AGRI-ECOLOGICAL APPRAISAL OF TRADITIONAL RICE-BASED ECOSYSTEM: THE KAPANGAN EXPERIENCE[1]

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ABSTRACT

The study dealt with the characterization of soil fertility, level of crop productivity, floral diversity assessment, and indigenous knowledge system and traditional rice farming practices in two of the few remaining traditional rice-based ecosystems, Sitio Gadang Proper, Gadang and Sitio Malagyao, Cuba, Kapangan, Benguet. The study revealed soil fertility was quite low in both sites since there was an alteration in rice farming practices. Floral diversity was observed to have considerable differences in the two ecosystem sites being composed since that in Sitio Gadang Proper, Gadang was undergoing the planting season while that in Sitio Malagyao, Cuba was in a fallow period. As expected, therefore, a generally more diverse ecosystem was observed in the latter site. The indigenous knowledge system and farming practices in both sites were similar though they just differed in the terminologies or local terms used. The introduction of new farming technologies, formal education and Christian religion affected the beliefs and practices done on the traditional farming practices in the study area. Apparently, these may be seen as threats that might further impinge on the already fragile traditional ecosystems.

KEYWORDS: Agri-ecology, ecosystem, indigenous practice, rice

INTRODUCTION

Kapangan is an interior municipality in the province of Benguet. It is located at the western portion of the province with coordinates at 16°13' to 16°41' latitude and 120°40' longitude with an elevation of 1,700 meters above sea level (Fig. 1). It has a total land area of 17,327 hectares or 6.68% of the total land area of Benguet (Kapangan Profile, 2005). Barangay Gadang has an estimated land area of 2,926 hectares or 16.9% of the total land area of Kapangan (Barangay Gadang Socio Economic Profile, 1996). Barangay Cuba has an estimated total land area of 989.8 hectares or 5.7% of the total land area of Kapangan (Barangay Cuba Socio-Economic Profile, 2002).

Rice farming in the Cordillera is an old practice that dates back before the coming of Spaniards. It was believed that the Indo-Malay group of people brought rice farming in the Philippines because of trading. They brought several varieties of lowland and upland varieties of rice, which has a distinctive aromatic flavor. In the earlier times, the practice of uma or the slash-and-burn method in rice farming was a common practice done in the sloppy terrains in the province. It is said that from this practice, locals were able to build the rice terraces, which was an ingenious way of cultivating rice (Tomin 2006). Indigenous or traditional knowledge (IK) plays a vital role in the design of sustainable agriculture systems. Agricultural indigenous knowledge was maintained for centuries; it was adapted and reformulated from one generation to another. The lack of technique to record wisdom is not a hindrance to preserve their knowledge practices. One of the reason probably was that their knowledge was well entrenched in their culture and beliefs (Liwaliw, 2002).

The study and application of IK is the comprehension of the characteristics of indigenous societies (Belasco and Diamond, 1980). At present, indigenous knowledge system (IKs) are continuously gaining recognition as a vital tool in attaining sustainable development. Quite a number of databases on IK reveal promising potentials for development projects as well as it may provide solutions/alternatives to development problems (Apolinar *et al.*, 1998). Traditional values embedded in cultural practices such as sacred rites, often provide conservation strategies for the management of natural resources. These practices contribute to biodiversity conservation. Successful strategies also depend on the degree of participation, conflict management in the communities and traditional knowledge transferred between generations (Liwaliw, 2002).

One of the most difficult things to look at is that related to human psyche, beliefs, values, and feelings. Some development planners sometimes do not take into consideration these factors where rural development programs and projects are seldom aimed at understanding indigenous cultural beliefs and values (Tudlong, 1993). Thus, this study aimed to characterize and document the remaining traditional rice-based ecosystem of Kapangan, Benguet particularly in the two barangays: Sitio Gadang Proper (Barangay Gadang) and Sitio Malagyao (Barangay Cuba) which are known to be native rice producers in the area. It aimed to assess the soil fertility, crop productivity, biodiversity and indigenous knowledge systems and farming practices associated with it.

