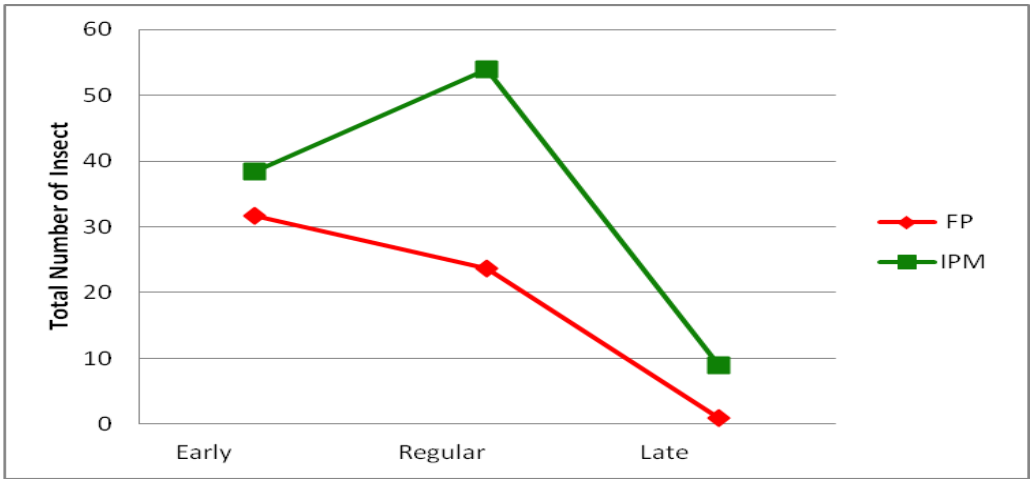

Fig. 10. Interaction effect of the different finger pepper planting dates and pest control approaches on the number of coccinelid beetles.

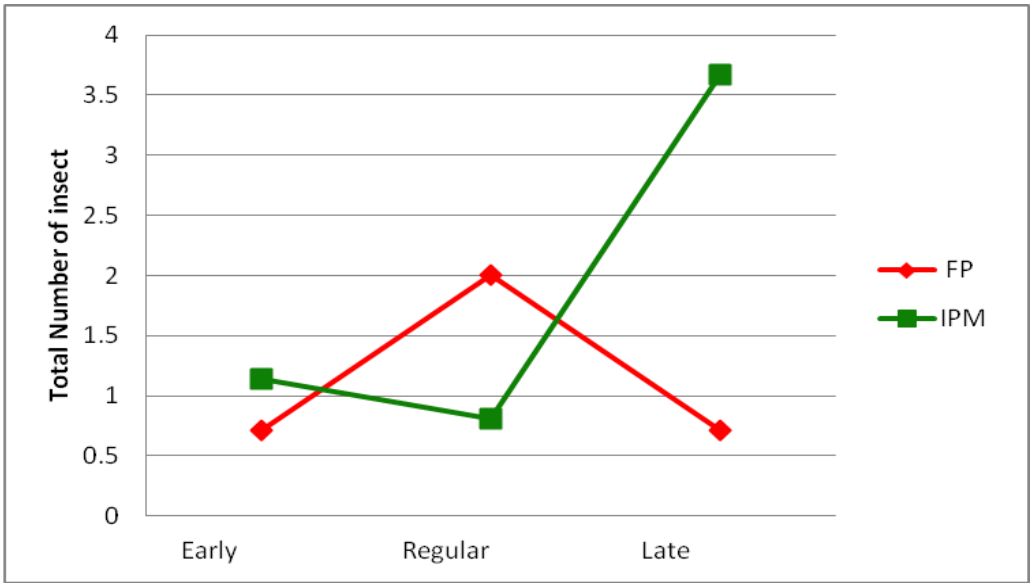

Fig. 11. Interaction effect of the different finger pepper planting dates and pest control approaches on the number of wasp.

C. Tomato

Spiders, coccinelid beetles, and wasps were observed in tomato under early and regular planting schedules (Table 6). Significant interaction was noted on the incidence of spiders and wasps, particularly in IPM plots established during regular planting (Figures 12 and 13), however, coccinelid beetle incidence was high during regular planting regardless of the pest control approach followed.

On the whole, natural enemies incidence was higher in IPM plots than in FP plots where the different crops were planted. Their incidence was high during regular planting. That trend was followed by those established during the early and late planting schedule. Aside from the three commonly observed natural enemies, spiders, coccinellid beetles, wasps, syrphid flies, predatory bugs, damselflies longhorn grasshoppers, and metioches were also noted; their incidence though was minimal.

Natural enemies are beneficial to farmers because they prey, suck, and pierce the eggs, larvae, and adults of harmful insects present in the field. Excessive and misuse of pesticides can kill these natural enemies.

Damage symptoms of insect pests and diseases

Symptoms and damages caused by insect pests and diseases were observed at different planting dates among the various crops (Table 7). Aborted flowers were also noted but they were only noticeable among crops, which were planted late.

Meanwhile, sunscald and fruit scars caused by thrips were common at early and regular planting, while fruitfly infestation was severe at late planting, both in IPM and FP plots. There were no sunscald and fruit scars during late planting because the fruits were harvested mature green. For tomato, moderate to severe infestation of mosaic symptoms of the leaves was observed at early planting both in IPM and FP plots. On the other hand, light and negligible infestation was observed in plants established during regular planting schedule. However, damaged fruits caused by fruit worm were more visible under the same planting schedule.

Table 6. Incidence of enemies in tomato at different planting dates using IPM and FP.

	NATURAL ENEMY		
	Spider	Coccinelid	Wasp
Planting Dates (A)	**	**	**
Early	11.67	0.81b	0.71
Regular	33.84	10.17a	2.34
Approach (B)	**	ns	**
IPM	34.17	3.52	2.19
FP	11.34	7.45	0.86
A:B	*	ns	**
CV (%)	21.60	17.89	5.29

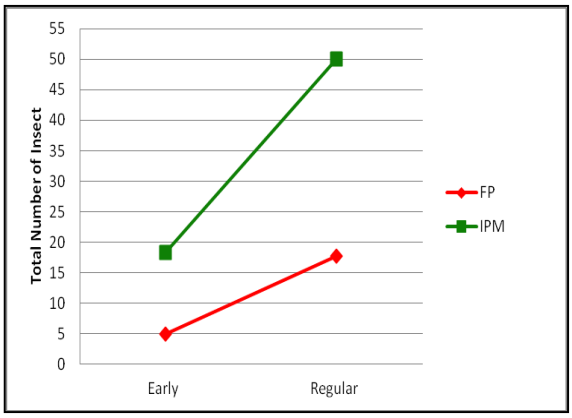

Fig 12. Interaction effects of the different tomato planting dates and pest control approaches on the number of spiders.

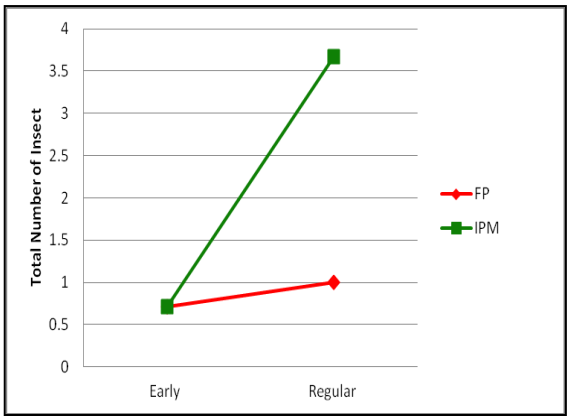

Fig 13. Interaction effect of the different tomato planting dates and pest control approach on the number of wasps.

Table 7. Damage symptoms observed in sweet pepper, finger pepper and tomato

PLANTING DATES	SWEET PEPPER				FINGER PEPPER		TOMATO	
	Aborted Flowers	Scald	Scars	Fruit fly damage	Aborted flowers	Scars	Mosaic	Fruit worm damage
IPM								
Early	1	2	1.5	2	1	1	2.5	1
Regular	1	1	1.5	1	1	1	1	1.5
Late	3	0	0	3	2	1	-	-
FP								
Early	1	2	2	2	1	1	2.5	1
Regular	1	1	2	1	1	2	1	1.5
Late	3	0	0	3	2	2	-	-

Degree of Plant Damage:

Rating:
0 – No damage
1 – 5-10% damaged leaf/fruit area
3 – 11-25% damaged leaf/fruit area
5 – 26-50% damaged leaf/fruit area
7 – 51-75% damaged leaf/fruit area
9 – 76-100% damaged leaf/fruit area

Plant Description:
Clear
Slight damage
Moderate damage
High damage
Very high damage
Severe damage

Agronomic Characteristics, Yield and Yield Components

A. Sweet Pepper

Plant height, fruit size of sweet pepper

Significant differences were observed in terms of plant height and fruit size (fruit length and diameter) of sweet pepper planted in different schedules. Sweet pepper established during the regular planting produced the tallest (57.13 cm) and those established during late planting had the shortest (49.47 cm) (Table 8). The same trend was observed in terms of fruit size. Longest fruits (7.64 cm) were produced from those established during regular planting, while the shortest (3.54 cm) ones were produced by those under late planting. Similarly, widest fruits (6.44 cm) were produced from those established during regular planting, while the broadest fruits (3.77 cm) were recorded by those planted late. Nevertheless, no significant differences were observed in terms of plant height, fruit length, and fruit diameter using either IPM or FP approaches.

Interaction effect between planting date and pest management approach was significant in terms of plant height and fruit length. Under the IPM approach, plant height was not affected by planting date. However, shorter plants were produced in FP plots established during late planting. On the other hand, longer fruits were produced by plants established during regular schedule under the IPM approach. In FP plots, fruit length was comparable between those planted during early and regular schedule, while fruits produced by plants that were established late, were significantly shorter (Figures 14a and 14b).

Table 8. Plant height, fruit length and fruit diameter of sweet pepper planted at different dates using IPM and FP approaches.

TREATMENT	PLANT HEIGHT (cm)	FRUIT LENGTH (cm)	FRUIT DIAMETER (cm)
Planting Date (A)	**	**	**
Early	53.87b	5.57b	5.59b
Regular	57.13a	7.64a	6.44a
Late	49.47c	3.54c	3.77c
Approach (B)	ns	ns	ns
IPM	54.77	5.87	5.41
FP	52.21	5.29	5.13
AxB	*	*	ns

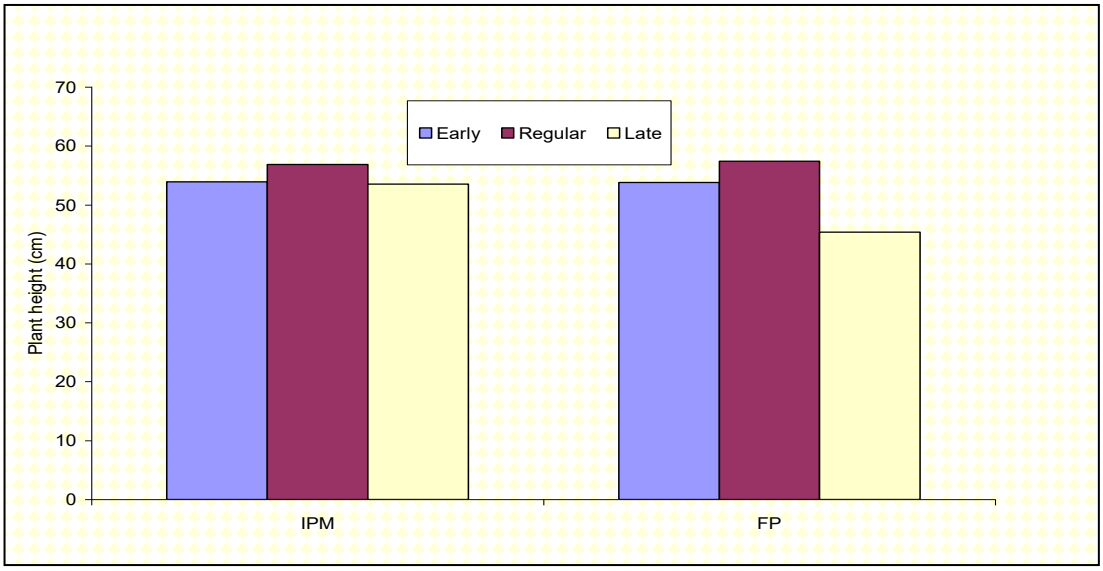

Fig. 14a. Interaction effects of the different planting dates and pest management approaches on the plant height of sweet pepper.

