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Self-Reliant Rice Farming Strategies in the Face of Climate Change for Small Farmers in Bataan, Philippines

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Abstract The study was designed to formulate strategies to enhance farmers' self-reliance in rice production that would increase their productivity and income in an ecologically sound way in the face of climate change. Focus group discussion was conducted among selected small farmers in major rice producing municipalities of Bataan Province to identify the strengths, weaknesses, opportunities, and threats related to rice farming activities during the harvest seasons of year 2011. SWOT Matrix was used to evaluate the internal and external aspects impacting rice production in the study area from which self-reliant rice farming strategies for small farmers were developed. Findings of the study disclosed that farmers' major concerns were the low production yield, high cost of production inputs, low level of farm mechanization, excessive use of fertilizers and pesticides, and soil degradation. Typhoons, floods and other calamities due to climate change, continued increase in cost of farm inputs, as well as pests and diseases were the major constraint to rice farming activities. The formulated strategies promote an approach that utilizes resources from the farm rather than relying on purchased inputs. In other words, self-reliant rice farming has low external inputs but high adoption of environmentally sound management practices which emphasizes food security and a resilient agro system with inbuilt assurance against climate change for sustainable agriculture.

Keywords: small farmers, self-reliant rice farming strategies, climate change, sustainable agriculture, SWOT matrix analysis

Introduction

Rice farming is being threatened by climate change, which is primarily manifested in the changing intensity and length of the rainy season and average rainfall in the Philippines (Carroll, 2009). Specifically, Bataan had incurred an estimated P2.6 million damage in its rice fields due to calamities in 2012, the Department of Agriculture reported (PIA, 2012).

Calderon *et al*. (2008) reported that Bataan has been facing the worsening problem of rice deficiency and increasing prices. The decreasing trend in rice

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yield from 2008 to 2011 both in irrigated and rain fed areas is due to uncertainties in production (BAS, 2012). Problems in rice production are also aggravated by physical, biological and socioeconomic constraints that contribute to the yield gap between actual farm yield and attainable yield including limited farmland, lack of rights to land cultivation, low price of rice, environmental and ecological degradation (Philrice, 2013), and inadequate irrigation and post-harvest facilities (Calderon *et al.*, 2008).

Therefore, appropriate rice farming practices should be utilized by small farmers in Bataan to minimize problems in rice production in the face of climate change. Such practices should have attributes that support the underlying principles for sustainable agriculture that contributes to the overall objectives of sustainable development (Teoh, 2003). Marinova and Hossain (2006) stressed that self-reliant living is a viable means of caring for nature and other human beings, and hence, for sustainability. Self-reliance as defined by UNHCR (2009) is the social and economic ability of an individual, household or community to meet basic needs in a sustainable approach and with dignity. It advocates the need for people to improve their way of living using local initiatives and resources in their own hands with self-help, mutual-help and indigenous participation thereby reducing their vulnerability (Fonchingong and Fonjong, 2003; Ghari, 1980) and offering them the opportunity to share in making important decisions about their living conditions (Galtung, 1980) for effective community development. Studies had shown that local communities are endowed with considerable skills and abilities and that, in many situations, local initiatives constitute the only means of survival for the poor and disadvantaged, highlighting the importance of increasing local control over local resources (Gooneratne and Mbilinyi, 1992). Scoones and Chibudu (1996) emphasized that adopting a self-reliant approaches, particularly in times of adversity, such as during droughts, can promote the diversification of survival strategies which drawn on indigenous knowledge in the communities involve. In self-reliance farming, food security and the reduction of household expenses should be highlighted. In addition to the existing indigenous knowledge, the dissemination of new agricultural innovation and technologies should also be the main concern, as farmers need such improvement in order to produce higher yields (Pattanapant and Shivakoti, 2009).

It is therefore the initiative task of the researcher to find out what are the strategies in rice farming appropriate for small farmers in Bataan, Philippines that would assist them on the approaches to increase their productivity in the face of climate change.

Materials and methods

A qualitative research design was employed in the study intended to set out the underlying principle for a more explicit approach in evaluating the rice farming activities in the study area to be better understood.

