Challenges and Opportunities for Giant Freshwater Prawn Culture through Participatory Learning and Fish Farmer Engagements

Hermogenes S. Tambalque III
WorldFish - Philippines Country Office
H.Tambalque@cgiar.org

Maripaz L. Perez
WorldFish - Philippines Country Office

Plutomeo M. Nieves
College of Fisheries, Bicol University

Valeriano L. Corre
College of Fisheries and Ocean Sciences
University of the Philippines Visayas

Jude A. Duarte
Southern Leyte State University, Philippines

Neil A. Pulido
Dipolog School of Fisheries

Henry E. Dejarme
Mindanao State University-Naawan

Dennis D. Tanay
National Fisheries Research
and Development Institute

Len R. Garces
WorldFish - Philippines Country Office

ABSTRACT

*This paper provides a review of on-farm studies conducted to explore the viability of giant freshwater prawn (*Macrobrachium rosenbergii*, locally known as ulang), culture in six regions in the Philippines. We adopted a participatory action learning approach aimed at improving pond productivity through engagement of 17 small-scale fish-farmer cooperators to adopt different ulang culture systems—ulang monoculture, ulang-rice polyculture, and ulang-tilapia polyculture. This paper focuses on comparing the production and profitability of ulang monoculture and ulang-tilapia polyculture.*

The cooperators were guided to follow proper protocols in pond preparation, feeding, and water management. Results showed an average survival rate of 65 percent for ulang monoculture; and 59 percent and 77 percent survival rates for ulang and tilapia in polyculture system, respectively. The major problems encountered across regions were unavailability of post-larvae; distance of post-larvae source; water availability; presence of predators; and inconsistent implementation of technical interventions by the cooperators. This paper also presents research and policy recommendations toward sustainable development of freshwater prawn culture which include establishment of a network of hatcheries and broodstock development; technology promotion and extensions services; and improving value chains and market strategy.

Keywords: *Macrobrachium rosenbergii*, giant freshwater prawn culture in the Philippines, small-scale aquaculture, participatory action learning, culture systems
JEL Classification: Q12, Q22

INTRODUCTION

The Philippines with its archipelagic characteristic provides an ideal environment for fisheries and aquaculture. However, pressure from overfishing and other destructive activities has led to fish stock depletion particularly in traditional marine fishing grounds (Barut, Santos, and Garces 2004). One way of minimizing impact on fishing grounds is through aquaculture to maintain fish production and meet the increasing demand for fish. The global aquaculture production has to increase in order to cope with the growing demand and compensate for the reduced production of capture fisheries (Bosma and Verdegem 2011). In 2011, the annual performance of the fishing industry that was attributed to the aquaculture sector was 52.4 percent (2.608 million tons) followed by the municipal sector with 26.8 percent (1.33 million tons), and the commercial sector with 20.8 percent (1.03 million tons) (BFAR 2011). The contribution of aquaculture underscores the importance of the sector in maintaining the supply of fish. 3

Giant freshwater prawn (Macrobrachium rosenbergii) has long been farmed using traditional methods in Southeast Asia. Workers in Thailand started growing prawns in earthen ponds in 1956 with juveniles collected from open water. Since Ling's (1969) success in rearing larvae to juveniles to adults of marketable size, pond culture of freshwater prawn has evolved. The giant freshwater prawn can even be reared in irrigated paddy fields that are able to retain water depth of not less than 15 centimeters (cm) (Soesanto 1980).

In the Philippines, the giant freshwater prawn is locally known as *ulang*. In the 1990s, the Bureau of Fisheries and Aquatic Resources (BFAR) of the Philippine Department of Agriculture pioneered studies on ulang production in the Philippines at the National Freshwater Fisheries Technology Center (NFFTC) in the Science City of Muñoz, Nueva Ecija. In the later part of 1998, BFAR successfully mass-produced the post-larvae stage of this species. In 2001, the ulang hatchery was further improved and a commercial hatchery was established in Muñoz and later on at the BFAR-National Integrated Fisheries Technology Development Center in Bonuan, Dagupan City, Pangasinan (Tayamen 2005).

Except for the Philippines, the culture of *M. rosenbergii* has contributed substantially to local aquaculture production in Southeast Asia (New 2005). In these countries, production is already gearing toward an all-male culture given that they grow faster than females (Aflalo et al. 2006; Nair et al. 2006). In the Philippines, government fishery agencies as well as research and academic institutions are working on optimal methods for the culture and propagation of ulang (Romana-Eguia et al. 2006).

With the country's extensive inland water resources, ulang aquaculture has a very large potential. On the average, farmed ulang weighs from 30–100 grams (g) each, which translates to 25–10 pieces per kilogram (kg). This is very much comparable to the medium to large or jumbo sizes of brackish water tiger shrimps or *sugpo*. In the wild, ulang grow to as much as 500 g and sells at PHP 300–350 per kg (USD 1 = PHP 55.50). However, the quantity harvested is limited and is seasonally-dependent (Tayamen 2005).

Participatory action research has been increasingly used as a promising approach for improving the impact of research on development and change. For example, the CGIAR Research Program on Aquatic Agricultural Systems aims to achieve learning and development by using participatory action research (PAR) to implement research that fosters empowerment and collective learning (Apgar and Douthwaite 2013). While many action research practitioners would suggest that learning approach alone can lead to real development impact, it was argued that more formal forms of strategic research to identify broader structural constraints and to enable cross-site learning among regions are complementary to such participatory forms of learning (German and Stroud 2007).

