

Original Research

Giant Freshwater Prawn Culture: On-Farm Trials in the Philippines

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Abstract

This study explored the viability of giant freshwater prawn (*Macrobrachium rosenbergii*, locally known as *ulang*) culture in six regions in the Philippines. Twelve farmer-cooperators employed *ulang* monoculture and eight employed *ulang*-tilapia polyculture. In Region 8, all farmer-cooperators conducted both monoculture and polyculture systems. This paper is focused on comparing *ulang* monoculture and *ulang*-tilapia polyculture.

The cooperators were asked to follow protocols recommended by the project for both culture systems. Results showed an average survival rate of 65.00 ± 9.07% for *ulang* monoculture; while 58.79 ± 15.23% and 76.54 ± 11.72% survival for *ulang* and tilapia in polyculture, respectively. The major problems encountered across regions were: a) unavailability of post-larvae (PL), b) distance of PL source, c) water supply, d) presence of predators, and e) inconsistent implementation of technical interventions by the cooperators. Unless the farmers realized that the profit could be greater than the cost of production (including acquiring PL from distant sources), there would be possibility that small-scale farmers would continue to rely on programs that provide financial assistance to sustain *ulang* farming.

Keywords: *Macrobrachium rosenbergii*, giant freshwater prawn, polyculture, small-scale aquaculture, cost-benefit analysis

The Philippine Archipelago provides an ideal environment for fisheries and aquaculture. However, pressures from overfishing and other destructive activities have led to fish stock depletion, particularly in traditional marine fishing grounds (Barut, Santos & Garces, 2004). Fishing pressure and the impacts of various anthropological activities may be more severe in inland bodies of water, but the number of interventions and studies are limited. Aquaculture can minimize the impacts of fishing pressure.

The global aquaculture production has to increase to cope with the growing demand for food fish and compensate for the reduced production of capture fisheries (Bosma & Verdegem, 2011). The studies of Nieves et al. (2011), Perez et al. (2011 a-d) and Pulido et al. (2011) were conducted to assess and promote alternative fish species that could be farmed to supplement income of fish growers.

The giant freshwater prawn (*Macrobrachium rosenbergii*) has been farmed in Southeast Asia for a long time using traditional methods. Workers in Thailand started growing prawns in earthen ponds in 1956 with juveniles collected from open waters. The

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giant freshwater prawn can be reared even in irrigated paddy fields that are able to retain water depths of not less than 15 cm (Soesanto, 1980). Pond culture of freshwater prawn has evolved since the success of Ling (1969) in rearing the larvae to juveniles and juveniles to grown adults of marketable size.

Ulang culture was introduced in Asia as well as in other parts of North and South America in the 1970s. In the 1990s, the Bureau of Fisheries and Aquatic Resources (BFAR) pioneered the studies on *ulang* production in the Philippines at the National Freshwater Fisheries Technology Center (NFFTC) in Muňoz, Nueva Ecija. In the later part of 1998, BFAR successfully mass-produced the post larvae (PL) stage of this species. In 2001, the *ulang* hatchery protocol was further improved and finally a commercial hatchery was established in Muňoz and later at the National Integrated Fisheries Technology Development Center in Bonuan, Dagupan City, Pangasinan (Tayamen, 2005).

Except for the Philippines, the culture of *M. rosenbergii* has already made substantial contributions to the local aquaculture production in Southeast Asia (New, 2005). Since the male prawn grows faster than the female, culture in these countries is already directed towards an all-male production (Aflalo et al., 2006; Mohanakumaran Nair et al., 2006). In the Philippines, the optimal methods for the culture and propagation of freshwater prawn are being developed by the government fishery agencies as well as other research and academic institutions (Romana-Eguia et al., 2006).

Ahmed, Ahammed & Lecouffe (2007) analyzed the current practices and marketing systems for *M. rosenbergii* in the Mymensingh Region, Bangladesh. Their results indicated that the private sector almost exclusively maintains prawn marketing. Since prawn is highly valued in the international market, almost 60% of production in the region are exported to the USA, Japan and Europe. The rest (40%) are sold in local markets in Mymensingh. Price depends on quality, size and weight, and grade. Despite marketing constraints, livelihood outcomes are positive and most of the households of traders (75%) have improved their social and economic conditions through prawn marketing activities.

In Vietnam, *ulang* production is becoming an increasingly important target species, as its culture, especially in rice fields, is considered to have the potential to raise the incomes of impoverished farmers (Phuong et al., 2006). In 2002, production reached over 10,000 tons, a major increase from about 2,500 tons in the 1990s. Lack of a stable supply of seed limited the expansion and development of *ulang* culture. However, research on larval rearing, especially in the 1990s, has led to the development of new seed production technology based on the ‘modified stagnant green water system’.