Focus group discussion was conducted among small farmer participants (those with less than 2 hectares of farm land and who are farm leaders with ample experience in rice farming) purposively selected in 6 major rice producing municipalities (Abucay, Dinalupihan, Hermosa, Pilar, Samal, and Orion) of Bataan Peninsula. FGD was conducted in each sample municipality with 10 participants in each group making a total of 60 small farmers who participated in this research activity in order to identify the strengths, weaknesses, opportunities, and threats impacting rice farming activities during the harvest seasons of year 2011.

Finally, SWOT matrix was utilized to evaluate the inputs gathered from which strategies were formulated aimed at enhancing self-reliance in rice production for small farmers in Bataan, Philippines.

Results and discussions

The condensed internal and external evaluation of the assessed areas of concern as well as the development potentials for agricultural strategies for small farmers in Bataan is illustrated in the SWOT Matrix, Figure 1. As reflected in the figure, farmers' major concerns are the low production yield, high cost of production inputs, low level of farm mechanization, and excessive use of fertilizers and pesticides. Typhoons, floods and other calamities, continues increase in cost of farm inputs, pests and diseases, as well as soil degradation are the major constraint to rice farming activities.

Strengths*:* Bataan Peninsula is blessed with farmlands and the favorable climate allows rice production throughout the year. The Department of Agriculture and the Provincial Agriculture Office are conducting continuous training to farmers in every municipality of Bataan known as Farmers' Field School which is a manifestation of government support being extended to farmers to become empowered with knowledge and technologies in rice farming. The farmers in Bataan are organized into irrigators association and farmers' cooperatives that serve as initial nucleus in the clustering approach and assist in the delivery of support services to farmer-members. The government and non-governments agencies should support the strengthening of farmers' association by lessons of experience in generating more effective, self-reliant and sustainable rice farming technologies and such intervention should emphasize farmer group capacities particularly in management, leadership, planning and evaluation.

Weaknesses: Although Bataan provides an ecological system for rice cultivation, the high post harvest losses both quantity and quality of the harvested rice grains can severely limit the profitability and marketability of locally produced rice. Lack of post-harvest facilities and infrastructure such as storage of inputs and low adoption of farm machineries can hinder the production of higher rice yield. In addition, the excessive use of chemical fertilizers and pesticides can affect the physical and chemical properties of soils, particularly in irrigated areas which can result to soil degradation affecting its productivity. Low yield in rice production is also aggravated by high cost of agricultural inputs such as fertilizer, pesticides, petroleum, and farm machines. Facing the burden as expected are the small farmers who have to spend more just to ensure adequate water supply for their crops. One farmer-respondent in focus group discussion mentioned that he had to spend more than P30,000 for diesel fuel consumption alone for his two water pumps to irrigate his one-and-a-half hectare of rice land this cropping season, compared with only P20,000 last year.

Opportunities: If small farmers consider the use of low cost technologies by promoting a variety of approaches of attaining low external input and sustainable rice farming such as traditional, indigenous, organic, ecological, regenerative, and resource conserving agriculture most likely enhance rice yield. Given the small size of rice farms, farmer organization/cooperatives should be part of a mechanization effort to reduce the costs and risks involved. With the existing knowledge of the farmers' selection of rice seed, there is a big opportunity for small farmers to produce their own seeds for them to use continually in their rice farming activities. The farmers' good practices on rice seed management existed already and corresponding initiatives supporting these practices should be implemented. IRRI (2006) and IPCC (2006) accentuated, the challenge for farmers to produce higher yield or more rice with less water, economically and in ways that will be adopted by them in a context of improving the efficiency of irrigation water for soil enhancement measures, more distribution of water and reduce run-off thereby reduces the amount of water required for land preparation, improve crop establishment and care, results in better crop stands, reduces weed problems, and results in uniform maturity.

Threats: Farmer participants in focus group discussion claimed that rice production in their respective area is plagued by problems wherein yields have been consistently low during the past 3 years due to typhoons, floods and other calamities, continues increasing cost of inputs such as fertilizers, herbicides, farm equipment rental fee, insecticides, manual labor, petroleum and transportation of produce. In addition, modern agriculture is seen as the factor that has most extensively constrained farmers' food systems. It has cause to a diminishing yield. The loss of agro-biodiversity and the emergence of new types of pests and diseases, and has threatened the farmers' agriculture.