With funding support from the Department of Science and Technology (DOST) Regional Offices II, V, VII, VIII, IX, and X and in partnership with state universities and colleges (SUCs) (i.e., Isabela State University, Mindanao State University-Naawan, and Southern Leyte State University-Bontoc), WorldFish embarked on the culture of giant freshwater prawn through on-farm trials in six regions to identify and ultimately provide alternative viable and sustainable livelihood options to small-scale fisherfolk. It is within this context that regional on-farm trials were conducted and piloting was done to explore the potential for replication in other areas in the Philippines. This study was therefore conducted to assess and promote alternative fish species that could be farmed to supplement income of fish growers (Nieves et al. 2011; Perez, Tambalque, and Domingo 2011; Perez, Soliven, and Dejarme 2011; Perez et al. 2011a; Perez et al. 2011b; Pulido, Perez, and Tambalque 2011).

This paper aims to present and review our experience on participatory action learning approach aimed at improving pond productivity through engagements with fish farmers. We also document the challenges and opportunities of ulang culture especially for small-scale fisherfolk. Specifically, the growth performance in terms of average body weight at harvest, survival rate, profitability, and viability of ulang in the two culture systems were compared. Research and policy recommendations as well as best practices for sustainability of ulang farming as a livelihood option for small-scale fishers are discussed.

METHODOLOGY

Selection of Project Sites

On-farm trials (Figure 1) were done by partnering with regional institutions such as state universities, the Department of Science and Technology (DOST), and BFAR. Together, they selected the appropriate sites for on-farm trials using the following set of biophysical and socioeconomic criteria: (1) availability of water (exploitation of groundwater or use of irrigation systems); (2) soil and water quality; (3) accessibility of giant freshwater prawn seed supply, (4) accessibility of technical support from a local university or DOST/BFAR regional office, and (4) potential for expanding production and marketing of the giant freshwater prawn.

Selection of Farmer-Cooperators

The study team with DOST and BFAR partners used the following criteria in choosing the appropriate fish-farmer cooperators:

1. Engaged in small-scale fish farming operation (for the purpose of this study = operating a 500–1000 square meter [m^2] pond), however in some study sites we also conducted the study in smaller ponds due to the interest and willingness of farmer cooperators to engage (Table 1);
2. Fish farming is one of the major sources of income for the household;
3. With financial resources or access to such resources to enable him/her to adopt the technology being introduced.

Three to four farmer cooperators in each site were chosen and briefed on the nature of the study. Considering that the study aimed to promote participatory learning, willingness to cooperate was confirmed at a stakeholder/inception meeting at the beginning of the project. The study team also conducted pre-scoping

Figure 1. Locations of project sites and partner institutions in the study

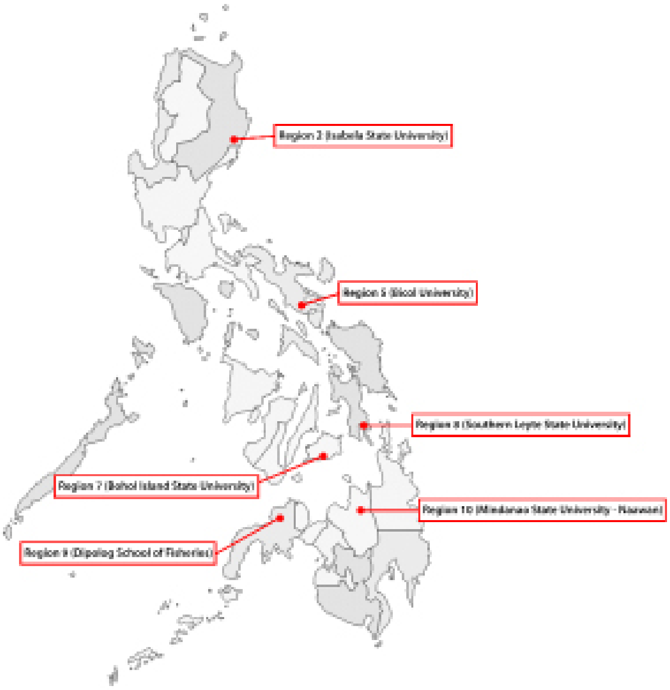


Table 1. Details of the regional pilot sites of the project

Region	Farmer	Pond Area (m²)	Type of Culture	Stocking Density	
				Ulang	Tilapia
Region II	1	1000	Polyculture	5 pcs/m²	1 pc/m²
	2	1000	Monoculture	5 pcs/m²	
	3	1000	Monoculture	5 pcs/m²	
Region V	1	1000	Polyculture	3 pcs/m²	1 pc/m²
	2	1000	Monoculture	3 pcs/m²	
Region VII	1	1215	Polyculture	4 pcs/m²	1 pc/m²
	2	403	Monoculture	8 pcs/m²	
	3	811	Monoculture	7 pcs/m²	
Region VIII	1	720	Polyculture	6 pcs/m²	1 pc/m²
	1	196	Monoculture	6 pcs/m²	
	1	560	Monoculture	6 pcs/m²	
	1	400	Monoculture	6 pcs/m²	
	2	300	Polyculture	6 pcs/m²	1 pc/m²
	2	216	Monoculture	7 pcs/m²	
	3	434	Polyculture	6 pcs/m²	1 pc/m²
	3	140	Monoculture	7 pcs/m²	
	3	145	Monoculture	7 pcs/m²	
Region IX	1	500	Polyculture	5 pcs/m²	1 pc/m²
	2	1000	Monoculture	5 pcs/m²	
	3	300	Monoculture	5 pcs/m²	
Region X	1	1600	Polyculture	3 pcs/m²	3 pcs/m²
	2	500	Monoculture	4 pcs/m²	
	3	1000	Monoculture	6 pcs/m²	

Sources: Nieves et al. 2011; Perez, Tambalque, and Domingo 2011; Perez, Soliven, and Dejarme 2011; Perez et al. 2011a; Perez et al. 2011b; Pulido, Perez, and Tambalque 2011 study to determine current farm practices of potential fish-farmer cooperators and constraints in their farm productivity. The fish-farmer cooperators were covered by the Consultancy for Agricultural Productivity Enhancement Program (CAPE) of DOST regional offices in collaboration with the respective SUCs. The study involved SUCs to ensure that an aquaculture expert works closely with each farmer cooperator and provides technical assistance in pond preparation and grow-out technology including feed formulation.