In China**,** rapid increase in production of *ulang* was due to the expansion of areas for culture, improved culture techniques and species diversification. Although no national data on the total culture area is available, the culture of *ulang* has expanded very quickly across the country. For example, it was cultured only in 12 provinces in 1993 with only one province reporting production of more than 1,000 tons. But by 2000, culture has expanded to 24 provinces and autonomous regions in China with seven (7) provinces reporting their production to exceed 1,000 tons (Weimin & Xianping, 2002).

The studies at NFFTC in Muňoz, Nueva Ecija have demonstrated the potential of *ulang* culture in small-scale backyard ponds as a monocrop, integrated with rice, or integrated with tilapia in various research stations of BFAR around the country (Rosario & Tayamen, 2007). In spite of the development of hatchery and grow-out technologies, there is no significant commercial production of *ulang* in the Philippines. With the country's extensive inland resources, *ulang* aquaculture has a very large potential. On the average, farmed *ulang* weighs from 30 to 100 g, which translates to 10 to 25 pieces per kilo. This is more compared to the medium to large or jumbo sizes of brackish water tiger shrimps *(Penaeus monodon*). In the wild, *ulang* grows to as much as 500 g and sells at PhP300 to PhP350/kg ($1 =P55.50), however, the harvest is seasonal and the quantity is limited (Tayamen, 2005).

The WorldFish, with funding support from the Department of Science and Technology (DOST) Regional Offices 2, 5, 7, 7, 9, and 10 and in partnership with State Universities and Colleges (SUCs) (i.e., Isabela State University (ISU), Mindanao State University (MSU)- Naawan, and Southern Leyte State University (SLSU)- Bontoc), embarked on the culture experiments of giant freshwater prawn through on-farm trials in six regions. The purpose was to identify and ultimately provide viable alternative and sustainable livelihood options for small-scale fishers. The pilot testing explored the potential of improving the livelihood of small-scale fish farmers through freshwater prawn farming, which could be replicated in other areas in the Philippines.

This study explored the challenges and opportunities in *ulang* culture to improve the livelihood of small-scale fisherfolk. Specifically, the growth performance in terms of average body weight at harvest, survival rate, profitability and viability of *ulang* in the three culture systems were compared. Also, best practices were identified for sustainable *ulang* farming, as a livelihood option for small-scale fishers.

Methodology

Selection of Project Sites

On-farm trials were conducted in Regions 2 - Cagayan Valley, 5 - Bicol, 7 - Central Visayas, 8 - Eastern Visayas, 9 - Zamboanga Peninsula, and 10 - Northern Mindanao (see Figure 1) through partnerships with DOST and state universities and colleges. The project team, in close coordination with the regional offices of DOST and BFAR, selected the appropriate sites for on-farm trials using the following biophysical and socio-economic criteria: (1) availability of water (exploitation of ground water or through 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 regional offices of DOST and BFAR, and (5) potential for expanding production and marketing of the giant freshwater prawn.

Selection of Farmer-Cooperators

The project team, DOST and BFAR regional partners recommended the following criteria in choosing the suitable cooperators:

- Engaged in small-scale fish farming operation (small-scale is defined in this study as operating a 500 m^2 to 1000 m^2 pond);
- Fish farming is one of the major sources of income for the household;
- Has 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 informed about the study. Their willingness to cooperate was confirmed during the stakeholder/inception meeting. The farmer cooperators were covered by the Consultancy for Agricultural Productivity Enhancement Program (CAPE) of DOST Regional Offices in collaboration with Isabela State University (ISU), Bicol State University (BU), Bohol Island State University (BISU), Dipolog School of Fisheries (DSF), Mindanao State University - Naawan (MSU) and Southern Leyte State University (SLSU). CAPE ensured that an aquaculture expert will work closely with the farmer-cooperator, especially in providing guidance on pond preparation and grow out technology production including feed formulation. Specific technical trainings on pond management, post-harvest handling and marketing were also provided to cooperators and other interested farmers in the project sites. The project emphasized on developing a cluster of small-scale giant freshwater prawn production and marketing groups in each project site to fast track future development of community based enterprises with focus on diversified small-scale aquaculture.

A total of 17 farmer-cooperators participated in the project, with three farmer-cooperators engaged in both *ulang* monoculture and *ulang*-tilapia polyculture (Table 1). Overall, the project had 15 and 8 monoculture and polyculture ponds, respectively. The average pond area was 577.9 ± 341.4 m^2 for *ulang* monoculture while 738.4 ± 317.6 m^2 for *ulang*-tilapia polyculture.

Farming Protocol

The following key culture interventions based on BFAR protocols (Rosario, 2002) were adopted in the pilot on-farm trials. Prior to seeding, the regional team members conducted several workshops and trainings for the farmer-cooperators. In order to standardize project implementation and ensure compliance with the protocol, the aquaculture experts monitored the regional activities.