The Agricultural Strategies: Based on the SWOT Matrix analyses, strengths and opportunities in the study area had been exploited to reinforce the weak elements as well as to minimize the threats associated that may eventually improve the existing rice farming practices. Thus, the strategies should focus on enhancing self-reliance in rice production by using the internal strengths to take advantage the external opportunities abound the study area while minimizing and overcoming the internal weaknesses and at the same time avoiding the impact of external threats. Self-reliance in the cultivation of rice once adopted by small farmers is expected to enhance food security and alleviate poverty through increased productivity and profitability in the long run of the rice farming communities in Bataan, Philippines. These include providing farmers the appropriate self-reliant rice farming strategies with climate-resilient rice crop management technologies/practices while addressing environmental concerns.

Vision **(S1-O5/S3-O2 strategy):** A self-reliant, sustainable rice farming and a diversified rural development in Bataan Province. Its transformation is guided by the sound practices of resources and technology with strong community participation.

Mission **(S1-O2,O3 strategy):** To help the rice farming communities in Bataan Province to attain self-reliance in rice production by increasing the productivity of small farmers to produce enough, accessible, and affordable rice in a sustainable and competitive manner and pursue a decent way of living.

General Objective **(W1-T1, O2, O3, O4, O5 strategy):** To enhance self-reliance in rice production through improved crop management technologies/practices resilient to climate change and strengthen the farm system in Bataan thereby transforming the lives of small farmers from poverty.

Enhancing self-reliance in rice production

Promote and enhance the use of own bred seeds **(S1-O2 strategy):** For more independent and more ecologically sound production methods, small farmers should select and use their own seeds. In this way, they demonstrate their ability to naturally adapt varieties to their locations, to conserve, renew, and increase biodiversity, to reconstitute the carbonized organic matter stored in soil and to produce a sufficient quantity of healthy food at a lower cost and with lower intake requirements (BEDE, 2011). By storing farmers' own bred seeds after the harvest season, farmers will be able to avoid unnecessary expenses and effort to reach and find seed for the next planting season. They will be able to sow at the right time, which transplanted to better returns. Small farmers should learn to collect and select their own seeds. Just before harvest, look for robust, highly productive plants; harvest their panicles individually and hand-thresh; dry the seeds and store these in preparation for the next crop; first drying should reduce moisture content to 13-14%; re drying after 15 days for at least 2 hrs (between 9-12am) further reduces moisture; seed testing should be conducted regularly for viability and germination rate (SRI-Pilipinas, 2009).

Improving soil fertility by using organic fertilizer **(W4-O5 strategy):** The soil at the farm should be continuously improved through organic matter like rice dust heaps should be composted and rice straw should never burn but is allowed to decompose. The composted waste is recycled to supply much needed soil nutrients, especially silicon, and replace those that have been depleted (UNEP, 2005). In addition, neem tree, madre de cacao, macabuhay leaves, carabao manure, soap and water are mixed together to form a homemade organic fertilizer which can be applied to infertile rice paddies and to the vegetable crops. The carabao's shed should be placed next to a major canal so that during rainy season, decomposed dung and urine naturally flow along the canals to the rainfed rice paddies (SRI-Pilipinas, 2009). The farm produces all the fertilizers it requires using nitrogen fixing crops, ground covers and leaves from nitrogen fixing tree species such as Gliricidia and wildflowers. Nutrients loss is prevented by minimizing erosion and recycling as much as organic matter as possible IPNS, 2011).