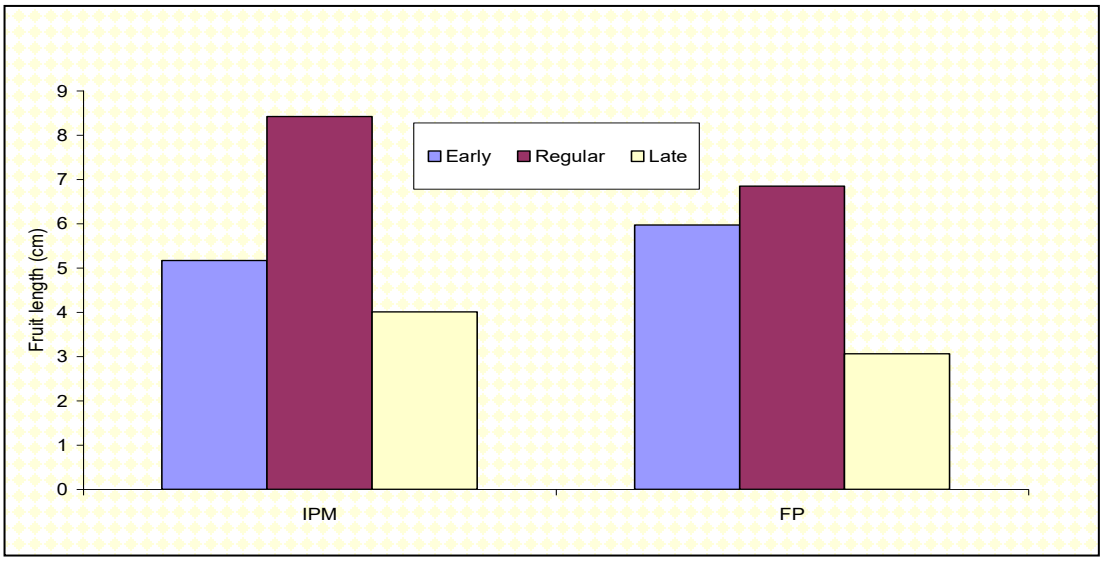

Fig. 14b. Interaction effects of the different planting dates and pest management approaches on the fruit length of sweet pepper.

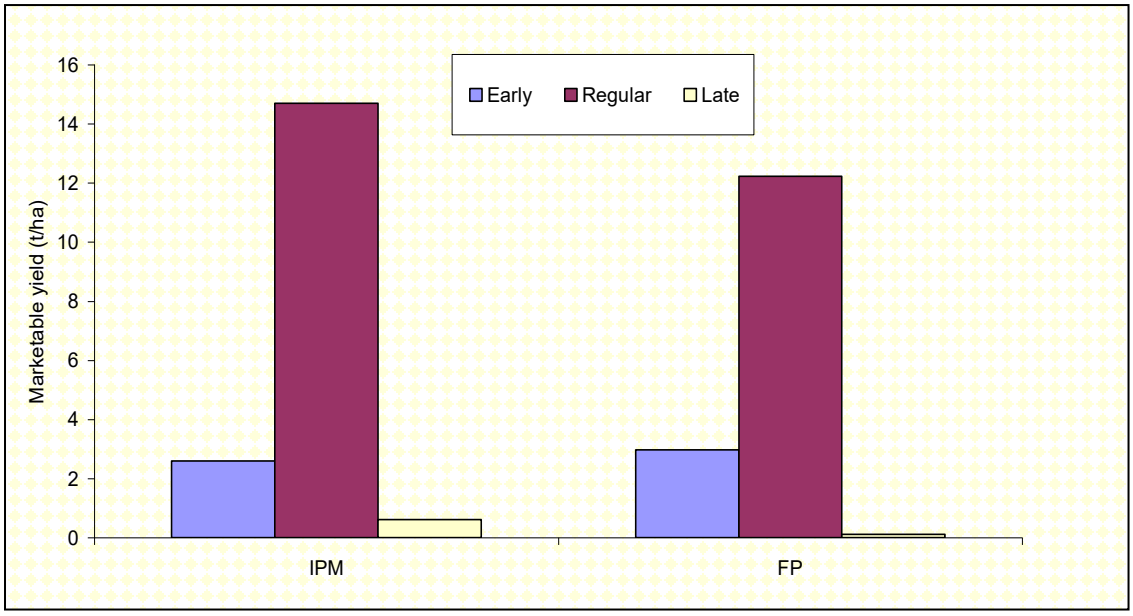

Fig. 15a. Interaction effect of the different planting dates and approaches on the marketable yield of sweet pepper.

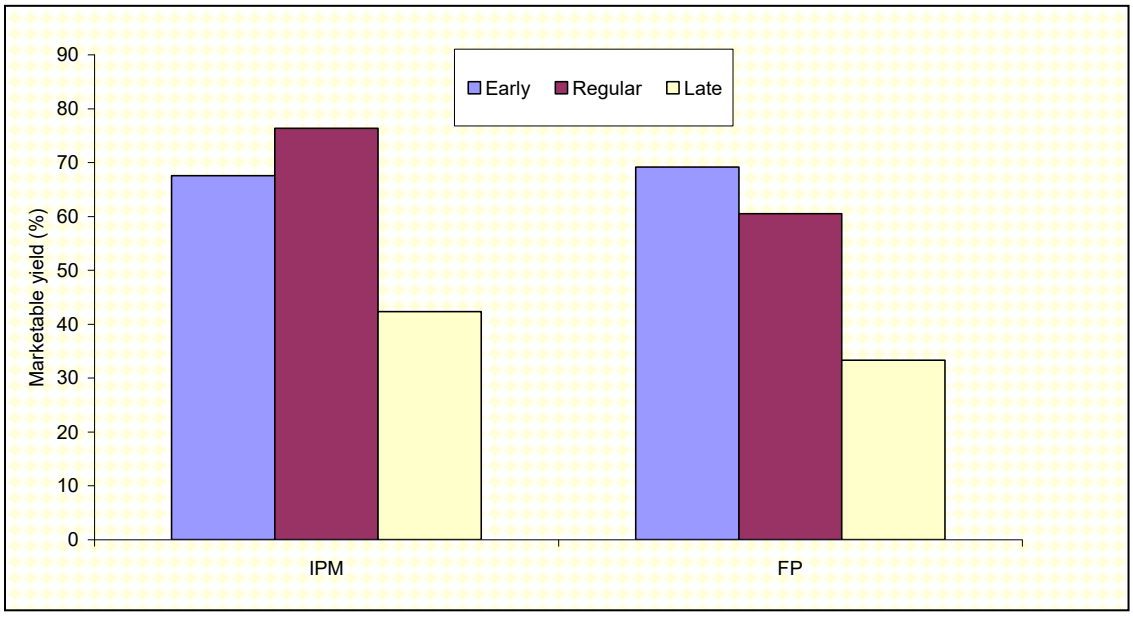

Fig. 15b. Interaction effect of the different planting dates and approaches on the percent marketable yield of sweet pepper.

B. Finger Pepper

Plant height, yield, and yield components of finger pepper

Significant differences in terms of plant height, number of fruits per kg, total yield, marketable yield, and percent marketable yield were observed in finger pepper when planted at different dates (Table 10). Taller plants were observed from those established during early planting followed by those planted during regular schedule. Meanwhile, shortest plants were those established late. More fruits were produced by those planted earlier than from those produced by those established during regular schedule. Similarly, the least number of fruits per kg was noted from those planted during the regular schedule.

Surprisingly, the plants with highest total yield, marketable yield, and percent marketable yield were those established late.

In terms of the interaction effects on percent marketable yield, the yield of plants under the IPM approach was not affected by the planting date. Nevertheless, those plants established later under the IPM approach had higher marketable yield than those planted in FP plots across the different planting dates (Figure 16).

Table 10. Plant height, number of fruits per kg, total yield, marketable yield and percent marketable yield of finger pepper planted at different dates using IPM and farmer's practice approaches.

TREATMENT	PLANT HEIGHT (cm)	NO. OF FRUITS/ KG	TOTAL YIELD (t ha $^{-1}$)	MARKETABLE YIELD (t ha $^{-1}$)	PERCENT MARKETABLE YIELD
Planting Date (A)	**	**	**	**	**
Early	69.73a	194.3a	20.90b	20.57b	87.5b
Regular	55.60b	106.3c	23.57b	22.03b	87.5b
Late	49.03c	146.0b	38.32a	37.50a	94.7a
Approach (B)	ns	ns	ns	ns	**
IPM	56.93	149.3	29.52	28.46	93.9a
FP	57.98	148.4	25.67	24.94	85.95b
AxB	*	ns	ns	ns	**

Means followed by a common letter are not significantly different at 5% level using DMRT.

C. Tomato

Plant height, fruit size and number of fruits per kg in tomato

No significant differences were observed in terms of tomato fruit size and number of fruits per kg in both IPM and FP plots (Table 11). In terms of plant height, however, those planted in IPM plots were taller (104.20cm) than those in FP plots (98.67cm), particularly those established earlier. During regular planting, taller plants were observed in the FP plots.

Table 11. Plant height, fruit size (length and diameter) and number of fruits per kilo of tomato planted at different dates using IPM and FP.

PLANTING DATE/ MANAGEMENT APPROACH	PLANT HEIGHT (75DAP)	FRUIT LENGTH (cm)	DIAMETER (cm)	NO. OF FRUITS PER KILO
EARLY	*	ns	ns	ns
IPM	104.20a	1.97	4.48	29
FP	98.67b	1.37	3.97	30
CV (%)	20.0	1.5	2.4	24.0
REGULAR	*	ns	ns	ns
IPM	92.67b	4.98	5.24	15
FP	94.00a	4.64	4.85	14
CV (%)	15.0	5.2	3.6	6.0

Means followed by a common letter are not significantly different at 5% level using DMRT.

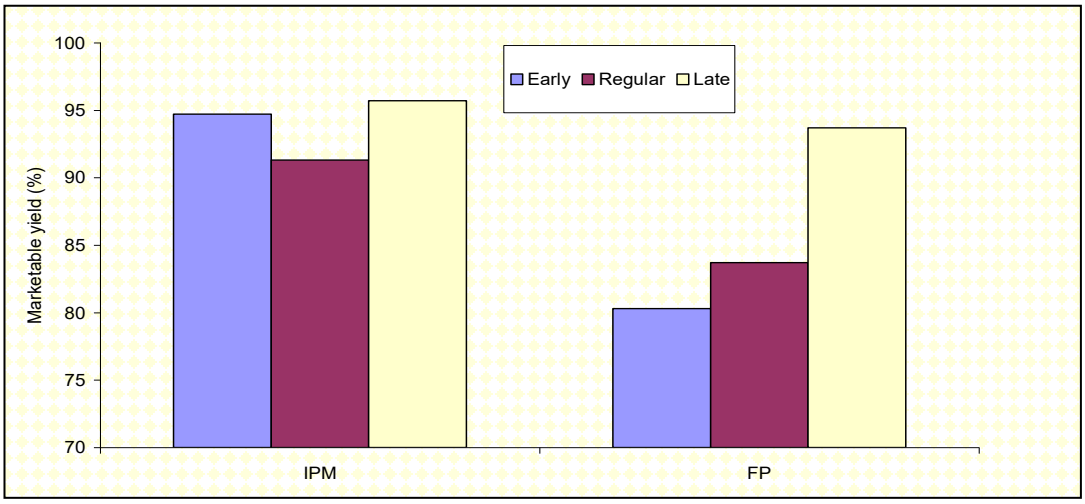

Fig. 16. Interaction effect of the different planting dates and pest management approaches on the percent marketable yield of finger pepper.