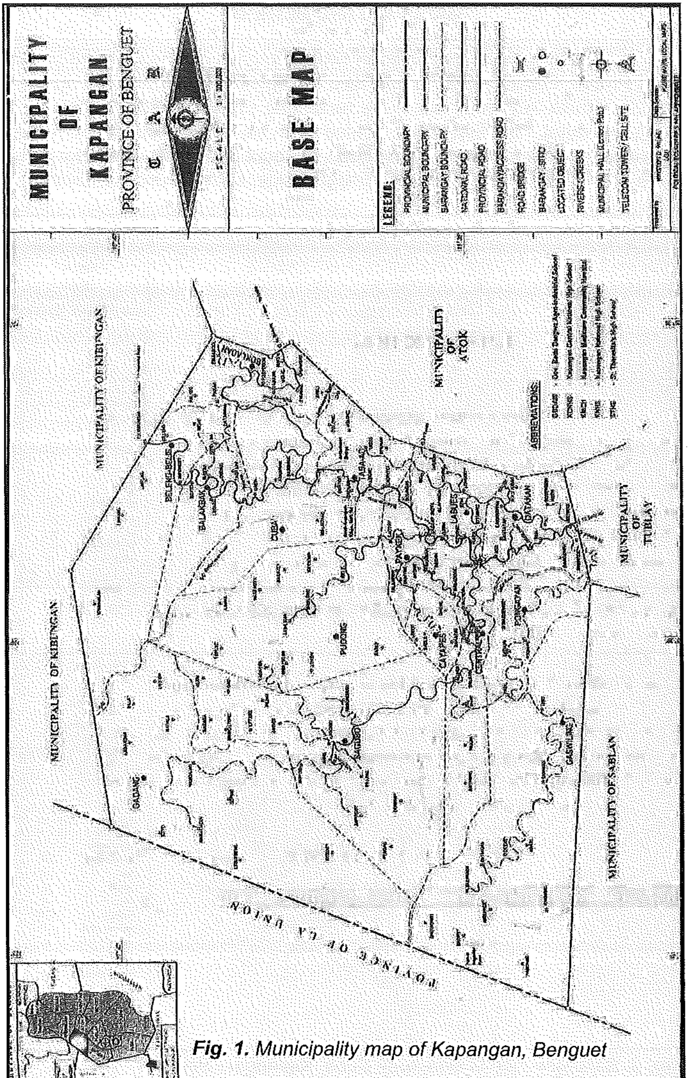

Fig. 1. Municipality map of Kapangan, Benguet

MATERIALS AND METHODS

The study was conducted in two barangays of Kapangan: Sitio Gadang Proper, Gadang (Site 1) and Sitio Malagyao, Cuba (Site 2) (Figures 2 and 3). These two are a few of the remaining sites where traditional rice is being cultivated. The first site is located at an elevation of about 650 meters above sea level (masl) while the second, at about 800 masl. The latter site is more accessible by roads from the Benguet side, compared to the former.