1. Pond preparation

Pond preparation was conducted as follows: (a) cleaning the culture area and its surroundings, (b) draining the pond, (c) applying industrial lime and tea seed, (d) checking for leaks, and (e) putting screens in inlets and outlets.

2. Installation of shelters

Prior to stocking of *ulang*, shelters were installed in the ponds to provide refuge against predators during post larvae, juvenile and molting when *ulang* were more vulnerable. Shelter materials used varied among cooperators in the six regions. These included coconut leaves, tamarind cuttings, or bamboo twigs.

3. Source of stocks and stocking density

The *ulang* post larvae (PL) were obtained from the hatchery facilities of SEAFDEC-Binangonan and MSU-Naawan. The postlarvae for ponds located in Luzon and Visayas (Regions 2, 5, 7 and 8) were obtained from SEADEC, while postlarvae for Mindanao (Regions 9 and 10) were from MSU. The size of the post larvae used in the culture trial was PL20 at a stocking rate of 5-6 PL per m^2 pond area as recommended by Rosario and Tayamen (2004). For the polyculture, tilapia fingerlings were stocked a month after *ulang* postlarvae were stocked at the rate of one fingerling per m^2.

4. Feeding System

For both monoculture and polyculture systems, feeding was done twice a day (early morning and late afternoon) using commercial tilapia feeds with 33% crude protein. Indigenous feed materials

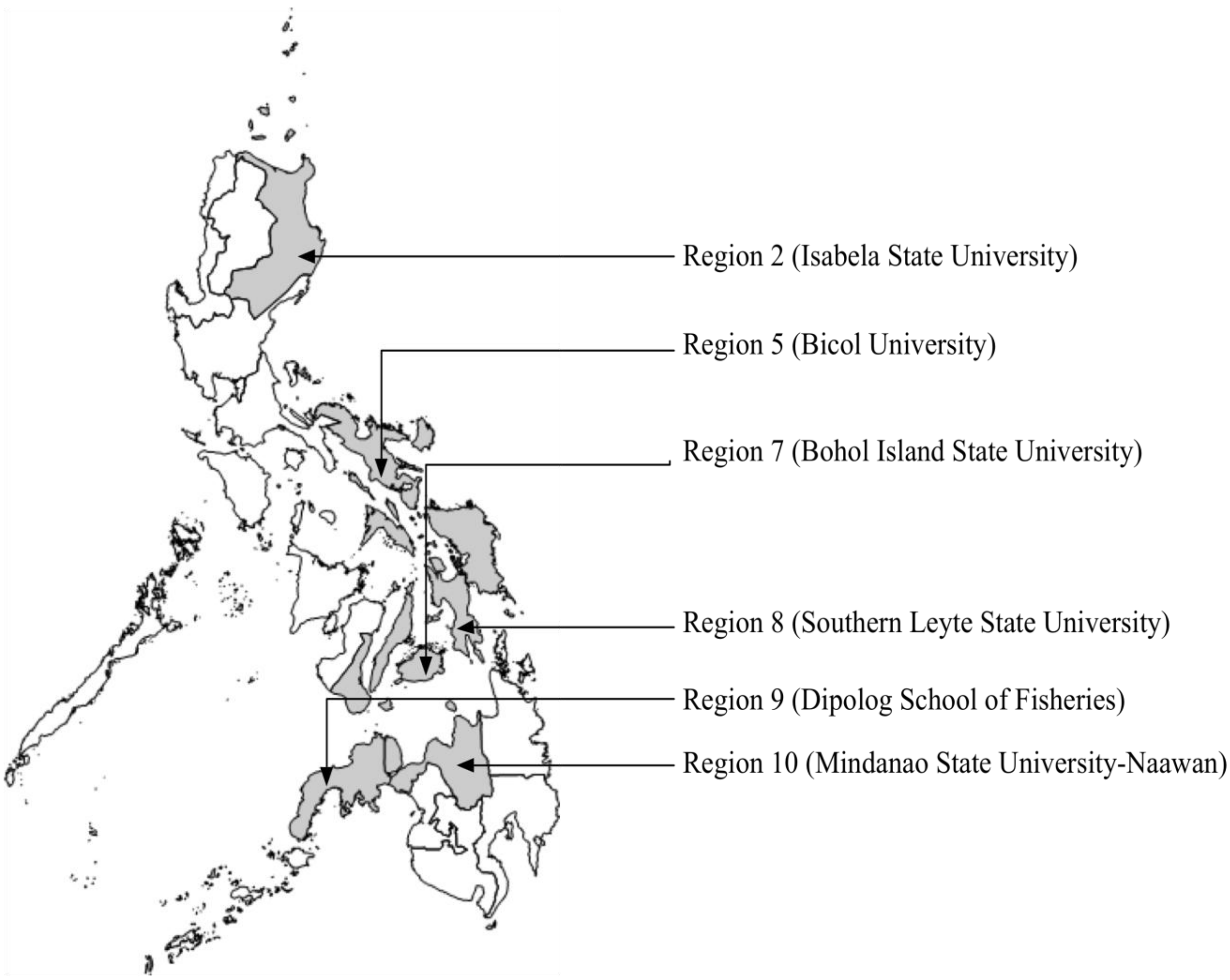

Figure 1. Location of regional project sites and corresponding partner state universities (SUCs) .

