EM-Composting and Hedgerow Planting for Upland Organic Rice of Nueva Vizcaya, Philippines

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ABSTRACT

The Nueva Vizcaya State University (NVSU), one of the four state universities of the Philippines in Cagayan Valley, started implementing its climate change program in 2013 with funding support from the Commission on Higher Education. The program consists of seven project components focused on developing sustainable agricultural production systems for climate change vulnerable areas of Nueva Vizcaya. A portion of the project component involving organic rice, vegetables, and bananas selected three rice farmers in the rainfed uplands of Buyasyas Village in the north-east of Sta. Fe, Nueva Vizcaya. The site is at 900 m above sea level with about 30 hectares of rainfed lands planted to traditional rice cultivars.

The study profiled the three rice farmer cooperators and their production practices for traditional rice cultivars. The study also showcased and facilitated the use and on-farm production of effective microorganism (EM) compost being promoted by NVSU and reinforced knowledge of farmers on soil conservation in hilly lands through hedgerow planting of an introduced pegionpea breeding line ICP 7035 from the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT).

After a cycle of rice production in the demonstration farms, the initial application of EM compost in selected portions enhanced soil fertility and indicated improved grain filling in *Mindoro*, a pigmented rice cultivar produced by farmer cooperators. The training on biofertilizer production guided farmers in establishing their own composting shed and starting their on-farm EM compost production. Hedgerow planting of ICP 7035 was adopted which provided protection against soil erosion and gave farmers fresh edible seeds. The paper reports significant findings of the study and its implications to climate change resilience and countryside development.

INTRODUCTION

Organic farming is a viable option for mitigating climate change. In this system, the ban of mineral nitrogen from chemicals, crop diversification, and improved soil aeration all diminish emissions of nitrous oxides. Furthermore, organic farming maximizes the use of cultural, biological, and mechanical methods instead of heavy reliance on synthetic inputs. It therefore enhances soil organic matter, enabling the soil to capture and retain more water, making the system specifically resilient to climate extremes like drought and flooding (Muller, 2009).

In the Philippines, there has been a substantial expansion in scale of operations under organic system through the years.

Maghirang (2011) cited a total of 70,000 organic producers nationwide from over 52,500 hectares as compared to 35,000 organic farms from a cumulative area of 14,140 hectares reported in 2006. Common organic crops for domestic consumption include rice, vegetables, fruits, herbs and spices integrated with backyard management of livestock and poultry (NOAP, 2012-2016). The Organic Certification Center of the Philippines (OCCP) estimated in 2009 the area and volume for organic rice at 7,066 hectares and 3.8 M kg, respectively.

The Philippine government has supported initiatives for organic agriculture with a number of legislations and favorable programs. Among these are the Philippine National Standard for Organic Agriculture and Processing (PNS/BAFPS 07:2003 ICS.65.020), accreditation of certifying bodies for organic agriculture through Administrative Order 13, series of 2003, and the creation of the Philippine National Organic Agriculture Board through Administrative Order 1, series of 2004. Recently, Republic Act No. 10068 was enacted, known as the Organic Agriculture Act of 2010, providing for the development and promotion of organic agriculture in the country. In 2011, the National Academy of Science and Technology organized the Organic Agriculture Forum which assessed the status of organic agriculture in the Philippines, identified issues related to productivity and sustainability, and recommended policies on organic agriculture.

There are vulnerable areas in Nueva Vizcaya where organic production of crops can help mitigate impacts of climate change. In Buyasyas, a north-east village of the municipality of Sta. Fe, farmers cultivate rainfed upland areas for some 8-10 traditional rice cultivars, sweet peas, snap beans, ginger, and sweet potato. Rice farmers in this area plant once a year at the onset of the rainy season in May and harvests from October to November. Swidden farming is practiced for production sites cultivated for rice. Farmers do not use chemical fertilizers and synthetic pesticides. Even organic inputs are not applied. Rice yield is consequently low ranging from 30 to 40 bags per hectare (Sana *et al.,* 2013). Improving production in this area through enhancing and sustaining practices of organic farming will mitigate impacts of climate change. The study therefore involved three rice cooperators in the village for modeling EM composting and hedgerow planting for improved organic rice production.