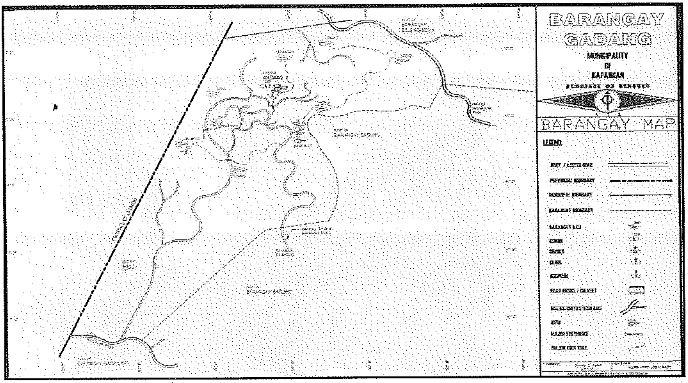

***Fig. 2.** Barangay map of Barangay Gadang, Kapangan, Benguet*

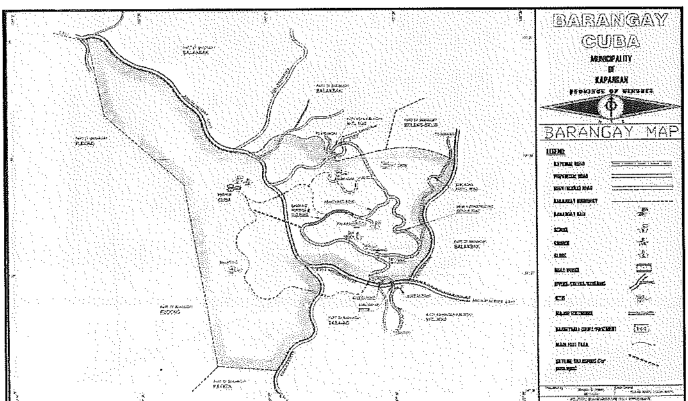

***Fig. 3.** Barangay map of Barangay Cuba, Kapangan, Benguet*

In each study site, an elder and an official were selected as key informants. They were selected based on their knowledge on traditional rice and farming practices and are engaged in traditional rice cultivation for 30 years and above.

A composite soil sample was collected from each site and routine analytical methods were used. Soil texture was determined using the 'roll' or 'feel' method. The pH measurement was taken using the electrometric method; the soil moisture content using gravimetric method, and finally; dry combustion was employed in the determination of organic matter content of the soil. Nitrogen was estimated from the measured organic matter. A number of soil analyses in various studies in Kapangan showing the measurements of organic matter and nitrogen content was used to estimate the nitrogen content of the study area through the derived regression equation. Floral diversity assessment was done using the quadrat/ plot method within the selected area. The quantitative data for floral assessment was generated by having a one-by-one meter plot in each parcel of the rice pond field. Density, frequency and importance value of each species identified was computed.

The composite soil samples were prepared for the determination of soil fertility parameters such as texture, pH, moisture content and organic matter content. The parameters were computed using the following formulae:

$$\%\text{Moisture Content (MC)} = \frac{\text{Fresh Weight-Oven Dry Weight}}{\text{Oven Dry Weight}} \times 100$$

$$\%\text{Organic Matter (OM)} = \frac{C-D}{C-A} \times 100$$

where: C= weight of the cubicle + soil (air dried)
D= weight of crucible + soil (furnaced)
A= weight of the crucible

The regression equations for the estimation of nitrogen content were as follows:

Site 1 (R^2= 0.9808)
Y (nitrogen) = 0.0494x + 0.0031

Site 2 (R^2= 0.9256)
Y (nitrogen) = 0.0545x – 0.0053

Where: x = organic matter value
Y = nitrogen content

Ecological indices were calculated basing on the following parameters with their respective formulae:

$$\text{Density (Di)} = \frac{\text{total number of species (ni)}}{\text{total sampled area (TSA)}} \times 100$$

$$\text{Frequency (Fi)} = \frac{\text{number of station where the species occur (Ji)}}{\text{total number of plots sampled (K)}} \times 100$$

$$\text{RDi} = \frac{(\text{Di})}{(\Sigma \text{Fi})} \times 100 \qquad \text{RFi} = \frac{(\text{Fi})}{(\Sigma \text{Di})} \times 100$$

$$\text{Importance Value (IV)} = \frac{\text{RDi} + \text{RFi}}{2} \times 100$$

where: RDi= relative density   RFi= relative frequency

The level of crop productivity was further described using a qualitative analysis. The farming practices and beliefs from the key-informants were summarized and qualitatively discussed. Secondary data was sourced from the available records or documents from the municipality of Kapangan.

Statistical Analysis

The data collected were consolidated, tabulated, categorized and analyzed using the appropriate statistical tools like percentage, mean and ranking. It was subjected into basic measure of frequency counts and weighted means. T-test was used for soil parameters such as pH, moisture content, organic matter content and nitrogen content to find out the true difference between the two sites' soil samples.