Yield and yield components

Higher percent marketable, marketable yield (t ha $^{-1}$), and total yield were obtained in IPM plots (Table 12). These were attributed to longer harvesting in IPM plots than in FP plots. Under the IPM approach, using organic fertilizer is encouraged, because it contributes to longer harvesting period. The slow release of nutrients from organic fertilizers sustains the plants and prolongs their vigor.

Weather data

Sets of weather data, especially on moisture and temperature, were also considered because they affect development of plants and the incidence of insects and diseases. In fact, pest incidence was higher during late planting. Specifically, the increase in temperature from early to late planting favored the prevalence of whiteflies and aphids (Tables 13-15).

The body temperature of most insects is linked to changes in ambient temperature. Physiological temperature range within the species determines the metabolism rate, as well as growth and development, and often exerts other physiological effects. Most insect pests develop rapidly in warm temperature.

Cost and Return Analysis

As shown in Table 16, early planting of sweet pepper was highly profitable using either IPM and FP, with a net return per peso invested at P1.93 – P1.96. Despite the low yield obtained, which was usually due to the heavy rainfall and typhoons during the conduct of the study, high income could still be obtained because of the very high prevailing price. In contrast, much higher yields were obtained at regular planting but data the two approaches, IPM could still give a net return per peso invested at P0.15. With FP, on the other hand, there was a loss

Table 12. Yield and yield components of tomato planted at different dates using IPM and FP.

PLANTING DATE/ MANAGEMENT APPROACH	PERCENT MARKETABLE	MARKETABLE (t ha $^{-1}$)	TOTAL YIELD (t ha $^{-1}$)
Early	*	*	*
IPM	89.00a	15.88a	17.48a
FP	87.43b	10.84b	12.38b
CV (%)	14.50	1.75	1.72
Regular	*	*	ns
IPM	89.50a	57.23a	62.17a
FP	80.23b	52.57b	60.43a
CV (%)	4.05	4.0	3.5

Means followed by a common letter are not significantly different at 5% level using DMRT

Table 13. Weather data taken at MMSU PAG-ASA Station during early planting from August to December 2006.

Month	Total Rainfall (mm)	Temperature (°C)		Relative Humidity (%)	Total Bright Sunshine (min.)
		Max.	Min.		
August	7.6	31.7	24.4	85	282
September	12.7	32	24.1	85	383
October	1.2	32.6	22.2	86	419
November	2.0	33.2	22.3	85	488
December	0	32.3	20.7	80	411
Mean	4.7	32.0	22.7	84.2	396.6

Table 14. Weather data taken at MMSU PAG-ASA Station during regular planting from October to February 2006-2007.

Month	Total Rainfall (mm)	Temperature (°C)		Relative Humidity (%)	Total Bright Sunshine (min.)
		Max.	Min.		
October	1.2	32.6	22.2	86	419
November	2.0	33.2	22.3	85	488
December	0	32.3	20.7	80	411
January	0.5	32.3	19.3	83	510
February	0.2	32.1	18.3	84	518
Mean	3.9	32.5	20.56	83.6	469.2

Table 15. Weather data taken at MMSU PAG-ASA Station during Late Planting from January to May 2007.

Month	Total Rainfall (mm)	Temperature (°C)		Relative Humidity (%)	Total Bright Sunshine (min.)
		Max.	Min.		
January	0.5	32.3	19.3	83	510
February	0.2	32.1	18.3	84	518
March	3.0	33.0	21.1	84	502
April	0	34.6	23.1	75	611
May	4.3	35.1	24.0	74	516
Mean	8	33.42	21.1	80	531.4

of P0.12 per peso invested particularly when sweet pepper was planted during the regular season. Meanwhile, late planting was not practical because of the very high loss that could be incurred, following either IPM or FP.

Regardless of the date of planting, a higher net income was obtained on finger pepper following the IPM (Table 17).

A higher net income, however, was obtained when the crop was planted early due to the prevailing high price during that period.

Similar trend was evident in producing tomato wherein net income was higher under the IPM approach than under the FP. Late planting for tomato was not practical because there were severe white flies infestations and viral infestation symptoms (Table 18).

Similarly, late planting of sweet pepper and tomato was not practical, because aside from pest infestation, the plants were affected by unpredictable weather conditions like rainfall at the later stages of crop growth, which led to aborted flowers and premature fruit droppings.

On the whole, the findings suggest that following IPM is more practical and profitable than that of the usual FP, particularly in controlling the pests attacking the crops. Consequently, higher yield and net income were obtained using the IPM approach. In addition, improper use of pesticides could be avoided, which may cause pest resurgence and environmental hazard.

Further, the results show that the accompanying risks of early planting could be commensurated by the higher net income obtained. Normally, only few farmers are willing to risk possible crop failure due to heavy rainfall and typhoons that could reduce supply and lead to higher prices.

Conclusions and Recommendations

Incidence of pests was very high in plants established late, while incidence of natural enemies was high in plants established during regular schedule.

Further, pest incidence was higher in FP plots, while natural enemies incidence was higher in IPM plots across all the different planting dates. Whitefly (under family *Aleyrodidae*) was the most prevalent pest observed both in IPM and FP plots. Meanwhile, various species of spiders (under families *Lycosidae* and *Salticidae*), C*occinelidae* beetles, and wasps (under the families *Icheumonidae* and *Brachonidae*) were the most apparent natural enemies.

Moreover, early planting of sweet and finger pepper using IPM was more profitable. Likewise, early planting of tomato following the IPM was highly profitable, particularly when using the MMSU Hybrid.

In addition, late planting was impractical for sweet pepper and tomato because unpredictable weather conditions, which could lead to flower abortion and fruit droppings, are risky. Shorter sweet pepper was observed in FP plots, which were established late.

Table 16. Cost and return analysis of sweet pepper production at different planting dates using IPM and FP.

ITEM	EARLY PLANTING		REGULAR PLANTING		LATE PLANTING	
	IPM	FP	IPM	FP	IPM	FP
A. Cost of Production						
a. Labor	39,784	40,714	45,625	44,993	31,114	39,412
b. Material Cost	17,857	24,524	17,857	24,524	17,857	24,524
B. Total Cost of Production	57,641	65,238	63,482	69,517	48,971	63,936
C. Yield (T Ha^{-1})	2.6	2.97	14.7	12.23	0.61	0.11
D. Gross Income	169,000	193,050	147000	122,300	15,250	2,750
E. Net Income	111,359	127,812	83,518	52,783	(-33,721)	(-61,186)
F. Return Per Peso Invested	1.93	1.96	1.32	.76	(-0.69)	(-0.96)

PRICE: Early planting – P30/kg Regular planting – P15/kg Late planting – P20/kg

Table 17. Cost and return analysis for finger pepper production at different planting dates using IPM and FP.

ITEM	EARLY PLANTING		REGULAR PLANTING		LATE PLANTING	
	IPM	FP	IPM	FP	IPM	FP
A. Cost of Production						
a. Labor	44,323	44,620	44,452	44,918	43,876	44,174
b. Material Cost	13,333	24,524	13,333	245,234	13,333	24,524
B. Total Cost Of Production	57,656	69,144	57,785	290,152	57,209	68,698
C. Yield (T Ha^{-1})	20.84	20.3	25.87	20.2	38.57	36.33
D. Gross Income	625,200	609,000	388,050	303,000	771,400	726,600
E. Net Income	567,544	539,856	330,265	12,848	714,191	657,902
F. Return Per Peso Invested	9.84	7.81	5.72	0.04	12.48	9.58

PRICE: Early planting – P65/kg Regular planting – P10/kg Late planting – P25/kg

Table 18. Cost and return analysis of tomato production at different planting dates using IPM and FP.

ITEM	EARLY PLANTING		REGULAR PLANTING		LATE PLANTING	
	IPM	FP	IPM	FP	IPM	FP
A. Cost of Production						
a. Labor	39,858	38,817	48,899	46,852	-	-
b. Material Cost	17,857	24,524	17,857	24,524	-	-
B. Total Cost of Production	57,715	63,340	66,756	71,346	-	-
C. Yield (T Ha^{-1})	15.88	10.84	57.23	52.57	-	-
D. Gross Income	635,200	433,600	1,144,600	1,051,400	-	-
E. Net Income	577,485	370,260	1,077,844	980,054	-	-
F. Return Per Peso Invested	10.01	5.85	16.15	13.74	-	-

PRICE: Early planting – P40/kg Regular planting – P20/kg

On the whole, following IPM was more economical, profitable, and practical than the usual FP. Through IPM, pesticide use is likewise minimized, which reduces possibilities of contamination and environmental damage.

Using the different pest management strategies effectively requires farmers to consider long-term effects of traditional pest control measures rather than their conveniences and short-term benefits.

Acknowledgement

The authors extend their gratitude to the Research Directorate, Mariano Marcos State University for the financial and other support as well as the farmer-respondents who unselfishly shared their time and fully cooperated during the conduct of the study.

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MMSU Science and Technology Journal
Vol. 3 No. 2 | July-December 2013

ISSN: 2012 0060

VARIABLITY OF RAINFALL AND TEMPERATURE IN ILOCOS NORTE, PHILIPPINES

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Abstract

Rainfall and temperature variability in the Philippines had been holistically studied, but the extent of this phenomenon has not been explored in specific localities. As such, available daily data on rainfall and air temperature for the past 35 years (1976-2010) were taken from the MMSU-PAGASA Agrometeorological Station in Batac City, Ilocos Norte, and the cyclone data in the last 30 years from the Synoptic Station in Laoag City, Ilocos Norte were analyzed. Results of the analysis could provide local decision-makers with the needed information and tools to manage or mitigate the risks brought about by changes in weather.

It was found that annual temperature increased from 27.1° C to 27.3°C, which deviated from the normal-base period. Moreover, the annual rainfall trend varied, but the monthly pattern significantly changed, and the maximum rainfall slightly changed. On the other hand, the number and intensity of tropical cyclone increased annually and deviated from the normal. Likewise, monthly trend and intensity remarkably changed. Based on these results, appropriate cropping calendars suitable to a given agro-ecological zone were developed.

Keywords: ***cropping calendar, Ilocos Norte, rainfall, temperature***

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Introduction

Due to the current changes of weather patterns leading to either insufficient or excessive rainfall, as well as natural disasters such as flood and drought, tremendous crop losses have become apparent and should be vigorously addressed.

A recent study result reported that extreme precipitation has been increasing as the globe warms. According to Brian Soden (2000) of the University of Miami, a warmer atmosphere contains more moisture, which boosts the intensity of rainfall. In fact, an increase in the number of cyclones and hurricanes over the past few years has been attributed to changes in temperature. Global temperatures have risen by over 0.7^{o}C in the last 100 years and eleven of the last 12 years (1995-2006) recorded the warmest.

Climate change could result in a variety of effects on agriculture. Some of which include changes in production patterns due to higher air temperature, and changes in precipitation patterns. Plants need varying amounts of rainfall to survive. However, too much or too little rainfall can be harmful or even devastating to crops. Drought can kill crops in massive numbers, while overly wet weather leads to the occurrence of diseases and harmful fungi. Parasites, diseases, fungi, and other pests tend to thrive and spread more rapaciously in warmer and more humid climates. On the other hand, Erik Runkle (2000) of Michigan State University reported that temperature is the primary factor that controls plant development. Generally, the warmer the temperature is, the faster a plant grows. Also, air temperature regulates most plant processes, i.e. germination, flowering, photosynthesis, transpiration, respiration, etc. Photosynthesis and respiration of plants and microbes increase with temperature, especially in temperate latitudes (*http://www.fao.org*). Forecast changes in temperature and rainfall are likely to reduce overall crop yields and increase eventually the risk of hunger. In 2009, Carina Galvez Lao of Philippine Atmospheric Geophysical and Astronomical Services Administration reported that rice yields are declining by as much as 10% for every degree Celsius increase in temperature in the tropics.