Adoption of natural and non-pesticidal management strategies **(W3-T3 strategy):** Non-pesticidal management primarily focuses on replacing the external inputs with the local knowledge, management skills, labor and effective utilization of natural products and processes that are locally available and work together as a community and so enhance farmers' self-reliance (Ranjaneyalu *et al.*, 2005). Some of these are: deep summer plowing to expose insect pupas so they die in the sun, light traps and bonfire to attract moths, yellow and white sticky boards in the fields, manual removal of the leaf surfaces on which heavy egg–laying took place, pheromore traps for pest incidence surveillance (Ranjaneyalu *et al.*, 2005 ; GTZ Sustainet, 2005), neem seed-kernel extracts and chili-garlic extracts to control bollworm and sucking insects; cooking oil and chopped garlic and onion as spray to control *tungro.* use of foliar pesticide from *kakawate* and neem leaves, *makabuhay* stems, and goat manure to control pests and improve the health of rice leaves; extract made from cow dung and urine to control aphids and leafhoppers (this extract also acts as fertilizers) (GTZ Sustainet, 2005); planting gabi or taro near the rice field, this may help control the damage inflicted by golden snails since the snails like to eat gabi leaves. The pest would only destroy the rice when it had no alternative food to eat. In addition, rice hull thrown in the paddies found to stick the snail's skin and kill the pest slowly; to keep rats away from the rice seedlings, a plot of their preferred food such as cassava and sweet potato are planted along the paddy (Garcia and Mulkins, 2001). Mamemachi (2012) reported that the paddy with ducks provided several advantages in terms of rice production: the ducks eat weeds, which means weeds do not need to be removed by hand; the ducks also eat insects, and the ducks' droppings provide nourishment for the growing rice; the ducks, while moving among the plants, are constantly paddling the water and thus prevent too much settling, such as sediments, at the bottom of the paddies; the ducks also eat golden snails, which are a serious threat to rice; and the ducks provide an acceptable level of stress so that the plants can grow stronger and healthier. For ducks, rice paddies are excellent environment because they provide water and food as well as a hiding place from predators.

Improving efficiency of irrigation system: **(S1-O4 strategy):** The following soil enhancement measures are recommended for adoption: Proper field leveling – for more uniform distribution of water and reduce run-off (De Guzman and Zamora, 2012). A well prepare leveled field reduces the amount of water required for land preparation, improves crop establishment and care, decreases the time to complete tasks, results in better crop stands, reduces weed problems, and results in uniform crop maturity (Asea *et al*., 2010). Furrow diking – allows the capture of irrigation or precipitation water in small earthen dams within furrows, to reduce run-off and increase the efficiency of irrigation (De Guzman and Zamora, 2012). Higher water use efficiency and paddy yield was obtained with the paddy transplanted on bed and furrow method compared to traditional basin flood irrigation method. Transplanting of two rows of paddy on bed & furrow each 22 cm with furrows compacted furrow gave the highest water use efficiency of 0.39 Kg/m3 with 32% saving of water Kahlown and Racoof, 2001). Residual management and conservation tillage – where the amount, orientation, and distribution of crop and plant residue on the soil surface are managed and such practices improve the ability of the soil to hold moisture, reduces water run-off from the field, and reduces surface evaporation (De Guzman and Zamora, 2012). Conservation tillage system is an ecological approach to soil surface management and seedbed preparation. It minimizes soil erosion risks, conserves soil water, decreases fluctuations in soil temperature of the surface layer, improves soil organic carbon content, and enhances soil structure (Singh and Kaur, 2001).

***Adoption of agricultural machinery and utilization of more efficient post-harvest facilities* (W2-O1 strategy):** Small to medium mechanization should be adopted by small farmers to enhance rice production. Post-harvest mechanization for processing agricultural products will be strongly needed in the rural industrial processes, and it will be more rapidly adopted by the farmers since the nature of its contribution to the beneficiary is more significant than pre-harvest mechanization (Handaka, 2009). Instead of buying their own machinery for their field operations, farmers as much as possible should resort to custom hiring. The custom service operation appears to be a workable strategy for promoting mechanization because it is based on a direct client-provider relationship governed by normal market forces (Paras and Amongo, 2005).

***Adoption of appropriate management strategies in natural resource conservation* (S1-O5 strategy)** – Ecological criteria should be considered in management interventions of natural resources like balancing use of nutrients and organic matter - Healthy soil is the foundation of the food system. It produces healthy crops that in turn nourish people. Maintaining a healthy soil demands care and effort from farmers because farming is not benign. By definition, farming disturbs the natural soil processes including that of nutrient cycling - the release and uptake of nutrients (FAO, 2005)

***Minimize consumption of farm inputs* (W3-T2 strategy)** – Farm waste can be recycled into organic fertilizer; therefore reducing the chemical inputs (Philrice, 2011). Small farmers should consider the use of low cost technologies but capable of enhancing rice yield which include making of mulches from crop residues, preparing compost from manure or recycled waste, green manure, bio-fertilizers, soil and water harvesting, bio-pesticides and agro-forestry. Traditional varieties are sometimes improved and reintroduced because it is assumed that they are better adapted to local ecological conditions and are more resistant to pests and diseases. These interventions are most likely recommended to improve ecological stability and overall productivity at the same time reducing risks and making more efficient use of inputs. Farmers should practice sustainable agriculture with low external inputs which can enable such farmers to achieve higher income and attain sustainability by optimizing the use of locally available resources, thereby achieving a synergetic effect among the various components of the farming system(soil, water, animals, plants, etc.) so that they complement each other in the production of output (LEISA, 1998).