RESULTS AND DISCUSSION

Soil Fertility

Table 1 shows that both sites were not significantly different in their mean pH. Bishop (1983) found out that most crops are grown at a pH range from 4 to 10, though crops are most productive at a pH of 5.25 to 8.2. Moreover, the ideal for rice growth ranges from 6-10 (PCARRD, 1981). According to RICE-IRRI (1973), result reveals that the two sites were acidic, with the computed pH of 5.7 (Site 1) and 5.3 (Site 2) since optimum pH for rice is 6.6. This could be attributed to the application of chemical inputs like fertilizers and pesticides, which go along with the introduction of HYV's of rice and vegetables as an effect of crop diversification. Table 1 shows the percent moisture content in both sites. Site 1 had an average of 6% moisture content while Site 2 had a mean value of 4.6%. Since the computed value (0.723) is less than the tabular value (4.303) at 5 % level of significance, they are not significantly different. With regards to moisture content, Site 1 had higher moisture content compared to Site 2. This is attributed to Sitio Gadang Proper having an abundant water supply all throughout the year.

Table 1. Soil texture, pH, and moisture content of the two sites

PARAMETERS		SITE 1 (SITIO GADANG PROPER)	SITE 2 (SITIO MALAGYAO)	STATISTICAL INTERPRETATION
Soil Texture		Silt Loam	Clay Loam	
pH reading	Trial			
	1	5.7	5.4	
	2	6.1	5.1	
	3	5.4	5.2	
Mean		5.7	5.3	t_c=1.589^{ns}
Moisture Content (%)				
	1	4.4	6.5	
	2	6.0	4.4	
	3	7.5	2.9	
Mean		6.0	4.6	t_c= 0.723^{ns}

$^{ns}t_{(0.05,2)}$= not significant
t_c=computed value

Organic matter content of the two sites was determined through dry combustion method. Organic matter contents were 17.3% (Site 1) and 13.3% (Site 2), as seen in Table 2. Site 1 significantly had a higher mean value as compared to Site 2. Seemingly because most of the area in Site 1 was devoted to traditional rice production, many farmers still adhered to organic fertilization like incorporation of rice straw and weeds into the soil. Site 2 had a lower organic matter content which could be attributed to the diversification of crops and management of the rice straw. Since rice straw were not incorporated into the soil, and vegetable crops are dependent on inorganic fertilizers and pesticides, the over all organic matter content of the soil could have declined. The statistical test implies that organic matter content of the two sites was not significantly different. The decline in soil fertility and soil productivity was also associated with the lowering of the soil organic matter content. It was therefore necessary that the soil organic matter must be maintained at adequately high level for a more satisfactory crop yield. Farmers associated this high level of organic matter with the longer-term fertility and productivity of the soil, resulting from organic fertilizers (Murakami, 1991).

The estimated nitrogen content (Table 2) was computed from the organic matter value measured with R2 = 0.9808 in Site 1 and R2 = 0.9256 in Site 2. The regression equations derived were as follows: $Y = 0.0494x + 0.0031$ (Site 1) and $Y = 0.0545x - 0.0053$ (Site 2). The regression value in Site 1 was also computed from available data of Barangay Sagubo on the organic and nitrogen content of the soil as the nearest to the site.

Table 2. Organic matter content and estimated nitrogen content of the two sites

TRIAL	ORGANIC MATTER CONTENT (%)			NITROGEN CONTENT (%)		
	SITE 1	SITE 2	STATISTICAL INTERPRETATION	SITE 1	SITE 2	STATISTICAL INTERPRETATION
1	16	14		0.793	0.757	
2	16	12		0.793	0.648	
3	20	14		0.991	0.757	
MEAN	**17.3**	**13.3**	**t_c=3.464^{ns}**	**0.859**	**0.721**	**t_c=7.248***

*$t_{(0.052)}$=significant
$^{ns}t_{(0.05,2)}$= not significant
t_c=computed value

Since other data from nearby barangays were not available, other barangays of Kapangan were considered such as Central and Datakan. The computed value of the regression equation in Site 2 was based on past local studies of the nearby barangays of Cuba namely Paykek, Pudong, Taba-ao, and Balakbak with regards to the organic matter value and the nitrogen content of the soil.