Cooperators and interested farmers in the project sites were also trained on pond management, postharvest handling, and marketing of freshwater prawn. The project focused on developing a cluster of small-scale production and marketing groups in each study site to fast-track future development of a community-based enterprise.

Twenty farmer-cooperators participated in the project. Overall, the project used 14 monoculture ponds and nine polyculture ponds with pond area ranging from 140–1,000 m^2 and an average pond area of 454.86 m^2 and 611.00 m^2, respectively.

Farming Protocol

The following key interventions, based on BFAR protocol, were adopted by the regional teams in the pilot on-farm trials (Rosario 2002). Prior to seeding, the project regional team members conducted workshops/trainings for the farmer-cooperators. In order to standardize implementation of activities and ensure compliance with pond culture protocols, aquaculture experts also monitored the activities including participatory sampling of the ponds and measurement of growth and survival of the prawn.

Pond Preparation

Cooperators followed the following steps for pond preparation: (a) cleaning of culture area and its surroundings, (b) draining and drying, (c) application of industrial lime and tea seeds, (d) checking for leaks, and (e) putting screens in inlets and outlets.

Installation of Shelter

Prior to stocking of ulang, shelters were installed in the ponds to provide refuge against predators during post-larvae stage, juvenile stage, and at molting stage when the ulang shed their shells and become vulnerable. Materials used as shelter for ulang varied among cooperators in the six regions and included coconut leaves, tamarind cuttings, and bamboo twigs.

Source of Stocks and Stocking Density

Ulang post-larvae at PL20 stage were obtained from hatcheries at SEAFDEC Binangonan and MSU-Naawan. Ponds in Regions II, V, VII, and VIII were stocked with post-larvae from SEAFDEC while the cooperators from Mindanao (Regions IX and X) received post-larvae from MSU-Naawan. Ponds were seeded at 5-6 post-larva prawn square meter of pond area as recommended by Rosario and Tayamen (2004). In polyculture, tilapia fingerlings (size 22 (1–3 g) were stocked at 1 fingerling/m2 a month after the ulang post-larvae stocking.

Feeding System

In both monoculture and polyculture systems, ulang were fed twice a day (early morning and late afternoon) with commercial tilapia feeds containing 33 percent crude protein. Indigenous feed ingredients such as chopped vegetables, cassava, Ipil-ipil (*Leucaena leucocephala*) leaves, and kitchen leftovers were also used as low-cost feed supplement (Rosario 2002). For Regions V, VII, and X they used natural food (thru fertilizing the pond) for the first month of culture period then commercial feeds (sinking) during the second month up to the harvest period. For Region II, commercial feeds were used during the first month of the culture period then supplemental indigenous feeds (i.e., boiled cassava, golden snail, rice bran, boiled taro, and kitchen leftovers) were used during the second month up to the harvest period. In Region VII, they used natural food (by fertilizing the pond) for the first month of the culture period then supplemental indigenous feeds (i.e., golden snail, cooked vegetables, rice bran, leftover cooked rice) for the second month up to harvest time. For Region IX, natural food thru fertilization of the pond was used during the first month of the culture period, then supplemental indigenous feeds (i.e., boiled corn, golden snail, rice bran, and kitchen leftovers) were used during the second month up to the harvest period.

The feeding rate ranged from 0.14–0.43 g/day/prawn for the monoculture system or an average of 0.23 g/day/prawn. In the polyculture system, prawns were fed 0.15 to 0.23 g/day/prawn or an average of 0.20 g/day/prawn. In addition, an average of 2.06 g/day was given for the tilapia. Feeding was done twice per day (i.e., 9 am and 3 pm) at the rate of 5 percent of the total body weight.

Water Management

The water depth was kept at 0.8 meter for monoculture and at least 1.0 meter for polyculture. Several sources of water for culture of ulang as described by Rosario (2002) were utilized such as communal irrigation canals, rivers and creeks, spring water, and underground wells.

Data Analysis

Ulang were harvested approximately five months after seeding with the culture period ranging from 134 to 141 days. Survival rates, average weight at harvest (growth performance), and productivity were estimated. In this paper, productivity was scaled as production per 500 m^2. Productivity or production per unit area was computed using a standardized area of 500 m^2 of ponds since there was variation in the pond sizes used in the pilot on-farm trials. Due to the high variability in the pond areas, limited number of farmer cooperators, different cultural practices and on-farm conditions, we only attempted to present descriptive statistics including standard deviation or the square root of variation.

Cost and return analysis was also estimated to measure income and profitability in each culture system. Operating cost included direct labor cost, depreciation cost (pond development and tools/equipment), material input cost (post-larvae stocked, feeds and supplements, fertilizer, fuel and oil, other inputs). Gross revenue or gross income refers to the market value (based on farm gate price in the region) of ulang, tilapia, and rice harvested in each culture system. Net income is the residual of gross revenue and operating cost.