Improving Production Practices Resilient to Climate Change

Adaptation technologies and practices for rice farming

Increasing water/rainfall use efficiency **(W4-O4, O5, T1 strategy) -** Any management intervention that increases yield is likely to increase water use efficiency (Gregory, 2004; Machado *et al.*, 2008). Improvement in yield and water use efficiency can be attained by: conservation tillage, zero tillage in crop rotations, use of residues and mulches, timely sowing, seed priming, balanced and timely fertilizer application, use of organic amendments, weed control and better irrigation scheduling, and others (Raza and Bodner, 2012) to increase water use efficiency, planting most fast growing trees and shrubs such as eucalyptus deglupta, camaldulensis, acacia mangium, and Gmelina arborea is recommended (De Guzman and Zamora, 2012); CGIAR (2006) reported that from flooding to alternate wetting and drying is needed to incorporate green mulch so as to increase the water use efficiency; d) direct seeding offers opportunities to improve water use efficiency in rice cultivation by reducing the irrigation water inflow requirement during soil preparation. Direct-seeded rice in lowland consumed less water than transplanted rice under same conditions as for soil preparation and crop water irrigation. It was also reported that the total water use dropped from 2195 mm for transplanted rice to 1700 mm under direct-seeded rice in wet conditions (Cabangon *et al.*, 2002).

Improve field management **(W3-O5,T1/W4-O5 strategy)** – a) Shift to organic agriculture to achieve increase soil organic matter, higher water holding capacity, better water percolation and hence less runoff and erosion, balanced fertilization resulting to healthier plant (De Guzman and Zamora, 2012). b) Soil and water-saving technologies - Soil conservation is achieved by controlling soil erosion (the extent of soil and organic matter loss) and regulating tillage practices. Proper soil conservation is the foundation for effective organic production of crops and animals (FIBL, 2012). CH_4 can substantially be reduced by mid-season drainage or alternate wetting and drying (IRRI, 2006). Controlled irrigation helps reduce irrigation water used in rice production by 16-35% without decreasing yield; therefore, more farms near the tail-end of the irrigation system could benefit. This could also help increase farmers income through reduction of farm inputs and minimize methane emission, which is higher in continuous flooding irrigation method (IRRI, 2006; IPCC, 2007). Improved water resources management through Integrated Water Resources Management, Alternate Wetting and Drying irrigation management technique and other water saving techniques in agriculture which has a potential of reducing water requirement by 15-20% and the GHG emission by 30-50% (APEC, 2012); c. adjustment of cropping calendar - Changing the crop planting date and making more effective use of rainfall: Both these strategies require changes in water resources or reservoirs and farm management strategies (FAO, 2000).

Mitigation strategies in rice farming

Improved rice crop management to increase soil carbon storage **(W3-O5,T1 strategy)** - Increased soil carbon storage can be achieved through improved agronomic practices which increase yields while also generating higher inputs of carbon residue such as using improved crop varieties; extending crop rotations; avoiding or reducing use of bare fallow. Another group of agronomic practices are those that provide temporary vegetative cover between successive agricultural crops, or between rows of tree or vine crops. These 'cover' crops add carbon to soils and may also extract plant available N unused by the preceding crop, thereby reducing N_2O emissions (APEC, 2012).