Nitrogen content of Site 1 had a higher mean value of 0.859% as compared to Site 2 which was 0.721%. Based on the computed result, both were significantly different. The difference in soil pH, moisture content, organic matter content and nitrogen content of both sites might be due to the farming practices being performed like the management of straw.

In Site 1, the rice straw is incorporated in the soil to be decomposed while in Site 2 the rice straw is cut and carried away from their field. According to CECAP and PhilRice (2000), rice straw when completely decomposed would release nitrogen which is needed by the young plants. The removal of the rice straw from the field lowers the soil nutrient contents. The removal of one ton of straw from a hectare of field loses about 5-8 kg N, 1.05-2.7 kg P, 12-17 kg K, 0.5-1.0 kg S and 40-70 kg Si. On the other hand, an integrated management of nitrogen that involves application of inorganic and organic sources of plant nutrients should be considered as an essential component of management practices for rice production provided agronomic data and socio-economic conditions are well-defined. There are some organic sources of nitrogen such as rice straw, weeds, compost, green-manures (*Azolla sp., Sesbania sp., Crotalaria sp.,* ipil-ipil), and others. According to the respondents in the two sites, kuliplip (Azolla) is dominant in the rice fields. In addition, they affirmed that kuliplip adds nutrients to the soil based on their observations and experiences. *Azolla* is a tiny, aquatic fern where the blue-green algae Anabaena lives and traps atmospheric nitrogen. *Azolla* reproduces rapidly that enough herbage can be produced for plowing under to supply half or all the nitrogen needed by the rice crop.

Crop Productivity

According to the key-informant interviewed (an elder) in Site 1, a rice pond field with an estimated area of 100 m2 planted with traditional rice variety in the past 10 years can have a maximum yield of about 23 to 25 *tan-ay* (Plate 1). Twelve grip size of newly harvested rice panicle is considered as one *tan-ay* (one *tan-ay* is equivalent to 7.5 kilograms). Three *tan-ay* of rice is approximately equivalent to one can, and three cans is approximately equivalent to one-half cavan milled rice. Thus, 15 *tan-ay* (0.65 cavan/100 m^2) can only be harvested in the said area for consumption purposes. From the productivity data of California a traditional rice in Ifugao specifically in Nagacadan and Bocos, the productivity of the TRV is 3,759.4 kg/ha and 3,563.3 kg/ha, respectively (Gomez and Pacardo, 2005). Seemingly, one factor that affects the productivity of the land in Site 2 might be due to the changes in the cropping pattern of the farmers, wherein, in one year they plant rice followed by vegetables. Such crops are believed to absorb and consume larger quantities of nutrients; thus, could have caused such imbalances. One of the key-informants interviewed (elder), mentioned that before, majority (90%) of the community are planting traditional rice variety whereas at present, a few (66.67%) are only planting. This might be due to water shortage in the area (Site 2). Other factors that affect the productivity of the traditional rice varieties according to the KIs were the apparent change in weather and climate. Weather has long been recognized as one of the major constraints in crop production. Agricultural scientists as well as farmers in the Philippines are especially concerned about the weather, knowing that in the tropics the crop yield potential is lower than in the temperate countries on a growing-season basis (Gayanilo and Tamisin, 1983). The introduction of high yielding varieties such as the C1 and C4 rice in the rice pond field and the change in the land utilization types of the area could be attributed to the low production of traditional rice. During the period of study, it was observed that the areas cultivated with TRVs are now planted with vegetables such as the Baguio beans, cucumber, among others.