The Philippines has experienced temperature spikes brought about by climate change. The northern and southern regions of the country have primarily experienced warming, while Metro Manila has experienced it less. In addition, the regions that have warmed the most (northern Luzon, Mindanao) have also dried the most. Largest precipitation trends are about 10 percent during the 20th century (http:// www.doe.gov.ph). Rainy seasons have come early, almost in an unexpected situation. Likewise, landslides have been reported from provinces and flash floods have also been a major problem.

The effect of climate on agriculture is more related to the variability in the local climate rather than in global one; the most significant of which is on rainfall. Some regions are forecast to receive more rain, others to receive less; above all, rain becomes more variable (http:// www.absoluteastronomy.com).

Hence, it is essential to analyze temperature and rainfall variability in Ilocos Norte to intensively prepare for the coming changes. Results of the study would provide decision-makers with the needed information and tools to assess the risks brought about by the variability of rainfall and air temperature. Such information would lead to an improved crop production management and a long-term agricultural planning and operation in the province.

Methodology

Thirty-five year (1976-2010) daily data on rainfall and air temperature from the MMSU Agrometeorological Station in the City of Batac, Ilocos Norte (18° 3'N latitude, 120° 32' E longitude, 17m AMSL) and 30-year (1981-2010) tropical cyclone data from Laoag City, Ilocos Norte Synoptic Station were analyzed to determine the rainfall variability, temperature, cyclone patterns, frequency, and intensity in Ilocos Norte. Annual and monthly variations were determined using descriptive statistics, while linear regression analysis determined the degree of annual change. Average data sets from 1976-1990 (the standard base period for most climate change studies defined by the World Meteorological Organization) were subdivided into Period 1 (1976-1990) and Period 2 (1991-2010) were compared to pinpoint the changes during these periods. The anomalies from the average of Period 1 (1976-1990) and those observed from 1976 to 2010 were likewise computed as follows:

$$\text{Anomaly} = x_j - \dot{x};$$

Where: x_j = mean annual temperature or rainfall or cyclone for year j

$\dot{X}$ = annual mean temperature or rainfall or cyclone for the period considered

The probability of tropical cyclone occurrence and dry spell within a given decade was computed as the ratio of the number of tropical cyclones or dry periods (below 0.5 mm rainfall) occurring within the decade and the total number that occurred within the given time frame (30 years). The probability of occurrence was computed as follows [Initial probability using Markov Chain by Robertson (1976) and Oldeman (1982)]:

$$P = f/N$$

Where: P = probability
f =frequency of occurrence
N = total number of data considered

Tropical cyclones were classified according to the strength of the winds (PAGASA) that accompanied them as follows:

Depression = 45-61 kph or 25-33 kt
Storm = 62-117 kph or 34-63 kt
Typhoon =118-239 kph or 64-129 kt
Super Typhoon = >240 kph or >130 kt

Based on the findings, cropping calendar for a given agro-ecological zone was developed. The modified cropping calendar was developed based on the average rainfall, probability of dry spell and tropical cyclone occurrences in a decadal period. Weather data were based on Period 2 (1991-2010). The best date or time from planting to harvest especially for rice was determined based on water

availability and tropical cyclones occurrences. The best time to plant other crops (garlic, corn, vegetables, etc.) after harvesting rice was also determined to utilize the residual moisture and to plan for other farming activities that could be employed to increase crop productivity.

Results and Discussion

Rainfall

The seasonal rainfall patterns fluctuated from year to year (Figure 1), with an annual rainfall of 2031.8 mm. The lowest recorded rainfall for the last 35 years was about 1,100mm and the highest was 3,500 mm. Although the amount has been variable, the annual change was 11.74 mm. Comparing the amount of rainfall during Period 1 (1976-1990) and Period 2 (1991-2010), it was found that the average rainfall increased by 92.7 mm. There were more years with rainfall below the normal amount both from the mean of 1976-2010 and Period 1. Deviation was as high as 1,500 mm (Figure 2). Rainfall anomaly between 1976-2010 and Period 1 was the same.

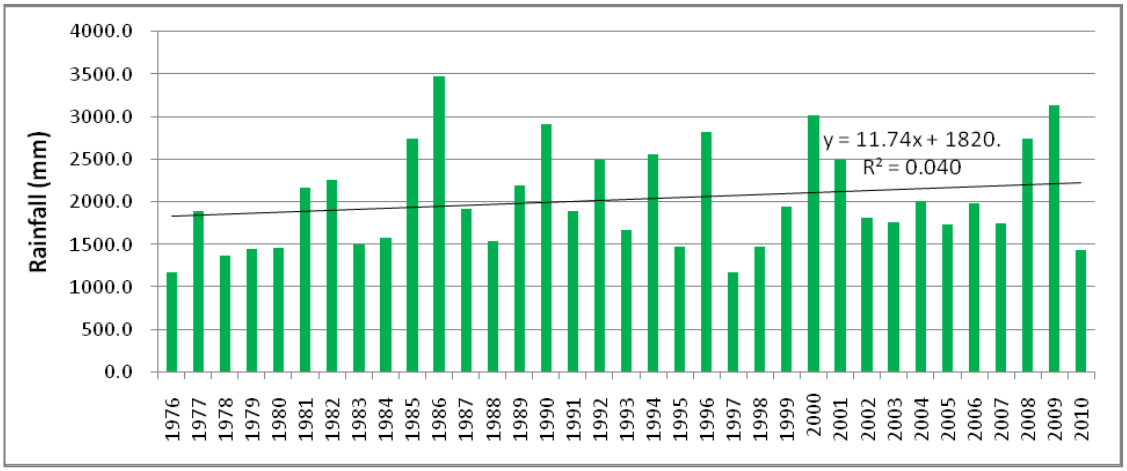

Fig. 1. Yearly rainfall in Ilocos Norte, Philippines from 1976-2010

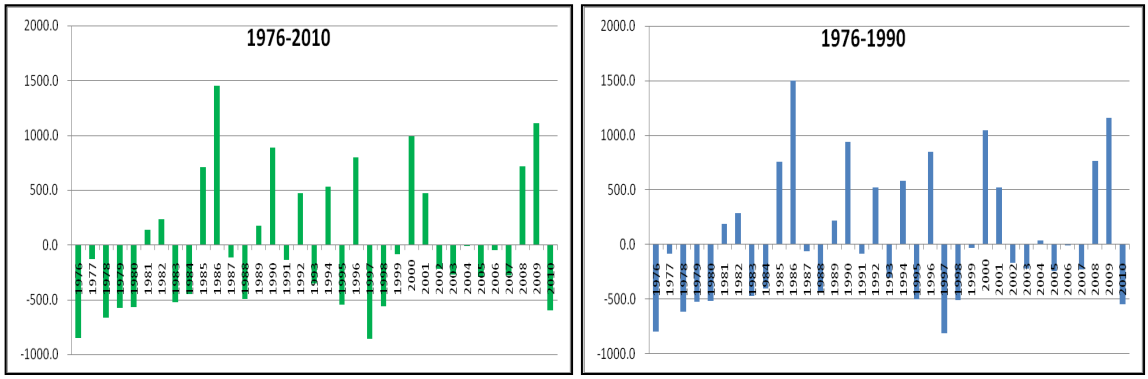

Fig. 2. Rainfall anomaly in Ilocos Norte from the average rainfall of 1976-2010 and Period 1 (1976-1990)

However, the increase or decrease in recorded rainfall was inconsistent.

Rainfall from 1976 to 2010 peaked in August (Figure 3). However, comparing Periods 1 and 2 (Figure 4), the peak of rainfall shifted from August (Period 1) to July (Period 2). Such shift of could affect the current cropping pattern and management in the study area. Nevertheless, the monthly amount of rainfall did not show any abrupt change in the last 20 years except that in July.

The number of days with moderate to heavy rainfall (>160 mm to >180 mm) was less variable from 2001-2010 compared to the other years. Over a period of 35 years however, the range was 2-15 days (Figure 5). As shown in Figure 6, the most number of days (4) with heavy rainfall (>180 mm) was in 2000 and 2009.

In spite of the rainfall pattern fluctuation and maximum rainfall frequency from year to year, mean rainfall analysis between Periods 1 and 2 showed no considerable difference (Figure 7). The maximum rainfall frequency, however, was observed to have slightly increased from Period 1 to Period 2 in July and August (Figure 8). This could be attributed to the global climate change, which triggered more intense rainfall.

Air Temperature

Figure 9 shows the annual variability of air temperature. The mean annual air temperature in Ilocos Norte over a period of 35 years was 27.1 °C, with a mean ranging from 25°C to 28.5°C. Lowest mean occurred in 1977, while the highest mean, in 1988. Based on linear regression analysis, the annual increase in mean air temperature is 0.017°C. The average air temperature during Period 1 was 27.1°C compared to 27.3°C during Period 2. In Figure 10, lower air temperatures were noted from 1976-1985, 2002-2005, and 2009-2010 based on the 1976-2010 mean. A 2.25 °C decrease in mean air temperature occurred in 1978.

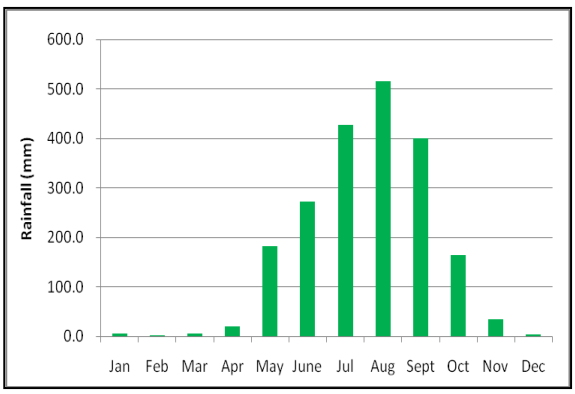

Fig. 3. Monthly rainfall in Ilocos Norte from the average rainfall of 1976-2010.

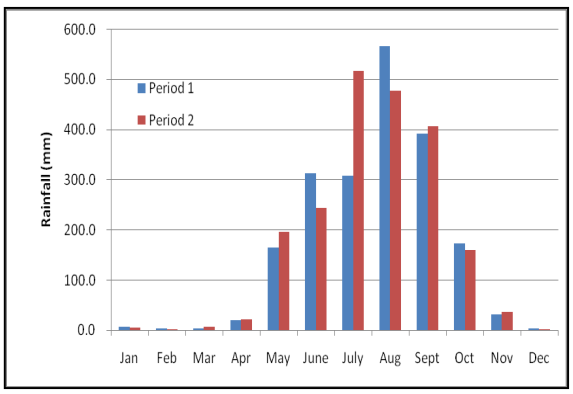

Fig. 4. Comparison of the monthly rainfall in Ilocos Norte between the two periods.

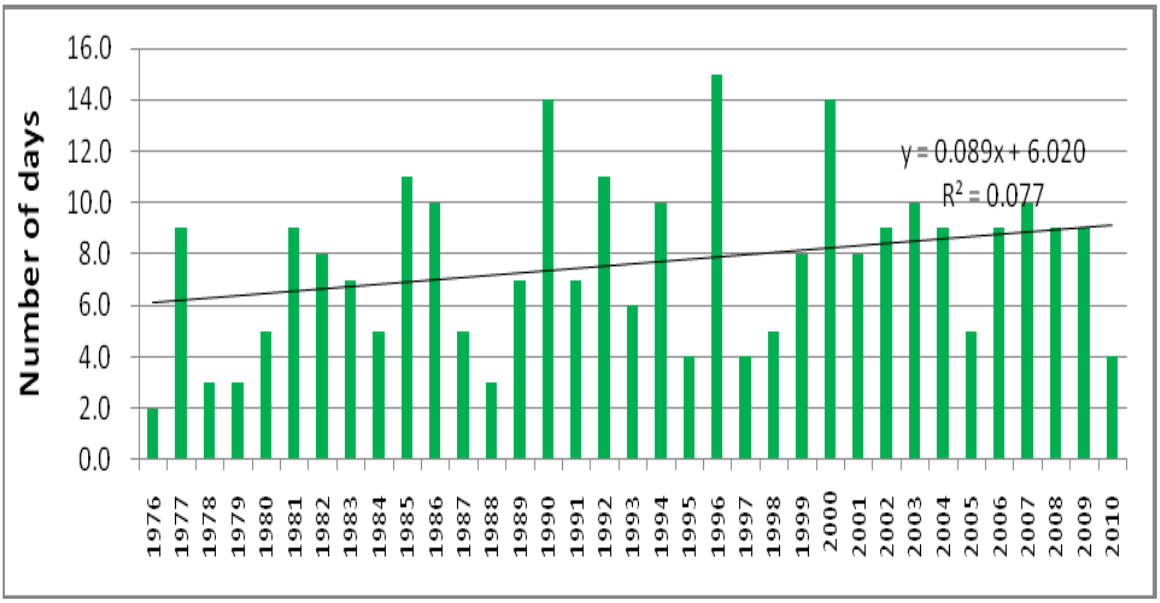

Fig. 5. Number of days with moderate rainfall (>60 mm/day) per year from 1976-2010.