RESULTS AND DISCUSSION

Survival Rate and Growth Performance

The highest ulang survival rate observed was 82.91 percent in monoculture in Region X, and 74.76 percent was recorded in the ulang-tilapia polyculture in Region IX (Table 2). It must be noted that both cases also have the longest culture period (166 days and 157 days for monoculture and polyculture, respectively). The overall average survival rate of ulang was 65 percent for monoculture and 58.79 percent

Table 2. Survival rate and average body weight at harvest between monoculture and polyculture modalities implemented across regions

	Ulang Monoculture	Ulang -Tilapia Polyculture	
	Ulang	Ulang	Tilapia
Overall			
Culture period (days)	144.33 ± 16.44	145.38 ± 10.84	
Survival rate (%)	65.00 ± 9.07	58.79 ± 15.23	76.54 ± 11.72
ABW at harvest (g)	31.22 ± 8.46	28.09 ± 5.82	191.34 ± 95.34
Number of pieces per kg	34 ± 8	38 ± 8	6 ± 3
Region II			
Culture period (days)	150.00 ± 0.00	150 ± 0.00	
Survival rate (%)	67.50 ± 2.50	65.00 ± 0.00	65.00 ± 0.00
ABW at harvest (g)	36.70 ± 6.17	30.70 ± 0.00	190 ± 0.00
Number of pieces per kg	28 ± 5	33 ± 0	5 ± 0
Region V			
Culture period (days)	151.00 ± 0.00	151.00 ± 0.00	
Survival rate (%)	54.00 ± 0.00	65.00 ± 0.0	86.00 ± 0.00
ABW at harvest (g)	39.53 ± 0.00	20.00 ± 0.0	426.00 ± 0.00
Number of pieces per kg	25 ± 0	50 ± 0	2 ± 0
Region VII			
Culture period (days)	135.00 ± 15.00	150 ± 0.00	
Survival rate (%)	57.50 ± 2.50	50.00 ± 0.00	55.00 ± 0.00
ABW at harvest (g)	25.0 ± 0.0	25.00 ± 0.00	118 ± 0.00
Number of pieces per kg	40 ± 0	40 ± 0	8 ± 0
Region VIII			
Culture period (days)	132.00 ± 11.24	134.67 ± 10.87	
Survival rate (%)	63.67 ± 4.150	64.00 ± 6.38	84.67 ± 2.49
ABW at harvest (g)	30.83 ± 11.38	29.00 ± 6.48	181.00 ± 11.86
Number of pieces per kg	36 ± 11	37 ± 9	6 ± 0.0
Region IX			
Culture period (days)	158.00 ± 1.00	157.00 ± 0.00	
Survival rate (%)	61.56 ± 0.84	74.76 ± 0.00	86.00 ± 0.00
ABW at harvest (g)	29.91 ± 1.34	35.71 ± 0.00	166.67 ± 0.00
Number of pieces per kg	34 ± 2	28 ± 0	6 ± 0
Region X			
Culture period (days)	166.50 ± 13.50	151.00 ± 0.00	
Survival rate (%)	82.91 ± 9.58	23.54 ± 0.00	66.29 ± 0.00
ABW at harvest (g)	30.25 ± 1.39	26.34 ± 0.00	86.74 ± 0.00
Number of pieces per kg	34 ± 2	38 ± 0	12 ± 0

Sources: Nieves et al. 2011; Perez, Tambalque, and Domingo 2011; Perez, Soliven, and Dejarme 2011; Perez et al. 2011a; Perez et al. 2011b for polyculture (Table 2). The overall average survival rate of tilapia was 76.54 percent. The survival rate observed from the study is similar to the findings of Asaduzzaman et al. (2009) that reported a prawn survival of 63.6 percent for treatment with tilapia at 0.5 fish per m^2 stocking density and 76.9 percent for setup installed with periphyton substrate. For the 75 percent tilapia and 25 percent freshwater prawn polyculture, survival rates of 76 percent and 58 percent were reported for tilapia and prawn, respectively, for culture with supplemental feeding and artificial substrates (Uddin et al. 2009).

Ulang grown in monoculture had an overall average body weight (ABW) during harvest of 31.22 g and 28.09 g in polyculture (Table 2). Thus, resulting in an average of 34 and 38 pieces/kg from monoculture and polyculture, respectively. Since the desired number per kg ranges from 20 to 25 pieces, the ulang produced in both culture systems was still below the desired weight.

The tilapia weighed an average of 191.34 g per piece, thus resulting in 6 pieces of tilapia per kg in the polyculture system. The average range of 3 to 5 pieces/kg is acceptable in tilapia monoculture.

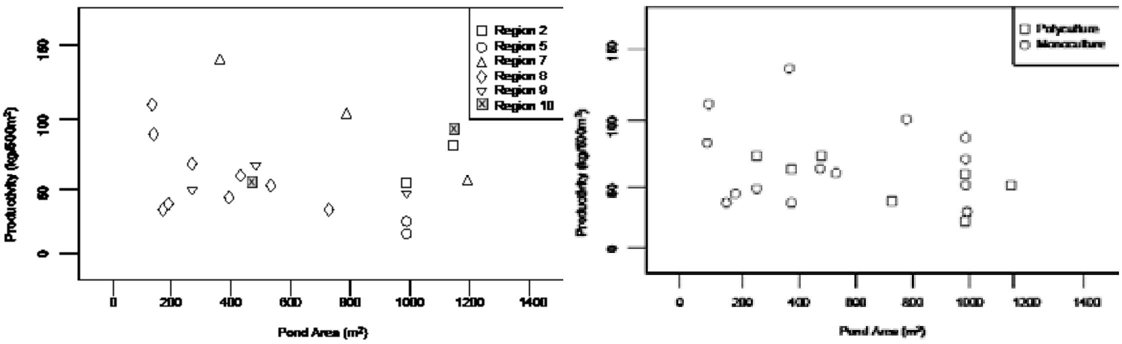
Production and Productivity

Figure 2 shows the plot of productivity as a function of pond area. Maximum productivity was 136.79 kg of ulang/500 m^2 from a 403-m^2 pond in Region VII while the lowest productivity was from a 1000-m^2 pond in Region V with 17.9 kg/500 m^2.