MATERIALS AND METHODS

Profiling of Farmer Cooperators

The three farmer cooperators of the study were identified and selected through coordination with the local government unit of Sta. Fe, Nueva Vizcaya and through previous contacts with the village officials and rice farmers in the area. The three farmers were among those interviewed in the previous characterization work of traditional rice cultivars of the village (Sana *et al.,* 2013). A memorandum of agreement was signed by these farmers before they were officially included as cooperators of the study. They were chosen based on the number of years in upland rice farming, the minimum of 1.0 hectare rainfed rice area, and the continuing cultivation of traditional rice cultivars. Profiling centered on demography and production practices for rice. Soil samples from production sites were also taken for analysis before land preparation and planting and after the harvest season.

On-farm Introduction and Production of EM-Compost

NVSU recently tried, used, and produced EM as a result of training and linkage with an organization doing nature farming. The product consists of three principal microorganisms: lactic acid bacteria, yeast, and phototrophic bacteria. This powerhouse of indigenous microorganisms helps inhibit growth of harmful pathogens by soil pH

Table 1. Demographic profile of farmer cooperators in Buyasyas Village, Sta. Fe, Nueva Vizcaya and the traditional rice cultivars produced

Name of farmer	Gender	Age	Years in Farming	Family Size	Education	Area Planted (m2)	Area Description	Rice Planted	Reasons for planting Rice
Warlito Busong	Male	55	30	5	Elementary	10,500	hilly, rainfed	Mindoro Tulloy	home consumption; for market
Terong Mallana	Male	47	25	8	Elementary	10,000	hilly, rainfed	Mindoro	home consumption
Apolonio Marcial	Male	63	32	4	High School	10,000	hilly, rainfed	Mindoro	home consumption

regulation in decomposing organic matter and producing bioactive substances, and in converting harmful ammonia and hydrogen sulfide into odorless gases (El-Shafei *et al.,* 2008). NVSU had its EM compost analyzed in terms of macro- and micro-nutrient composition based on proportionate mixture of organic raw materials.

EM composting was introduced to the cooperators through a training which also advocated organic production systems for rice, banana, and vegetables. A total of 30 bags (20 kg/bag) EM compost was made available where 10 bags each were given to the cooperators. Actual application was supervised three to four weeks after seeding in selected portions of the production sites covering about 2,500 m2. Cooperators broadcasted the biofertilizers on spots where weak seedlings were observed. On-farm EM composting was also monitored to ensure adoption, continuing production, and use by cooperators.

Hedgerow Pegionpea Establishment

The pigeonpea line ICP 7035 from ICRISAT was introduced to farmer cooperators as hedgerow crops for traditional rice. ICP 7035 is one of the two well adapted pegionpea breeding lines which the NVSU Extension Unit advocated for seed and pod production in selected municipalities of the province. During land preparation, hedgerow planting along contour lines of ICP 7035 was facilitated. Hedgerows were established and maintained even after rice harvest.

Farmers' Visit and Sharing Day

A total of 45 rice and vegetable farmers from Sta. Fe and Kayapa, Nueva Vizcaya were assembled a week before rice harvesting in Buyasyas Village for a field visit and sharing of experiences. The activity was organized on October 22, 2013 to showcase organic rice production, gather feedbacks, and allow cooperators to encourage their co-farmers with benefits from the use of EM compost and pegionpea hedgerows. Data on soil profile and rice yield served as objective support to the positive feedbacks.

RESULTS AND DISCUSSIONS

Profile of Farmers and Their Production Practices

The three farmer cooperators are aged 47 to 63 with farming experience above 25 years. Further, all of them did not finish high school, but instead they focused on rice and vegetable farming as main source of livelihood. *Mindoro* was the most preferred cultivar in the area. *Mindoro* is included in the nine traditional rice cultivars previously characterized by Sana *et al.* (2013) based on morphology, agronomic and grain quality traits, and disease resistance profile. The cultivar yields 1.5 to 2.0 tons/ha, a level that surpasses all the others by over 0.3 to

0.5 tons. It matures in 150 days, has medium grains with intermediate amylose content (non-glutinous), and low gelatinization temperature and therefore of good eating quality. It has Premium Class grains based on percentage head rice recovery and shows resistance to bacterial leaf blight (*Xanthomonas campestris*) Race 6 (Sana *et al.,* 2013).