Plate 1. The *tan-ay* being sun-dried

Floral Diversity

Species observed within the rice pond fields in Site 1 (Gadang Proper) are *Oryza sativa* and *Azolla*. *Oryza sativa* had 7 different varieties which were as follows: *balalaki, bongkitan,* california, *malunaw, saigolot, kandiling,* and *topel*. *Bongkitan* was the most dominant variety in the area (Plate 2). The result of the floral diversity assessment in Site 2 (Malagyao) is seen in Table 3, with 44 species. *Oryza sativa* ('pagey') has the highest number with 1,896 (Plate 3) followed by *Ageratum conizoides* ('buena') having a total number of 1,187, *Eclipta prostrate* with 548, followed by *Eleusine indica* ('sangitan'), *Scirpus juncoides* ('balili'), *Echinochloa colonum* ('sab-sab-bog'), *Jussiaea augustifolia, Fimbristylis miliacea* ('sep-sepit'), *Blumea lacera*, and *Synedrella nodiflora,* respectively. The difference in diversity of the two sites might be attributed to the management being undertaken in the two sites. During the conduct of the assessment in Site 1, the rice pond fields had been transplanted with traditional rice which means that other vegetation within the rice ponds like weeds were uprooted. In Site 2, the area planted with traditional rice varieties was then undergoing fallow period, which would have enhanced the growth of weeds.

Table 3. Floral diversity in Site 2 (Sitio Malagyao)

SCIENTIFIC NAMES	BIODIVERSITY INDICES							
	ni	Ji	Di	Fi	RDi	RFi	IV	Rank
Oryza sativa	1,896	50	47,400	113.6	28.0	13.1	34.5	1
Ageratum conozoides	1,187	32	29,675	72.7	17.5	8.4	21.7	2
Eclipta prostrata	548	22	13,700	50.0	8.1	5.7	11.0	3
Eleusine indica	393	19	9,825	43.2	5.8	5.0	8.3	4
Scirpus juncoides	357	22	8,925	50.0	5.3	5.7	8.1	5
Echinochloa colonum	282	22	7,050	50.0	42	5.7	7.0	6
Jussiaea augustifolia	206	26	5,150	59.1	3.0	6.8	6.4	7
Fimbristylis miliacea	255	13	6,375	29.5	3.8	3.4	5.5	8
Blumea lacera	216	15	5,400	34.1	3.2	3.9	5.1	9
Synedrella nodiflora	120	20	3,000	45.5	1.5	5.2	4.4	10
Brachiaria replants	31	7	775	15.9	0.5	1.8	1.4	
Bulbostylis barbata	2	1	50	2.3	0.0	0.3	0.2	
Centella asiatica	43	6	1,075	13.6	0.6	1.6	1.4	
Colocasia esculenta	8	1	200	2.3	0.1	0.3	0.2	
Crassocephalum crepidioides	13	6	325	13.6	0.2	1.6	1.0	
Cynodon dactylon	17	11	4,475	25.0	2.6	2.9	4.1	
Cyperus difformis	85	8	2,125	18.2	1.3	2.1	2.3	
Cyperus esculentus	119	8	2,975	18.2	1.8	2.1	2.8	
Dactyloctenium aegyptium	12	2	300	4.5	0.2	0.5	0.4	
Digitaria setigera	21	1	525	2.3	0.3	0.3	0.4	
Drynaria cordata	51	7	1,275	15.9	0.8	1.8	1.7	
Eleocharis acicularis	56	2	1,400	4.5	0.8	0.5	1.1	
Eleocharis pellucida	99	2	2,475	4.5	1.5	0.5	1.7	
Emilia sonchifolia	12	2	300	4.5	0.2	0.5	0.4	
Equisetum ramosissimum	5	2	125	4.5	0.1	0.5	0.3	
Euphorbia hirta	8	4	200	9.1	0.1	1.0	0.6	
Gomphrena celosioides	4	1	100	2.3	0.1	0.3	0.2	
Hedyotis corymbosa	2	2	50	4.5	0.0	0.5	0.3	
Holcus lanatus	21	1	525	2.3	0.3	0.3	0.4	
Imperata cylindrica	82	5	2,050	11.4	1.2	1.3	1.9	
Kyllinga monocephala	20	1	500	2.3	0.3	0.3	0.4	
Lepidium virginicum	42	4	1,050	9.1	0.6	1.0	1.1	
Ludwiga octovalvis	16	4	400	9.1	0.2	1.0	0.8	