Survival and average body weight at harvest or growth performance determines the computed value of productivity. The result shows that increasing pond area does not translate into increased productivity. While the ideal pond size for ulang culture is from 2,000–16,000 m^2 with widths of not more than 30 m (New 2002). The largest pond used in the study was only 1,215 m^2.

The apparent lack of fit between pond area and productivity can be explained by huge variations in pond management employed among farmer-cooperators and diversity of regional farming conditions. Due to the participatory nature of the study, we allowed the farmers to follow their normal practices, although some recommendations to improve them were suggested during the start-up training. Hence, there was variation in compliance by farmer cooperators on the farming protocols

Figure 2. Productivity by area and by region (left); and by area and culture system (right)



(e.g., pond preparation, feeding management, and types of locally-available feeds) may have contributed to differences in farm productivity.

Given the average survival rate and average growth performance from the on-farm trials and assuming a stocking density of 6 PL/ m^2, a 500-m^2 pond area can produce 58.14 (± 21.58) kg and 42.38 (± 21.62) kg of ulang, in monoculture and polyculture, respectively (Table 3); while 72.58 (± 34.88) kg of tilapia can also be produced in the polyculture system.

Profitability and Income

In an area of 500 m^2, net profit per cropping was estimated to be positive in both culture systems but was relatively higher in the monoculture system with an estimated net profit of PHP 9,852.92 per culture period while ulang-tilapia polyculture system recorded PHP 8,789.18 (Table 4). It is expected that polyculture with ulang should be higher than monoculture because of the added value from tilapia. If managed properly, the income from tilapia sales can offset the added operating cost in polyculture of ulang and tilapia. Excluding Region X from the national average, where loss of PHP 3,717.19 was recorded, the mean profit of ulang-tilapia polyculture becomes PHP 10,575.80 while ulang monoculture was only PHP 9,849.01.

Projected Profitability under Maximum Survival Rate and Growth Performance

In ulang monoculture, the highest survival rate attained in the on-farm trials is 83 percent and the highest growth performance attained is 40 g per piece. Given a stocking density of 6 prawns/m^2 (which was practiced in polyculture trials in Region IX and was used to compare the profitability) and if the highest survival rate can be attained across regions, there will be an added average yield of 18.65 kg in a pond area of 500 m^2 (Table 5).

Table 3. Yield per unit area between monoculture and polyculture employed by the project

	Ulang Monoculture	Ulang-Tilapia Polyculture	
		Ulang	Tilapia
Pond area per cooperator (m2)	500	500	
Yield (kg/500 m2)	58.14 ± 21.58	42.38 ± 21.62	72.58 ± 34.88

Sources: Nieves et al. 2011; Perez, Tambalque, and Domingo 2011; Perez, Soliven, and Dejarme 2011; Perez et al. 2011a; Perez et al. 2011b

Table 4. Profitability of ulang production in a 500 m^2 pond area by culture system

	Ulang Monoculture	Ulang-Tilapia Polyculture
Gross receipts (PHP)	22,710.67 ± 10,818.31	26,332.19 ± 17,469.56
Value of ulang produced	22,710.67 ± 10,818.31	14,141.97 ± 6,659.44
Added income (from tilapia)		12,190.23 ± 14,274.03
Operating cost (PHP)	12,857.75 ± 3,604.05	17,543.01 ± 12,143.01
Net profit (PHP)	9,852.92 ± 8,8757.27	8,789.18 ± 7,073.75

Sources: Nieves et al. 2011; Perez, Tambalque, and Domingo 2011; Perez, Soliven, and Dejarme 2011; Perez et al. 2011a; Perez et al. 2011b

Similarly, if the ulang attain a size of 40 g per piece, this growth performance will result in an added average yield of 13.29 kg. There will be an added average yield of 31.94 kg if highest survival rate and growth performance are attained. Regions with relatively low survival rate and growth performance will gain most in the improvement of survival rate, growth performance, or both. For example, survival rate can be improved by stocking bigger sizes of post-larvae in monoculture system, and the timing of stocking (i.e., ulang should be stocked first then after one month stocking of tilapia follows) for polyculture system.

In the polyculture system, the highest survival rate is 74.76 percent (in Region IX) and 86.00 percent (in Region V and IX) for ulang and tilapia, respectively. In terms of ulang growth performance, the highest obtained in the on-farm trials was 35.71 g/piece and the highest obtained in tilapia is 426.00 g/piece.

Across regions, if the highest survival rate and growth performance in both ulang and tilapia can be attained, added average yield will be 26.89 kg for ulang and 98.85 kg for tilapia (Table 6). These added yields result in an added average income of PHP 15,976.46. Improved ulang survival rate and ABW results in average income increase of PHP 4,038.55 and PHP 4,029.66, respectively. Improved tilapia survival rate only contributes an average income increase of PHP 724.33 while increasing ABW result in an increase of PHP 7,183.92 (Table 6).