Based on information from the farmer cooperators and actual observations in the village, production practices follow Swidden farming where land clearing is done through burning to open the site (Table 2). Initial plowing and tilling of soil is done manually with grab hoe and bolo before the rains come. A group of rice farmers (10-15 individuals) usually agrees to provide free labor for land preparation with mutual commitment to do the same for all rice farms of the group, a Filipino practice termed as *Bayanihan*. Direct seeding is done at the onset of the rainy season in May where 8 to 10 seeds are dibbled in holes made through a pointed wooden gadget called "*Asad*". Manual weeding is done twice or thrice during the vegetative stage. No inorganic fertilizers nor pesticides are applied to support crop growth and control insect pests and diseases. Planting 2 to 3 cultivars in a single area and their resistance contribute to natural pest control. Harvesting and threshing are done manually and grains are stored under ambient conditions. Unhusked rice is pounded in "*Alsong*" (Figure 2B), a large wooden mortar and pestle for manual milling. The fallow period of 1 to 2 years is deliberately observed for enriching the soil.

EM-Compost Application and On-farm Production

The NVSU EM compost is rich in organic matter (43.48%) with pH level at 7.60 based on the analysis done by the Cagayan

Table 2. Farmers' cultural practices and management for growing traditional rice cultivars

Operation	Cultural practice	Description of Practice
Land clearing and preparation	Manual using bolo and grab hoe	First clearing (basal) with burning to open area for growing TRV. Grab hoe is used to plow initially and to pulverize soil.
Planting	Direct seeded	Dibble method where 8-10 seeds are broadcasted per hill. Done in late May or early June at the onset of rainy season. Two or three cultivars may be planted in a farm.
Fertilizer application	No fertilizer applied	
Weed control	Manual weeding	Done twice or thrice during the vegetative stage.
Pest management	Scarecrow for birds; network of strings with cans and bamboo poles;	Farmers do rounds daily during grain filling stage till harvest to protect rice from birds. No chemical application for insect pest and disease control.
Harvesting	Manual	Collecting individual panicles or cutting hills using scythe.
Threshing	Manual threshing	Beating rice bundles and collecting grains in nets.
Drying	Sundrying	In bundles or grains spread over a net, sack or bedsheet
Storage	In sacks at ambient temperature	Intended seeds are maintained till next cropping after 6-7 months. Some remain in bundles hanging over the kitchen area.
Milling	Manual	Use of alsong (wooden mortar and pestle)
Soil Enrichment	Fallow Period	Area is left idle for 1-2 years after 3-4 years of consecutive croppings from initial land clearing.

Valley Research Center of the Department of Agriculture in Region 02 (Table 3). The NPK percentage composition of the material is comparable to commercial organic fertilizers. The NVSU EM compost also has magnesium and calcium and is specifically rich in manganese, copper, zinc, and iron.

Results of soil analysis before and after EM applications in the production sites indicate a decrease in soil pH with lower values ranging from 4.9-5.5 in the farms of Apolonio Marcial and Warlito Busong, respectively, for soils applied with EM compost (Tables 4 and 5). Slight reduction in soil pH happens with EM compost application because of the release of organic acids. The regulation of soil pH occurs with EM to maintain soil pH at optimum and to enhance soil fertility (El-Shafei *et al.,* 2008). There was no mark increase in organic matter content but there was notable increase in P and K levels in two of the three farms. In the case of Apolonio Marcial, P and K levels increased from 6.0 ppm and 162 ppm to 18 ppm and 386 ppm, respectively. Likewise, micronutrient (Zinc, Copper, Manganese, and Iron) levels increased with EM compost applications specifically in Apolonio Marcial's farm. Results suggest nutrient enhancement benefits from EM compost application.

Table 3. NVSU EM compost profile based on analysis done by the Cagayan Valley Research Center of the Department of Agriculture at Ilagan, Isabela

Component	Concentration
Organic Matter (%)	43.48
pH	7.60
Nitrogen (%)	2.17
Phosphorus (%)	2.86
Potassium (%)	0.66
Calcium (%)	4.78
Magnesium (%)	1.88
Manganese (ppm)	9.22
Zinc (ppm)	365.00
Copper (ppm)	405.00
Iron (ppm)	3,375.00

Yield levels in the three farms ranged from 0.80 to 1.50 tons/ha (Table 6), similar with previous croppings. However, 1,000 grain weight recorded from samples taken from portions applied with EM compost increased from a mean value of 21.62g to a mean value of 22.60g, suggesting the production of heavier grains from plants supported with EM compost. Cooperators agreed with observing more compact filled grains from plants applied with EM compost. In the study of El-Shafei *et al.* (2008), the 4 ton/ha application of EM compost significantly increased 1,000 grain weight by over 8.2% compared to plants without EM treatment. The increase in grain weight was attributed specifically to high levels of available N and K. K is known to affect translocation of photosynthates and in the case of rice, the improvement in grain filling.