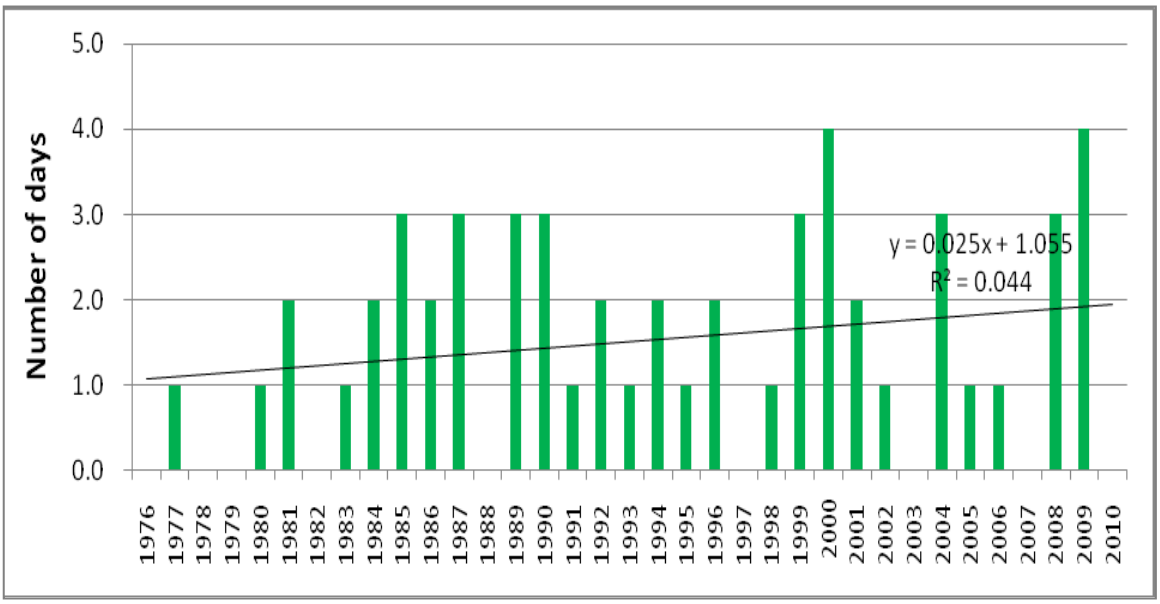

Fig. 6. Number of days with heavy rainfall (>180 mm/day) per year from 1976-2010.

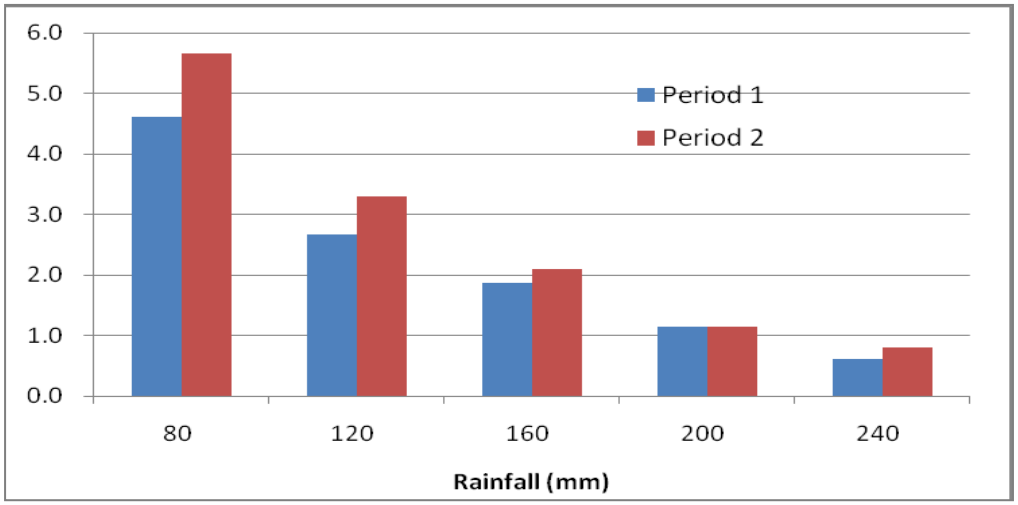

Fig. 7. Comparison of frequency of extreme rainfall occurrence between the two periods.

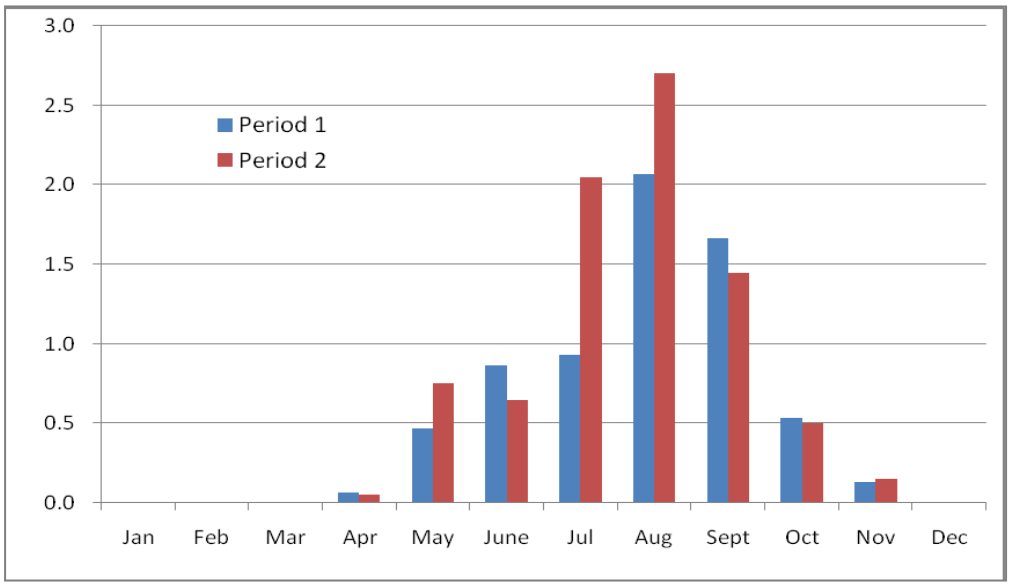

Fig. 8. Comparison of monthly occurrence of moderate to heavy rainfall between two periods.

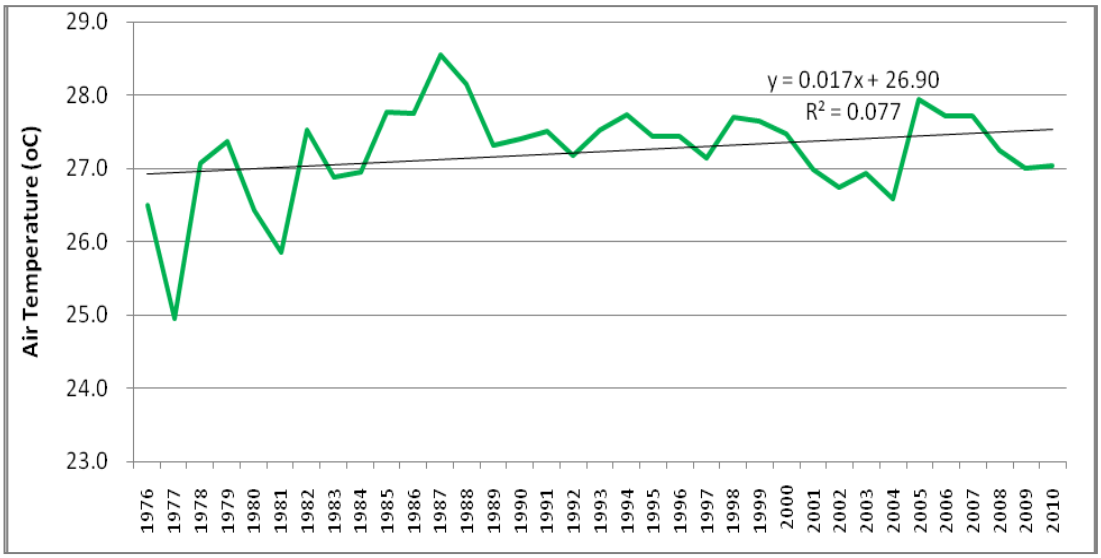

Fig. 9. Yearly mean air temperature in Ilocos Norte, Philippines from 1976-2010.

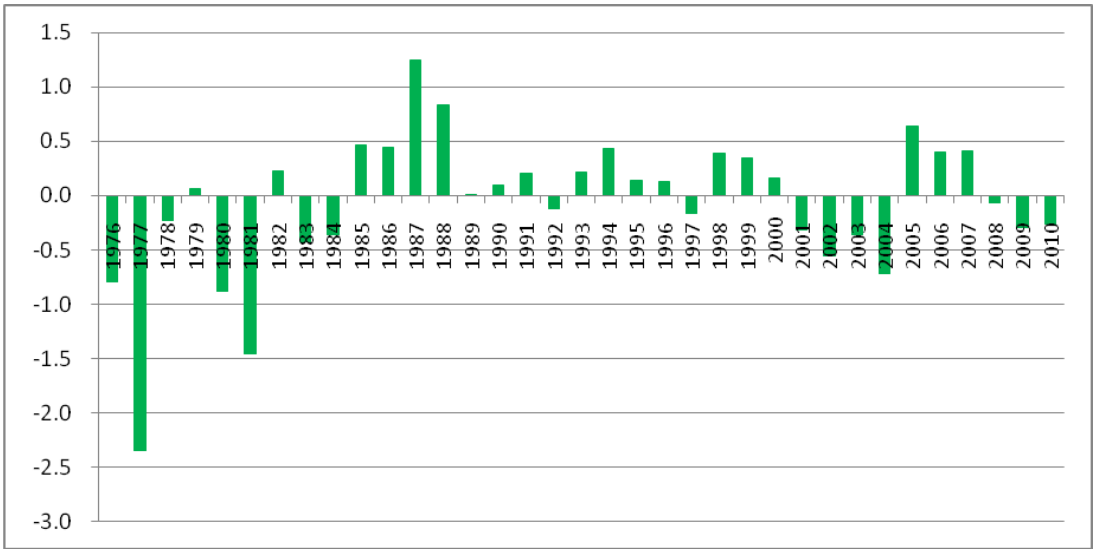

Fig. 10. Yearly mean air temperature anomaly from the average mean air temperature of 1976-2010.

Generally, from 1985-2000, mean air temperature increased variably from 0.2° C to 1.4 °C. A consistent increase (from 0.4 to 0.7) was noted from 2006-2008. More consistent air temperature increase from 1985-2000 and 2006-2008 could be noted if mean air temperature was based on Period 1 (Figure 11).

The mean annual maximum air temperature was 32.5°C with a maximum air temperature ranging from 31.4°C to 33.4°C. The lowest was recorded in 1981 and the highest was in 1998, 2003, and 2004. Higher trend of maximum air temperature values occurred in 1998. The increase in maximum air temperature was about 0.03°C annually (Figure 12).

The average maximum air temperature during Period 1 was 32.1°C compared to 32.7°C during Period 2.