Prospects of Freshwater Prawn (Ulang) Culture

Ulang is the only freshwater prawn that can be bred in captivity and cultured in the Philippines. The farmer-cooperators believe that there is high economic demand for ulang and there is high profit in culturing it. However, they perceived that the market preference for this species is not yet established, unlike tilapia and other fish species. Potential fish farmers are concerned with the availability of post-larvae in their respective communities and the high production cost of culturing ulang. The latter can be addressed, as mentioned, by supplemental feeding of indigenous feeds. Controlling the carbon to nitrogen ratio (C:N) in the pond to allow for growth of natural food such as biofilm and flocculating microbes (Asaduzzaman et al. 2010; 2008) might address the need for reducing the dependence of freshwater prawn stock on commercial feeds. Ulang culture is gaining popularity in Northern Mindanao, since four hatcheries have been developed from 2003–2004 (Dejarme 2005).

Polyculture with compatible aquatic species and crops must be explored in the country. A system similar to ‘gher’ (prawn-fish-rice) culture (Rahman and Barmon 2012) must be evaluated in the country aside from exploring the beneficial effects of adding tilapia to freshwater prawn culture (Asaduzzaman et al. 2009).

Problems/Constraints

Earlier studies at BFAR-NFFTC in the Science City of Muñoz, Nueva Ecija have demonstrated the potential of ulang culture in small-scale backyard ponds as a monocrop, integrated with rice, or integrated with tilapia (Rosario and Tayamen 2007). But in the face of the development of hatchery and grow-out technologies, there is limited commercial production of the species in the Philippines. This has been attributed to various constraints that include: (1) insufficient supply of breeders, (2) inadequate supply of post-larvae for stocking, (3) limited market supply, (4) limited funds for interested stakeholders, (5) lack of information, (6) limited promotion of technology, (7) inadequate skilled and/or trained technicians, and (8) limited R&D on ulang hatchery.

Table 5. Effect of high survival rate and high growth performance to productivity, profitability, and viability of ulang monoculture by region

Items	Region II	Region V	Region VII	Region VIII	Region IX	Region X	Average
(a) Yield effect at 83% Survival (kg)	16.42	34.69	19.06	22.54	19.21		18.65
(b) Yield effect at 40 g ABW (kg)	6.73		25.88	4.27	18.62	24.25	13.29
(c) Total (kg), (a) + (b)	23.15	34.69	44.93	26.81	37.83	24.25	31.94
(d) Revenue effect (added income, PHP):							
Improved survival rate	4,925.00	10,408.00	5,717.00	6,763.00			4,635.00
Improved ABW	2,020.00			1,281.00	5,585.00	7,275.00	2,694.00
Total (PHP)	6,944.00	10,408.00	5,717.00	8,044.00	5,585.00	7,275.00	7,329.00

Sources: Nieves et al. 2011; Perez, Tambalque, and Domingo 2011; Perez, Soliven, and Dejarme 2011; Perez et al. 2011a; Perez et al. 2011b; Pulido, Perez, and Tambalque 2011

Table 6. Effect of high survival rate and high growth performance to productivity, profitability and viability of ulang polyculture by region

Items	Region II	Region V	Region VII	Region VIII	Region IX	Region X	Average
(a) Yield effect at 74.76% ulang and 86.00% tilapia survival (kg)							
(a.1) ulang	8.99	5.86	18.57	9.36		40.47	13.46
(a.2) tilapia	19.95	0.00	18.29	1.21		8.55	9.05
(b) Yield effect at 34 g ulang and 567 g tilapia ABW							
(b.1) ulang	9.77	30.63	16.07	12.88		6.62	13.43
(b.2) tilapia	76.70		84.70	103.72	111.37	112.45	89.80
(c) Total (kg), (a) + (b)							
(c.1) ulang	18.76	36.49	34.64	22.24		47.09	26.89
(c.2) tilapia	96.65		102.99	104.92	111.37	121.00	98.85
(d) Revenue effect (added income in PHP):							
Improved ulang survival rate	2,696.69	1,756.80	5,571.00	2,808.36		12,142.21	4,038.55
Improved tilapia survival rate	1,596.00		1,463.20	96.53		683.86	724.33
Improved ulang ABW	2,930.85	9,190.35	4,819.50	3,864.96		1,985.13	4,029.66
Improved tilapia ABW	6,136.00		6,776.00	8,297.33	8,909.60	8,995.82	7,183.92
Total (PHP)	13,359.54	10,947.15	18,629.70	15,067.19	8,909.60	23,807.02	15,976.46

Sources: Nieves et al. 2011; Perez, Tambalque, and Domingo 2011; Perez, Soliven, and Dejarme 2011; Perez et al. 2011a; Perez et al. 2011b; Pulido, Perez, and Tambalque 2011

In this study we have noted the following problems encountered across the regions during the on-farm trials were: (1) limited availability of post-larvae in the region, (2) variations of freshwater quality and availability, (3) presence of predators, and (4) technical know-how and capacity of the fish farmer cooperators. Several issues and barriers in ulang culture per region and specific solutions were also identified. Based on this experience, suggested follow-up trials with the same cooperators are recommended along with the establishment and rehabilitation of ulang hatcheries in each region to sustain post-larvae availability with technical support by BFAR regional offices. Many of the farmer-cooperators have difficulty in securing the required post-larvae within their areas. Due to the distance from the post-larvae sources to the regional project sites, mortality was high especially during transport of the seed stocks. In Regions II and V, for example, ulang post-larvae was obtained from SEAFDEC at Binangonan, Rizal or CLSU in Muñoz, Nueva Ecija.