Table 3. *Continued...*

SCIENTIFIC NAMES	BIODIVERSITY INDICES							
	ni	Ji	Di	Fi	RDi	RFi	IV	Rank
Mikania cordata	12	3	300	6.8	0.2	0.8	0.6	
Monochoria vaginalis	41	5	1,025	11.4	0.6	1.3	1.3	
Nasturium officinale	3	I	75	2.3	0.0	0.3	0.2	
Oxalis repens	3	I	75	2.3	0.0	0.3	0.2	
Paspalum conjugatum	13	10	3,325	22.7	2.0	2.6	3.3	
Paspalum lividum	38	6	950	13.6	0.6	1.6	1.3	
Paspalum thunbergii	29	2	725	4.5	0.4	0.5	0.7	
Puerania lobata	5	1	125	2.3	0.1	0.3	0.2	
Pyllanthus debilis	65	15	1,625	34.1	1.0	3.9	2.9	
Rorripa indica	52	8	1,300	18.2	0.8	2.1	1.8	
Sida acuta	2	2	50	4.5	0.0	0.5	0.3	
TOTAL	**6,774**	**44**	**169,350**	**870.5**	**100**	**100**		

Where:
ni - number of individual species
Ji - number of Stations where the species occurred or observed
Oi - density of individual species
Fi - frequency of individual species
RDi - relative density of certain species
RFi - relative frequency of certain species

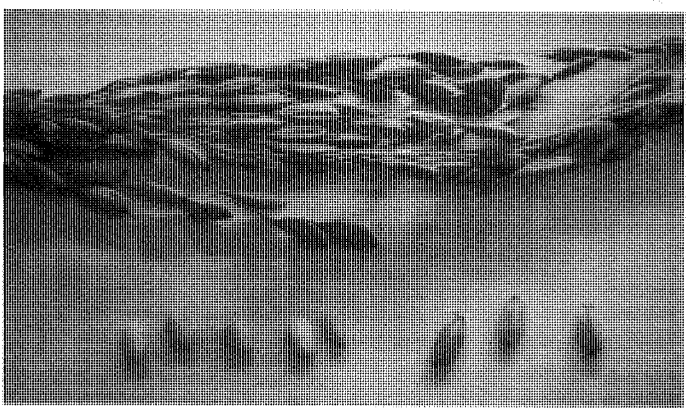

Plate 2. The traditional rice variety: *Bongkitan* (Gadang)

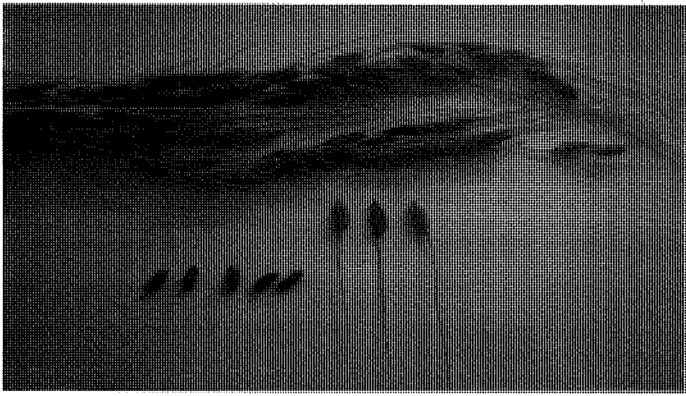

Plate 3. The traditional rice variety: *Balatinaw/Malunaw* (Cuba)

Indigenous Knowledge Systems (IKS) and Farming Practices

Indigenous farming practices in the area include organic farming practices that do not use synthetic pesticides, herbicides, and chemical fertilizers. More importantly, farmers manage their land following sound principles of soil replenishment, biodiversity and ecological balance. IKS and farming practices of Kapangan's ancestral domain's early inhabitants survived mainly on what Mother Nature provided. As the time changed and with the interaction with migrants and neighboring communities they started to cultivate and plant crops of economic value through the use of their indigenous knowledge. Table 4 presents the different IKS and practices as well as the rituals being performed mainly in the study site in Kapangan. These are mainly centered on indigenous rice production during the early times.