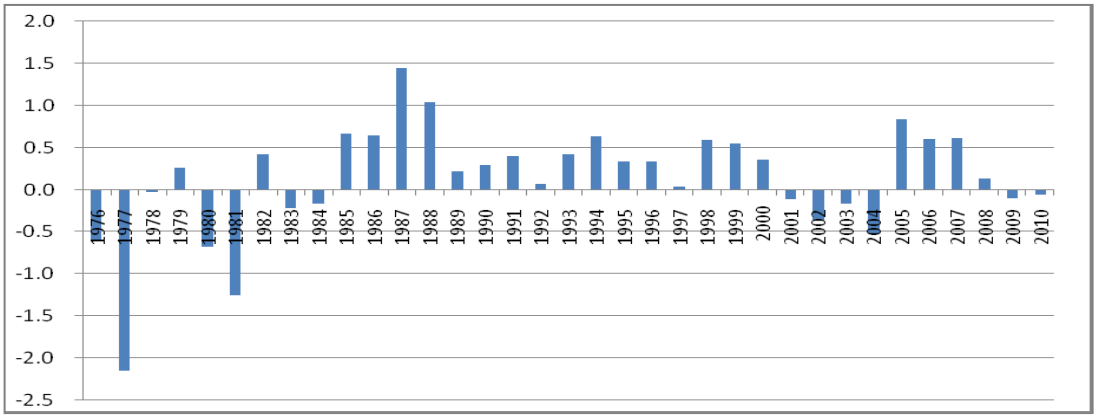

Fig. 11. Yearly mean air temperature anomaly from the average mean air temperature of Period 1 (1976-1990)

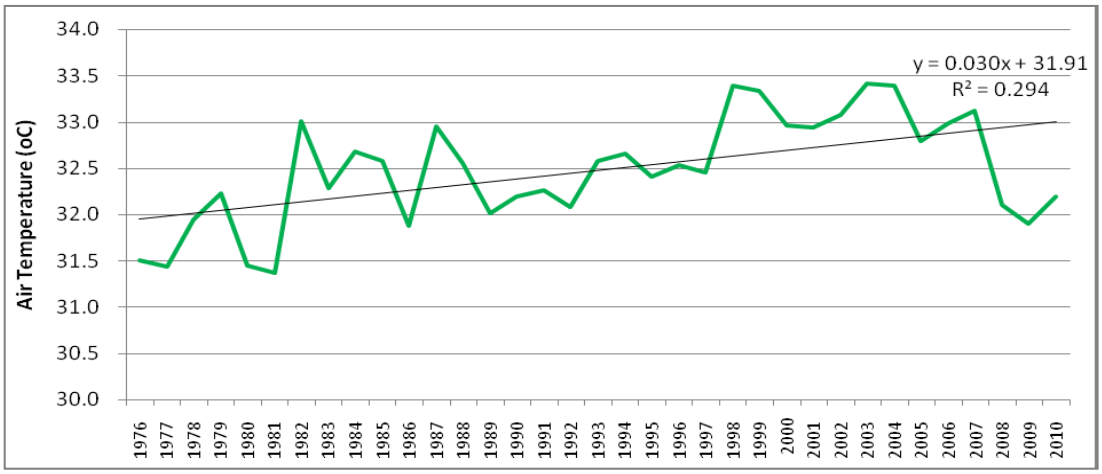

Fig. 12. Yearly maximum air temperature in Ilocos Norte, Philippines from 1976-2010.

From 1998 to 2008, maximum air temperature was consistently higher (0.3 to 0.9°C) based on the 1976-2010 mean (Figure 13). However, based on Period 1 (Figure 14), an increase in the maximum air temperature was evident from 1993-2010 (0.3 to 1.3°C) except in 2009.

Tropical Cyclones

Annually, the average number of tropical cyclones crossing and affecting Ilocos Norte was seven. However, the average number of cyclones during Period 2 had increased to nine cyclones as compared to that of Period 1, which was five. Based on linear regression analysis, the annual increase in the number of cyclones crossing and affecting the study area was 0.288 (Figure 15), which varied from 2 to 16 per year. Since 1990, anomaly has increased from the normal trend (Figures 16-17).

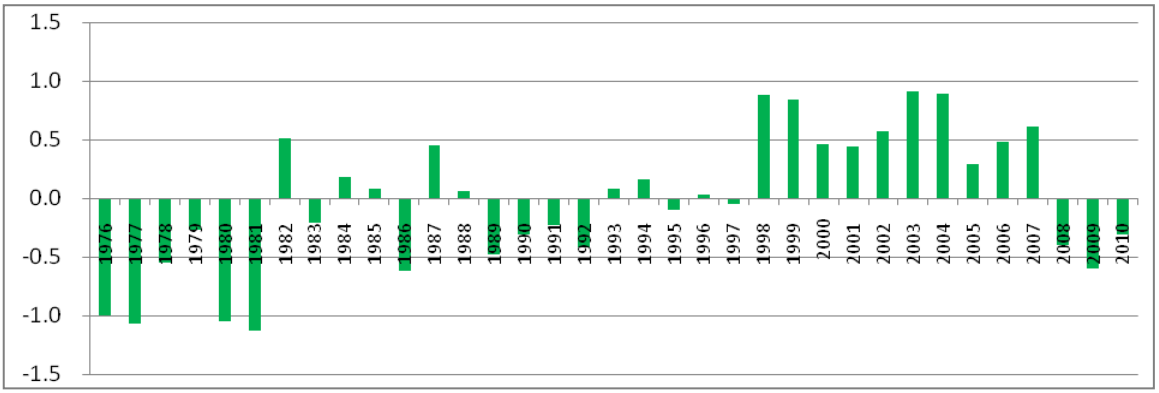

Fig. 13. Yearly maximum air temperature anomaly from the average maximum air temperature of 1976-2010.

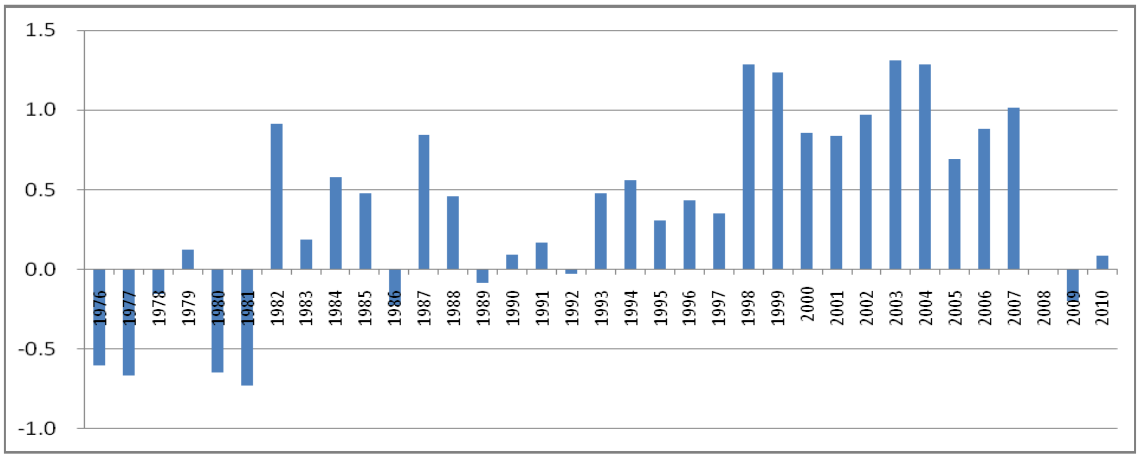

Fig. 14. Yearly maximum air temperature anomaly from the average maximum air temperature of Period 1 (1976-1990).

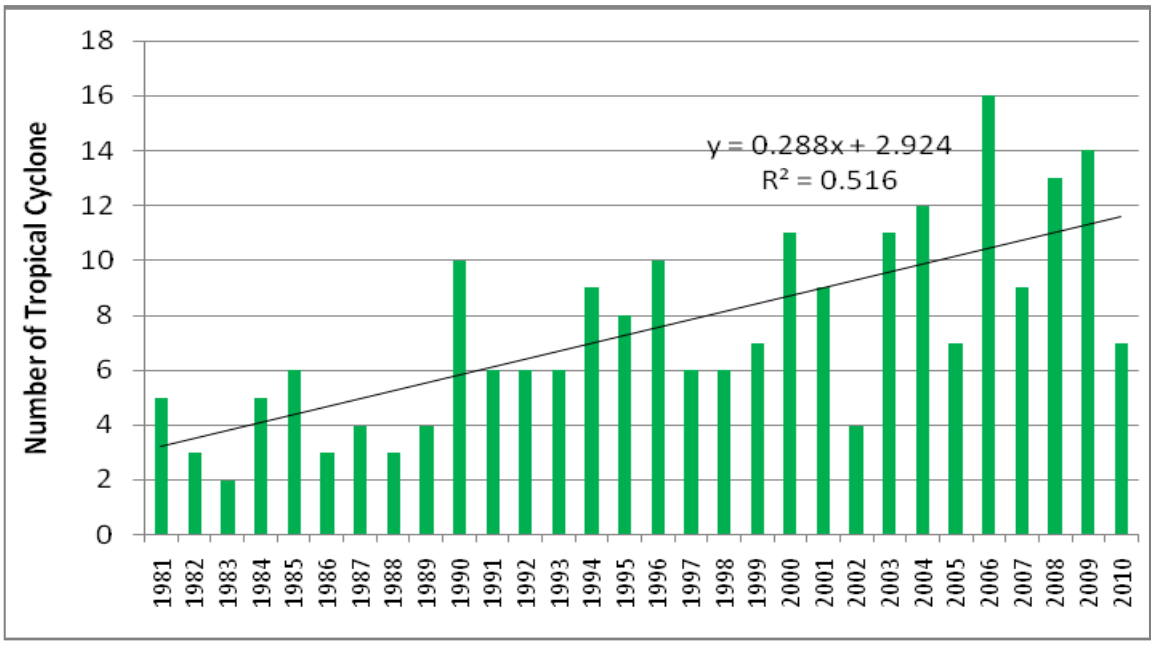

Fig. 15. Annual number of tropical cyclones that passed or crossed Ilocos Norte from 1981-2010.

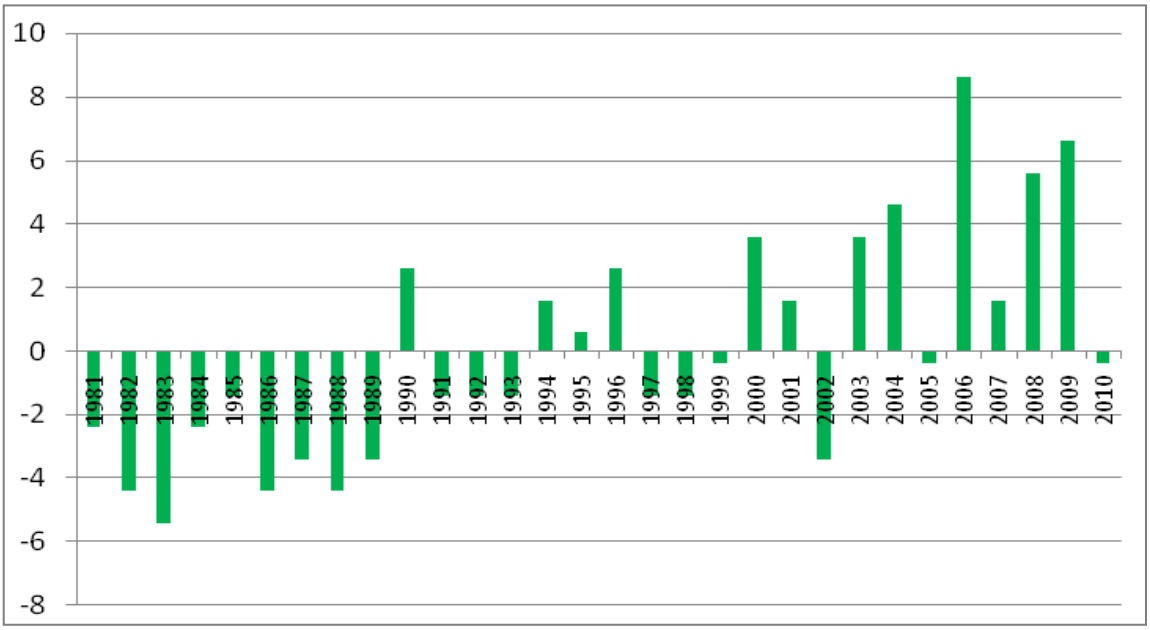

Fig. 16. Annual frequency of tropical cyclones anomaly from the average tropical cyclones of 1981-2010.