The training on compost production entitled "*Abono Ko, Gawa Ko*", was held in Tidang Village, Kayapa, Nueva Vizcaya on June 6 to 7, 2013 participated by 20 farmers, including 10 farmers from Buyasyas Village. Through the training, each participant had the chance to prepare the compost pile substrate for predecomposition using EM, and produce his own EM solution. Farmers from Buyasyas, Sta. Fe started EM composting in an abandoned school building in the community. They gathered rice straw from their harvest and piled them with other plant debris and swine manure. EM composting in the village has engaged farmers in recycling available plant debris and has limited the usual practice of burning.

Pegionpea Hedgerow Establishment

The ICRISAT breeding line ICP 7035 was successfully introduced on-farm in the village. Two of the farmer cooperators, Terong Mallana and Warlito Busong established their hedgerows along contour lines in hillsides

Table 4. Soil profile (pH, OM, and macronutrients) of the three farms in Buyasyas Village with and without EM compost applications after rice harvest

Cooperator	Soil Profile							
	pH		OM(%)		P(ppm)		K(ppm)	
	No EM	With EM	No EM	With EM	No EM	With EM	No EM	With EM
Warlito Busong	5.6	5.5	2.2	2.2	1.0	6.0	214	172
Terong Mallana	5.3	5.3	2.6	2.4	5.0	8.0	172	233
Apolonio Marcial	5.3	4.9	2.2	2.6	6.0	18.0	162	386

Table 5. Micronutrient profile of the three farms in Buyasyas Village with and without EM compost applications after rice harvest

Cooperator	Soil Profile							
	Zn(ppm)		Cu(ppm)		Mn(ppm)		Fe(ppm)	
	No EM	With EM	No EM	With EM	No EM	With EM	No EM	With EM
Warlito Busong	2.13	6.95	5.33	3.88	99.1	90.4	135.3	169.3
Terong Mallana	6.24	6.19	5.85	3.81	145.6	130.6	172.9	156.7
Apolonio Marcial	2.14	3.55	2.39	3.13	75.42	110.7	226.0	262.6

where their traditional upland rice cultivars were planted. The set up was showcased during the Farmers' Visit and Sharing Day. The hedgerows contributed to soil erosion control and provided edible seeds to the farmer cooperators.

Pegionpea (*Cajanus cajan*), like the common *Madre de Cacao* (*Gliricidia sepium*) and *Ipil-ipil* (*Leucaena leucosepala*), has been used as hedgerows in hill slopes to effectively check surface run-off (Firoz, *et al.,* 2012). In Buyasyas Village, erosion control in hillsides is done by constructing run-off traps with bundle of twigs and plant debris across slopes where upland rice is cultivated. This practice was enhanced with hedgerow planting of pegionpea along contours which the farmer adoptors maintained even after rice harvest.

Farmers' Visit and Sharing Day

A total of 45 participants joined the activity held in Buyasyas Village at the rice production sites of two of the three cooperators. The visit gathered the municipal agriculturists of the two towns and their other officials, representatives from the DA-Nueva Vizcaya Experiment Station (DA-NVES), NVSU officials, the cooperators of the project, and farmer neighbors. In the activity, participants toured the three rice farms and appreciated the improved set-up with contour pegionpea hedgerows in hillsides.

Notable positive feedbacks from farmers about EM compost application include recovery of weak seedlings, sustained growth of rice plants, and production of more filled grains. Data on 1,000 grain weight supported the observations. Moreover, farmers appreciated the pegionpea contour hedgerows which provided edible seeds while contributing effectively to soil erosion control. Farmer cooperators and farmer visitors suggested on-farm evaluation of other ICRISAT's pegionpea breeding lines for hedgerow planting and as fallow crop after traditional rice.

Table 6. Rice yield of the three farms in Buyasyas Village and 1,000 grain weight recorded from unhusked rice samples taken from portions with and without EM compost application

Cooperator	Yield (tons/ha)	1,000 Grain Weight (g) (No EM Compost)		1,000 Grain Weight (g) (With EM Compost)	
		Range	Mean	Range	Mean
Warlito Busong	1.50	21.4-22.2	21.62	22.2-23.0	22.60
Terong Mallana	1.20	21.3-22.0	21.65	22.0-22.6	22.30
Apolonio Marcial	0.80	21.6-22.3	21.95	22.2-23.1	22.48

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