Research and Policy Recommendations

After one decade of BFAR's successful production of ulang post-larvae, the commercial-scale hatchery production for this freshwater species remains to be established and sustained. Ulang has a promising potential of being one of the alternative species for culture in the freshwater environment. However, as long as the supply of post-larvae remains scarce, if not accessible to the potential growing/farming sites, the practice of ulang culture will remain marginal.

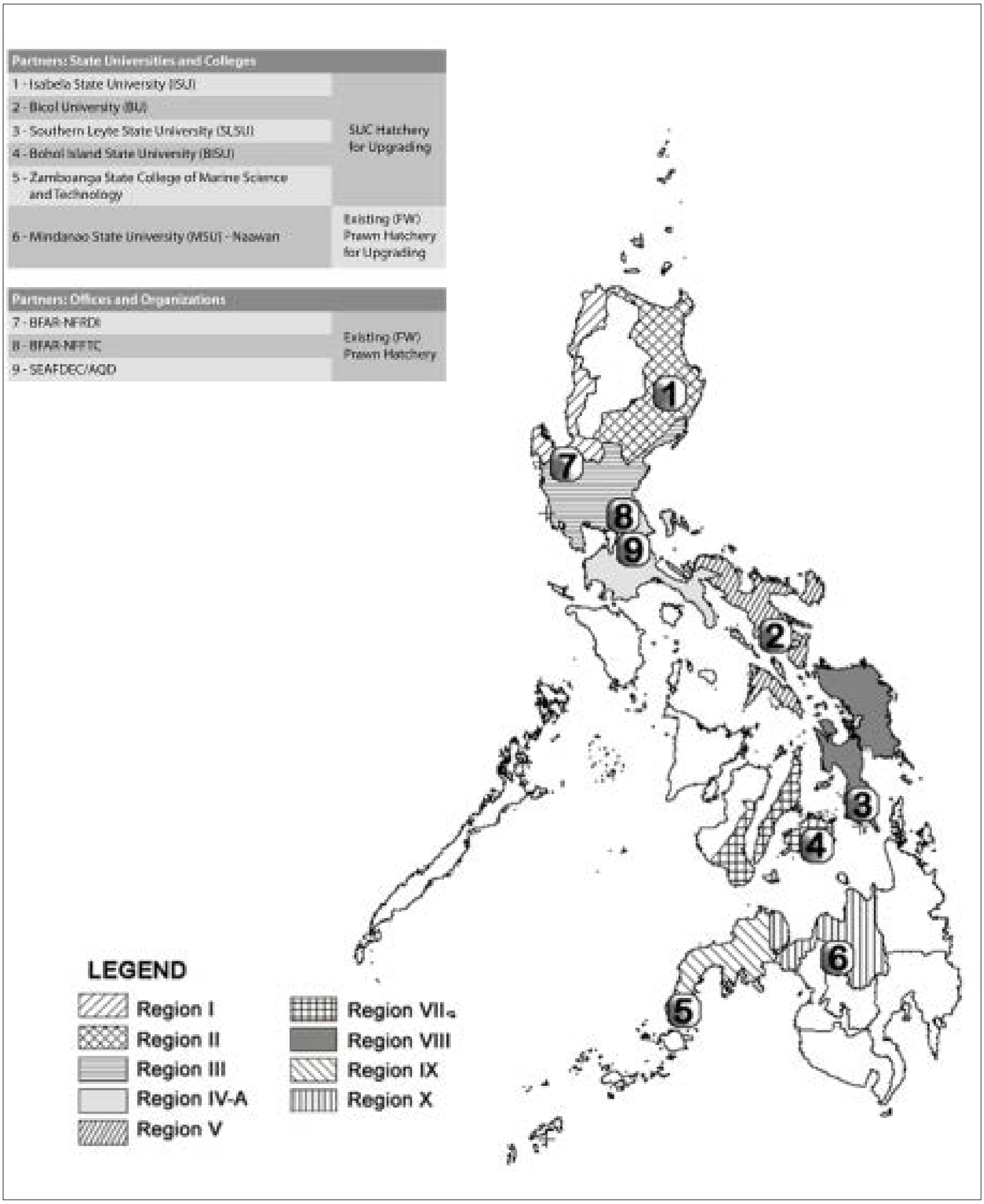
Aside from establishing a stable supply of affordable ulang post-larvae, it is also important that the freshwater prawn receives research, development, and extension efforts and resources that are similar to its brackish water and marine counterparts. At present only two BFAR national centers are maintaining a hatchery for ulang and no broodstock development program is performed. BFAR-NIFTDC in Dagupan City established the genebank for ulang in the Philippines. Unfortunately, ulang is not one of the priority aquaculture species. Government resources are focused on aquatic species that are considered to address the issues of food security (i.e., tilapia and milkfish).

Moreover, the target consumers of ulang production need to be established. Ulang if cultured as affordable protein source is not economically feasible. The species must be cultured as one of the alternatives to other high-value marine and brackishwater crustaceans. Hence, the technology for ulang culture must be repackaged to yield products that will specifically target high-end markets. Therefore, in order for ulang to become one of the feasible alternative sources of income to rural fish-farmers, long-term and focused government interventions are warranted.

Hatchery Network and Broodstock Development Policy

Given the complex life history of ulang, a network of cooperating hatcheries must be established. This network can be established from existing hatcheries of BFAR national offices and SUCs (Figure 3). Hatcheries from SUCs, however, will require upgrading and technical assistance on integrating freshwater prawn. At present only MSU-Naawan has an existing hatchery for freshwater prawn (Figure 3). Moreover, both freshwater and seawater access of these hatcheries will play an important role in establishing the network. As an example, it would be favorable for BFAR-NFFTC in Muñoz, Nueva Ecija to focus on broodstock development, given that freshwater prawns mature in the freshwater environment. While the BFAR-NFFTC develops the economically

Figure 3. Proposed national network of freshwater prawn hatcheries in the Philippines



advantageous strain, BFAR-NIFTDC, which has access to marine waters, must focus on the hatchery aspect of the species. The policy of cooperation is needed in the freshwater prawn particularly in the production of post-larvae.