Figure 18 shows the increasing number of tropical depressions, storms, and typhoons since 1990.

Similarly, Figure 19 presents the monthly occurrence of tropical cyclones during the wet seasons since 1990. From 1981-1990, tropical cyclones primarily occurred from June to October. However, they set in as early as April (2003) and lasted as late as December (2004 and 2006) from 1991 to 2010.

Figure 20 shows that the frequency of tropical cyclones increased except in June when compared to the average Periods 1 and 2. An increase in almost one cyclone from July to September was likewise observed.

Comparing the probability of tropical cyclone occurrence between the two periods, an increase from 10 to 40% tropical cyclone (Figure 21), which could be depressions, tropical storms, or typhoons (Figures 22-24), was evident.

Cropping Calendar

Based on the analysis of the rainfall data and tropical cyclone occurrences, a cropping calendar for a specific agro-ecological zone was developed using the data from 1991 to 2010 (Period 2). The cropping calendars presented below are modifications of those developed by Acosta, et al (2000).

Submerge-prone lowlands. A cropping pattern with two rice crops followed by a drought resistant crop (mungbean) is recommended in relatively low lying areas (Figure 25). The first rice crop starts as early as the last 10 days of June when rainfall is about to set in. Supplemental irrigation may be needed during seeding periods due to a high probability of having a 10-day dry spell. Transplanting is done as early as the 10th of July. Rainfall is expected to be sufficient during the vegetative and reproductive stages of the rice crop due to a high amount of rainfall. The risk that a farmer may face due to early

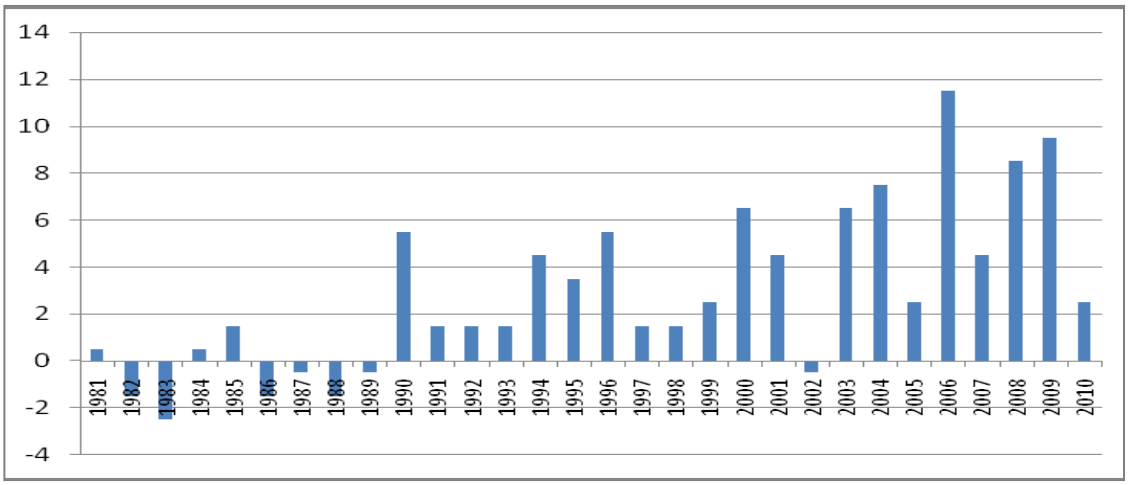

Fig. 17. Annual frequency of tropical cyclones anomaly from the average tropical cyclones of 1981-1990.

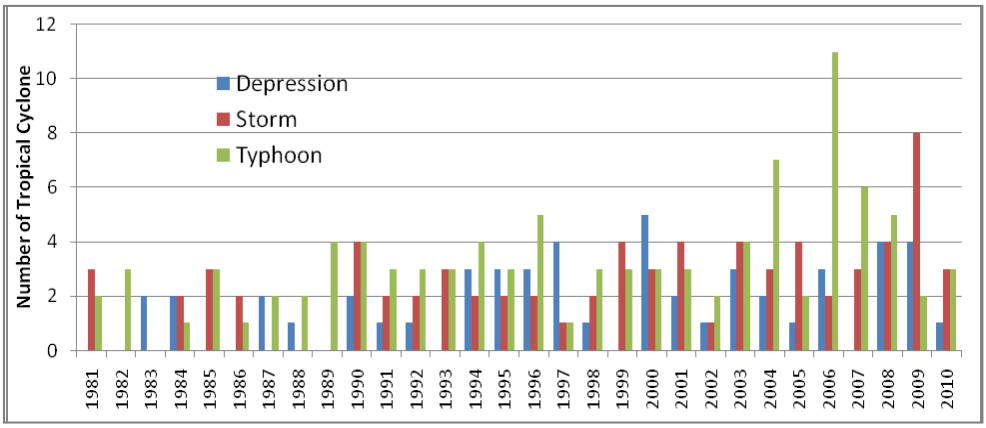

Fig. 18. Annual number of tropical cyclones according to strength that passed or crossed Ilocos Norte from 1981-2010.

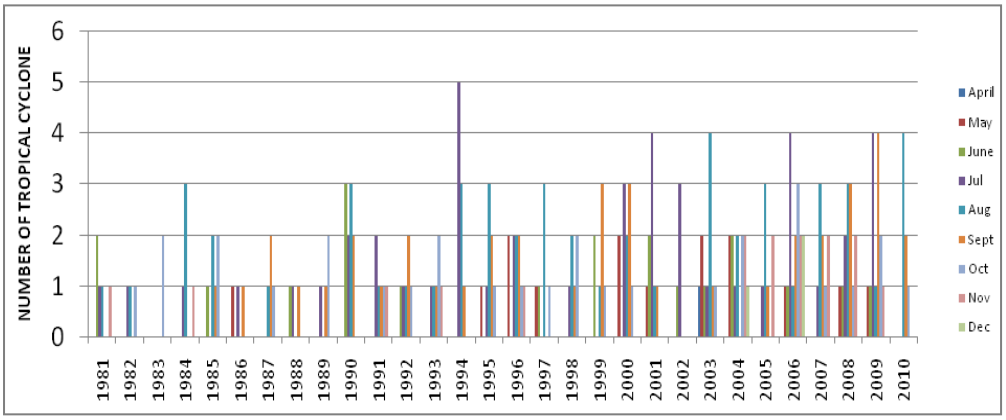

Fig. 19. Number of monthly tropical cyclones in Ilocos Norte from 1981-2010

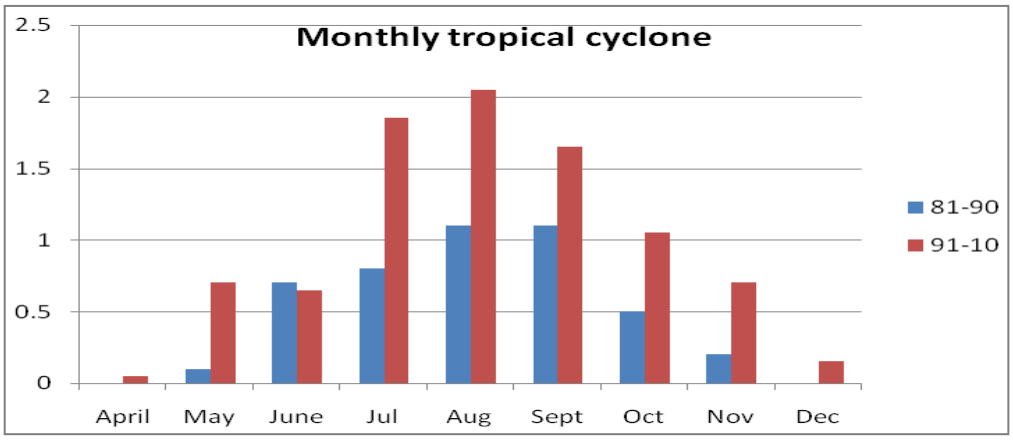

Fig. 20. Comparison of the frequency of tropical cyclones between the average of 1981-1990 and Period 2 (1991-2010)

transplanting is the high probability of tropical cyclone occurrences during the panicle to early heading stages and wet soil condition during harvesting. Harvesting is done as early as the 10th day of October or towards the end of October when rainfall begins to recede.

A second rice crop may start as early as the first 10 days of November. The reproductive stage falls on the first 10 days of January. The ripening and harvesting stages are favorable from the last 10 days of February to March.

Drought-prone lowlands. For relatively high-lying areas, rice–upland crops (rice-garlic-mungbean) are recommended (Figure 26). The first crop is rice, which starts as early as the first 10 days of July and then followed by garlic (or corn, pepper, tomato, eggplant), which starts in the last 10 days of November when rainfall has already receded on as early as the 10th day of November if garlic is planted right away after harvesting of rice.

The probability of tropical cyclones is negligible during these days. Although rainfall may occur in lesser amounts, this may seem favorable for crop establishment.

With supplemental irrigation from shallow tube wells during periods of low moisture from late December to February, garlic and other cash crops are expected to attain their optimum yield.

Residual moisture could be maximized by planting a drought-tolerant crop like mungbean from the first 10 days of March to April. *Upland areas*. A vegetable-based cropping pattern is recommended in upland or non-bunded areas wherein water is hard to maintain. With this pattern, off-season vegetables such as tomato, onion as shallots, ginger, gabi, peanut (unshelled), corn, etc. can be planted (Figure 27).

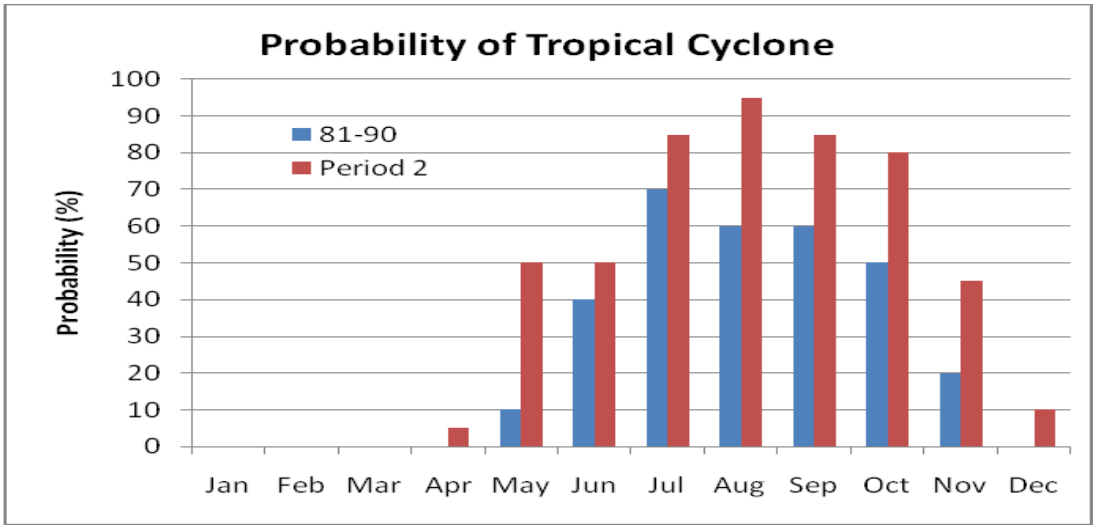

Fig. 21. Comparison of the probability of tropical cyclones between the average of 1981-1990 and Period 2.