Farming practices such as the *man-alado*, is done during land preparation. Harrowing (*depes*) is a farming practice wherein a farmer steps on a wooden harrow (Plate 4) pulled by a *nuwang* (Plate 5). This practice is done to let the rice stubbles overturn for total decomposition and as a source of nitrogen for the soil. Indigenous practice on water management involves the continuous flooding with gravity irrigation method. The water comes from the river or streams and diverted to the rice field. Harvesting is determined when the grains turn to golden yellow. The grains harvested are dried and properly stored to be planted the next cropping season. The panicles bundled in grip size are then stored in the granary (*abong*) until the farmers decide to pound or mill the rice (Plate 6). In the absence of the rice granary, harvested rice is hanged above in the kitchen where heat from the fire dries the rice. Traditional practice of pounding rice is done in a wooden mortar and pestle or the stone pestle.

Table 4 *IKS and rituals being performed during the earlier times*

IKS AND RITUALS	DESCRIPTION
liyaw/ilaw	A ritual performed before trans-planting. This is done to prevent infestation and abundant harvest. The owner of the field will butcher chicken.
pakde/pakshe	This is perfonncd before harvesting to ensure a bountiful harvest and for good fortune.
begnas	This is perfonned to counteract or drive away the sudden appearances of swarn insects, locusts, and other infestations which are believed to be a work of a wicked spirit
denet	A ritual which is performed to appeal to the graces of the gods and goddesses and *kabunian* for a bountiful harvest. Chicken is being offered for this purpose
i-uwangan	A ritual which is done first before beginning the harvest. The ritual requires a chicken and some *ta-puey* is done in the rice fields. Accordingly, it serves as an offering in exchange for a good harvest
podong (grass)	A knot which is tied on a comer of the paddies. This is done to prevent people from passing by the harvesting area,otherwise there would be a lesser harvest and it would not last long.

Plate 4. A person doing the 'depes', done to level the rice field and for the weeds to be overturned for total decomposition

Plate 5. A carabao ('nuwang') used during the land preparation, is seen feeding on the rice stubbles after harvest

Plate 6. A storage house ('abong') where the newly harvested rice grains are stored

Plate 7. 'Lakem', a traditional tool used during harvest ('ani')

Plate 8. 'Alado', a traditional tool used for plowing the rice field

Plate 9. A wooden 'palakpak' used for harrowing the field; usually being pulled by the nuwang while a person is stepping on it

CONCLUSION AND IMPLICATIONS

Based on the results, the entry of modern technologies in rice farming and the pressure on population has resulted to the alteration of land use and diversification of crops. Fertilizer application to the land was apparently needed for the growth of crops and to increase the crop yield. The occurrence was seen to be detrimental to the traditional rice-based ecosystem. Floral diversity in the study area, especially in Site 2 was generally higher, since the rice fields were in a fallow period, in contrast to the other site where weeding was done by the farmers prior to the floral assessment. The different indigenous farming practices such as butchering of pig or chicken before planting have partly undergone modifications because of the introduction of Christian religion as well as formal education with the present generations. Some farming practices such as *man-alado* is being replaced by modern technological instruments such as fuel-driven machine (tractors). Over-all, these directions seem to lead, albeit slowly, to the future loss of the threatened traditional rice-based ecosystems, which are very fragile by their nature. Something should really be done to preserve somehow this rich showcase of human and environment dynamics, before they are forever gone.

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