Suggested criteria for ulang broodstock development must include faster growth, disease resistance, and high fecundity. It is important to include disease resistance in the selection and strain development to avoid the health problems that affected the tiger prawn (*Penaeus monodon*) industry and more recently, *P. vannamei*. High fecundity is suggested to ensure that large volume post-larvae can be easily produced from the hatchery. Finally, development of a strain that exhibits faster growth will make the culture of ulang even more profitable and attractive to potential prawn farmers.

It is suggested that hatcheries increase R&D efforts on proper conditioning of breeders. Optimization under local conditions on hatchery protocol is recommended for post-larvae production. Both high fecundity and optimized production techniques are necessary to achieve affordable and accessible post-larvae to prawn growers.

Technology Promotion and Extension Approach

In terms of ulang culture, government extension and technology promotion must focus on integrating ulang with popular culture species. Instead of using ulang as the major culture species in polyculture, it is recommended that freshwater prawn be initially promoted as secondary species in polyculture with tilapia and low-salinity milkfish ponds. By assigning ulang as secondary species in polyculture with popular species, farmers will be able to grow ulang to more profitable sizes. Moreover, this approach is an effective way to introduce freshwater prawn farming to the traditionally risk-averse fish growers. Again problems with availability and access to affordable post-larvae will undermine this proposed approach, hence, the importance of ulang hatchery network in the country is highlighted.

Aside from a policy on cooperation and optimization of government resources, a policy of diversification is needed in order to become resilient against disruptive events such as economic fluctuation, disease infestation among farmed species, and climate change in general. The polyculture method described and recommended above is an income and livelihood diversification approach that will only require government intervention on post-larvae production and technology extension. Structures for tilapia and milkfish culture are already in place, hence, capital investment for ulang production using this approach is minimal.

The structure of ulang population in ponds affects growth rate and sizes of the individual. It is therefore recommended that selective and partial harvests for dominant males (orange and blue claws) are performed as another method for increasing ulang yield. Partial harvesting is practiced in Thailand. For example, the female prawns averaging 25–33 g are harvested after four to five months of culture, then the large males (100–125 g) are harvested on the sixth month (Uraiwan and Sodsuk 2007). This recommendation is compatible with a monoculture system where ulang is cultured as a primary crop. Adopting the proposed harvest method however requires a specific form of product value chain.

In the Philippines, farming of *M. rosenbergii* in cages was also suggested as a viable alternative to pond culture and has the potential of improve aquaculture production in lakeshore fish farming communities (Cuvin-Aralar et al. 2007).

Value Chain and Market Strategy

As a result of the proposed approach for culture and harvest of ulang, coordinated farming season and harvest is required in order to raise ulang yield to be economically viable and attain ideal market volume. The role of product aggregator/trader is key to the success on connecting the farm's small harvest to the local and international market. A policy on empowerment of prospective ulang farmers must be established through financial assistance, training, and cooperative organizing. By enabling the ulang growers to bypass middlemen and directly transact with retailers and exporters, the benefits from ulang culture will be maximized.

Also, the price of ulang in the market must be competitive to its market alternative and local counterparts. This marketing strategy can be achieved through the proposed empowerment of ulang growers. It is also important to lower the cost of production for ulang compared to tiger prawn and Pacific white shrimp.

CONCLUSION

This study was conducted primarily to explore the viability of ulang in Regions II, V, VII, VIII, IX, and X in the Philippines and identify the challenges and opportunities in improving livelihoods of small-scale fish-farmers. The growth performance, in terms of average body weight at harvest, survival rate, profitability, and viability of ulang production in two culture systems were compared, and best practices were identified for sustainability of ulang farming as a livelihood option for small-scale fish-farmers. Since ulang culture is still in its early development stages in the country, on-farm piloting trials were conducted with technical assistance from the regional teams organized by WorldFish in partnership with DOST, BFAR, and SUCs. The farmer-cooperators raised ulang in monoculture and polyculture (ulang and tilapia) in their designated ponds.

The following lessons were noted during the study:

1. Beneficiaries identified should be the ones actually attending technical trainings. At the beginning of the study, the participants of the technical trainings conducted were not the identified beneficiaries. For the duration of the study, the training participants were the ones that relayed technical information to the actual beneficiaries. For future studies, it is recommended to ensure that actual beneficiaries are trained.
2. There should be a local aquaculture expert who speaks the beneficiaries' language. Language barrier was noted as a concern because some recommendations were misinterpreted by technicians resulting in poor implementation of technical interventions. This can be addressed by tapping local experts in the area; however, constant and clear communication between technical consultants and the beneficiary/ aquaculture technician may already solve the problem.
3. Availability of post-larvae must be year-round. The availability of post-larvae supply any time of the year is recommended; however, it was also noted that given the present market demand for ulang in the areas, suppliers could not afford to provide post-larvae for only a few pond owners at a time. On the other hand, small-scale growers who would like to venture into ulang culture get discouraged from the high cost of production including acquiring post-larvae by volume from distant sources. If this problem persists, there is a possibility that small-scale ulang farmers would continue to rely on projects and programs that would provide initial financial assistance to sustain ulang farming.

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