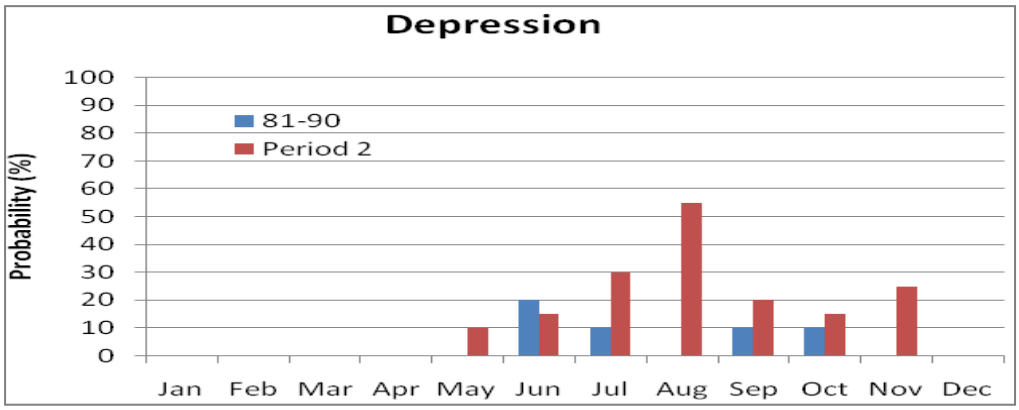

Fig. 22. Comparison of the probability of tropical depression between the average of 1981-1990 and Period 2

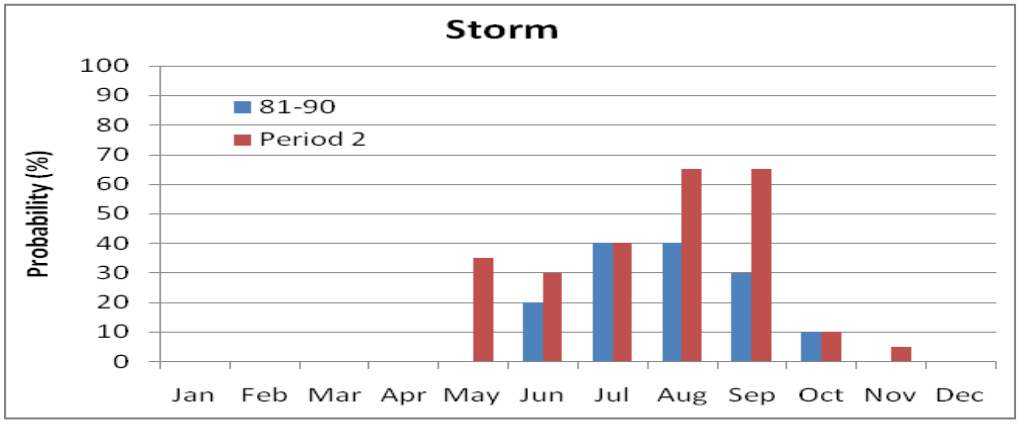

Fig. 23. Comparison of the probability of tropical storms between the average of 1981- 1990 and Period 2.

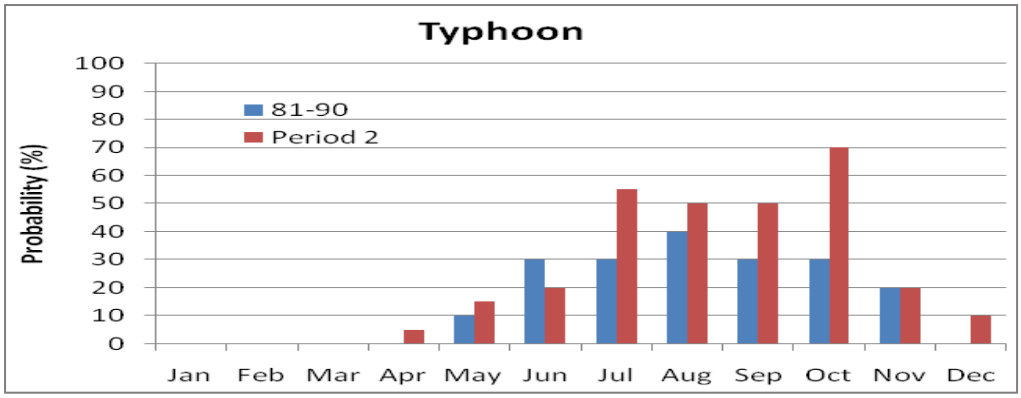

Fig. 24. Comparison of the probability of typhoons between the average of 1981-1990 and Period 2.

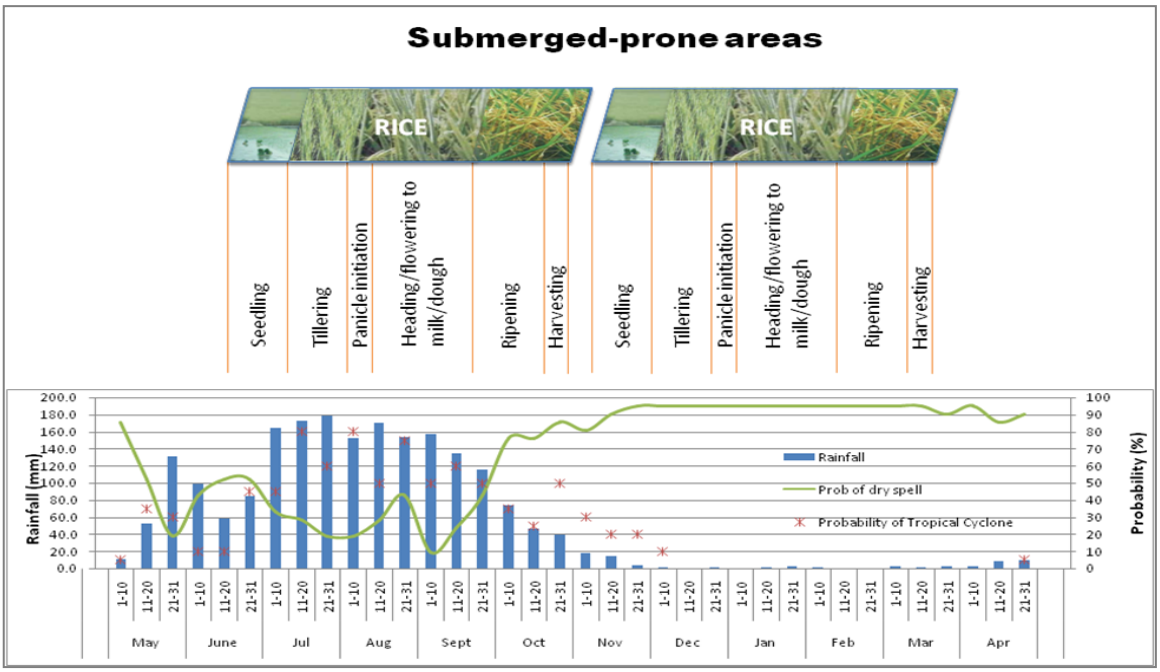

Fig. 25. Cropping calendar in submerge-prone lowlands.

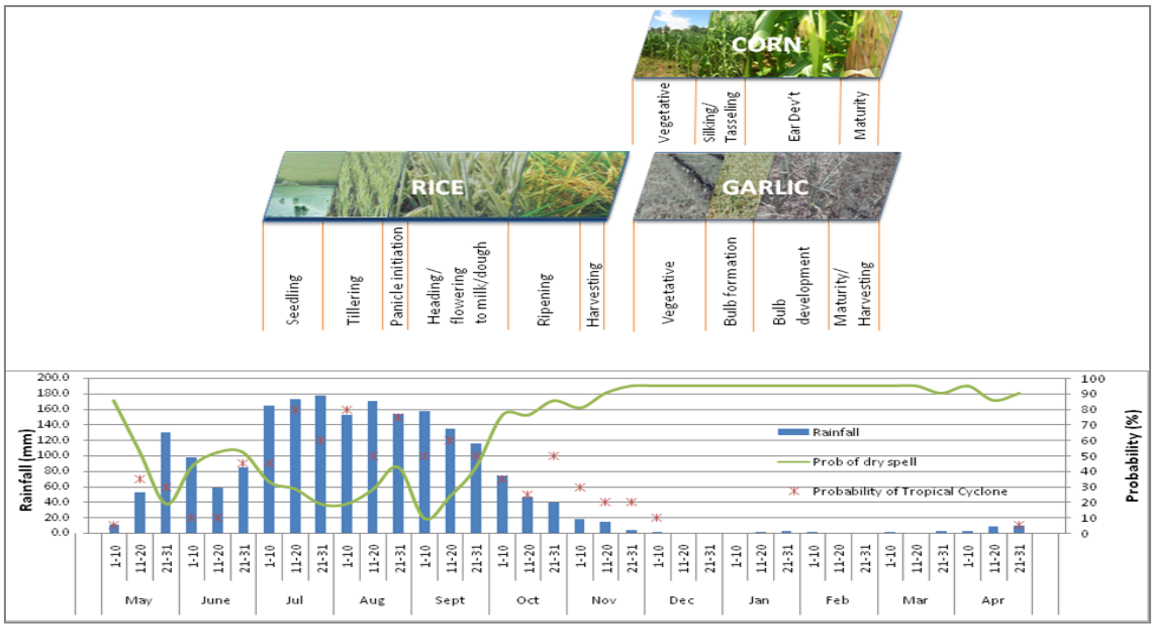

Fig. 26. Cropping calendar in drought-prone lowlands.

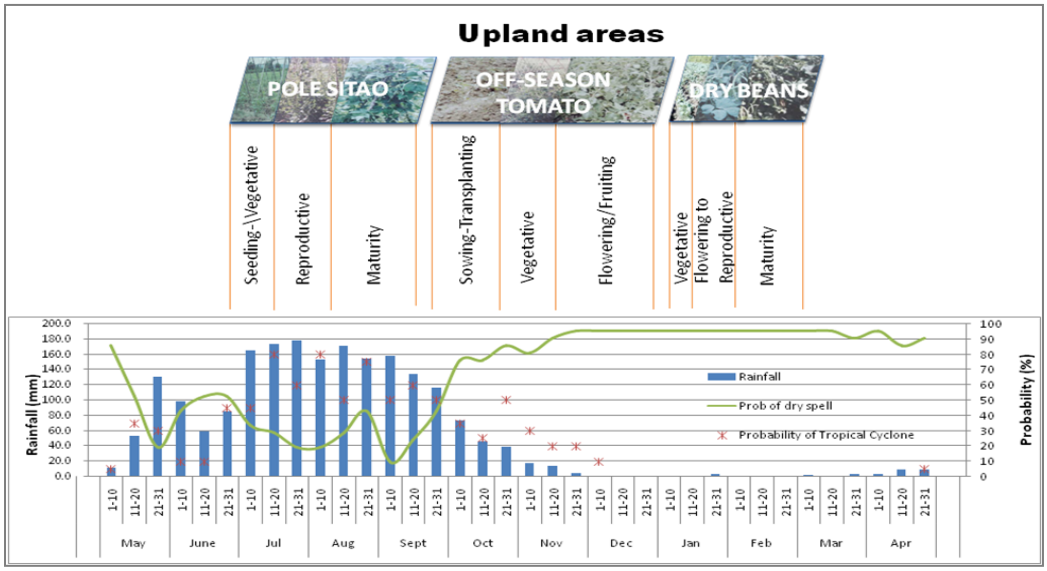

Fig. 27. Cropping calendar in upland areas

Conclusion and Recommendations

Climate change is clearly manifested in this study. Its consequences are alarming as they could hamper development efforts in Ilocos Norte. Policies on water resources efficiency should be crafted and implemented to minimize the potential impact of climate change, particularly on land degradation and forest denudation. The said policies should be anchored on information derived from the study and the cropping calendars developed in order to minimize farming risks and to maximize agricultural planning and operations.

To showcase the effectiveness of the proposed cropping calendars, a demo farm of pilot area should be established. Likewise, relevant and timely messages through information, education, and communication, focus group discussions, and print and broadcast media must be widely disseminated.

Acknowledgement

A heartfelt gratitude to the Philippine Atmospheric and Astronomical Services Administration (PAGASA) for providing the weather data that was used in this study. This work was supported by the Mariano Marcos State University, City of Batac, Philippines under the administration of Dr. Miriam E. Pascua.

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