Estimates indicate that tillage reductions on global cropland could provide a full "wedge" of emissions reductions — up to 25 Gt over the next 50 years (Pacala and Socolow, 2004). Residue management in the form of retained crop residues also tends to increase soil carbon storage which occurs as the residue is the precursor for soil organic matter, the main carbon store in the soil. Moreover, avoiding the burning of residues also avoids emissions (IPCC, 2007) and controlling the input of straws from rice into the flooded soils. Most of the methane produced is from the decomposition of the rice straws that are often in flooded water since this will favor the growth of methanogenic bacteria. Thus, rice straw should be used as feed for carabao while the composted manure from the carabao is applied to the paddy and this will invariably increase plant nutrients, retain plant nutrients, increase production stability and quality of rice, decrease methane emissions, promote rice growth and encourage aggregate soil structures (Epule *et al.*, 2011).

Improved rice-growing techniques to reduce methane emissions **(S1-T1 strategy) -** Practicing mid-season drainage has been found to reduce methane emissions to as much as 80% better than continuous flooding, without having any significant effect on rice yield. In addition, direct seeding method of crop establishment has been shown to reduce emission of methane owing to shorter flooding periods and crop maturity, and decreased soil disturbances. A study on direct seeding resulted in a 16-54% reduction in methane emission compared to transplanting (Philrice, 2011).

Strengthen farmers' organization **(S3-O2,O3/S2-O2 strategy)** - A local organization through which farmers can negotiate their interests has been shown to be the key to the success of development projects (Danne *et al.*, 1991). There is also evidence that externally initiated programs are more likely to be sustainable and equitable if Farmers' Organizations, rather than the state, are given primary management responsibility (Fowler, 1992). But Farmers' Organizations are limited in what they can accomplish alone; partnership with government is likely to be more effective in many instances (Bebbington, 1992). Therefore, the basic strategies of the people-based development of Bataan Province are as follows:1) Empowering small farmers' organizations by promoting and enhancing self-reliance or self-help through on-farm activities such as income generation projects in Bataan Province; like compost making or vermin-culture; sustainable rice farming practices; cooperative work in agriculture in coordination with Non Government Organizations; 2) Local capacity building of the small farmers to undertake their own development initiatives through training programs sponsored by NGOs on effective farm management to boost managerial skills (involving planning, organizing, controlling their own farm); participatory leadership practices; self-financing strategies of farmers' organizations.3) Networking among non-governmental organizations and farmers' organizations based on common interest of issues, cooperative movement and rural development.

Conclusion, implications and recommendations

Small farmers' major concerns were low production yield, low level of farm mechanization, excessive use of fertilizers and pesticides, high cost of farm inputs, and soil degradation. Calamities due to climate change, continues increase in farm inputs, pests and diseases were the major constraints to rice farming activities which could be attributed by climate change. These were made the bases to carry out SWOT matrix analyses and developed appropriate rice farming strategies for small farmers – an approach called self-reliance in rice production that has low external inputs but high internal regeneration of inputs which emphasizes food security and a resilient agro system with inbuilt assurance against climate change for sustainable, natural, green and organic agriculture.

The recommended interventions can bring positive impact among small farmers in Bataan to improve their productivity and income in an ecologically sound way. Specifically, the following are the benefits the formulated strategies can provide the small farmers, the community, and the environment: 1) Improving the environmental stability and overall productivity while reducing risks and making more efficient use of inputs; 2) Enhancing rice yield thus promoting food security; 3) Achieving higher synergy whereby reducing or non-utilization of agro-chemicals and other external inputs that that are environmentally unsound and promoting financial viability of the farmers by reducing costs of production; 4) Minimizing the vulnerability to climate change by reducing greenhouse gases emissions and reducing losses and waste in rice production; 5) Building the community and improving the quality of life of the people; and 6) Strengthening small farmers' community-based organizations.

Training sessions and information campaign is therefore needed to emphasize the benefits for small farmers when introducing and spreading the formulated strategies successfully. Farmers should gradually shift the current agricultural practices to natural processes so that they will not experience an abrupt and drastic drop on rice yield. There should be a clean and comprehensive conservation policy on rice paddies; an ordinance on not burning of rice straw and other crop residues and it is deemed to be included in the municipal provision of Bataan Province on environmental protection on natural resources conservation. Participatory action research should be undertaken to reinforce the study by implementing the formulated agricultural strategies on enhancing self-reliance in rice production to take into account its impact to small farmers. Future research should be undertaken to further evaluate the ecological soundness, economic viability and social justice of the formulated agricultural strategies after two or three years of adoption.

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