Table 1. Details of the regional pilot sites showing the pond area, culture system and stocking density.

Region	Farmer-Cooperator	Pond Area (m^2)	Culture System	Stocking density	
				Ulang	Tilapia
Region 2	1	1000	Polyculture	5 pcs/m^2	1 pc/m^2
	2	1000	Monoculture	5 pcs/m^2	
	3	1000	Monoculture	5 pcs/m^2	
Region 5	4	1000	Polyculture	3 pcs/m^2	1 pc/m^2
	5	1000	Monoculture	3 pcs/m^2	
Region 7	6	1215	Polyculture	4 pcs/m^2	1 pc/m^2
	7	403	Monoculture	8 pcs/m^2	
	8	811	Monoculture	7 pcs/m^2	
Region 8	9	720	Polyculture	6 pcs/m^2	1 pc/m^2
	9	196	Monoculture	6 pcs/m^2	
	9	560	Monoculture	6 pcs/m^2	
	9	400	Monoculture	6 pcs/m^2	
	10	300	Polyculture	6 pcs/m2	1 pc/m^2
	10	216	Monoculture	7 pcs/m^2	
	11	434	Polyculture	6 pcs/m2	1 pc/m^2
	11	140	Monoculture	7 pcs/m^2	
	11	145	Monoculture	7 pcs/m^2	
Region 9	12	500	Polyculture	5 pcs/m^2	1 pc/m^2
	13	1000	Monoculture	5 pcs/m^2	
	14	300	Monoculture	5 pcs/m^2	
Region 10	15	1600	Polyculture	3 pcs/m^2	3 pcs/m^2
	16	500	Monoculture	4 pcs/m^2	
	17	1000	Monoculture	6 pcs/m^2	

like chopped vegetables, ipil-ipil leaves (Rosario, 2002) and kitchen leftovers were also used as low-cost feed supplements. Feeding rates ranged from 0.14 to 0.43 g/day/*ulang* (x=0.23) for the monoculture system and 0.15 to 0.23 g/day/*ulang* (x=0.20) for the polyculture. In addition, tilapia for the polyculture system was fed at an average of 2.06 g/day/tilapia.

5. Water Management

The water level was maintained at 0.8 meter for monoculture and at least 1.0 m for polyculture. Water quality monitoring was done regularly.

Data Analysis

Ulang were harvested approximately five months after stocking. The culture period was from 134 to 141 days. Survival rates, average weight at harvest (growth performance) and productivity were estimated. Productivity or production per unit area was computed using a standardized area of 500 m^2 of pond because of the differnet pond sizes used in the pilot on farm trials. Cost and return analysis was used to measure income and profitability in each culture system. The 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, and other inputs). Gross revenue or gross income refers to the market value of *ulang* and tilapia 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 survival rate of *ulang* was attained at 92.5% in monoculture and 74.76% in *ulang*-tilapia polyculture (Figure 2). The average survival rate of *ulang* was 65.0 ± 9.1% in monoculture and 58.8 ± 15.2% in polyculture (Table 2). The survival rate of tilapia was 76.5 ± 11.7%.

The average body weight of the harvested *ulang* in monoculture was 31.2 ± 8.5 g and 28.1 ± 5.8 g in polyculture (Table 2). Tilapia has an average body weight of 191.3 ± 95.3 g. Given these body weights, there were 34 ± 8 pieces of *ulang* per kg in monoculture and 38 ± 8 pieces per kg in *ulang*-tilapia polyculture. There were six pieces of tilapia per kg in polyculture.

Production and Productivity

In Figure 2, the maximum productivity was observed at 136.8 kg/500 m^2 of *ulang,* which were produced from 403 m^2 pond in Region 7. The lowest productivity was 9.3 kg/500 m^2 from a 1000 m^2 pond in Region 10. The survival and average body weight at harvest or growth performance determined the computed value of productivity. The result showed that increasing pond area does not translate into increased productivity. While the ideal pond size for *ulang* culture is from 2,000 to 16,000 m^2, with width of not more than 30 m (New, 2002), the largest pond used during this study was only 1,215 m^2.

The apparent lack of fit between pond area and productivity can be explained by huge variation in pond management employed among farmer-cooperators and diversity of regional farming conditions. In addition, the variation in compliance by farmer-cooperators on the farming protocols (e.g., pond preparation, feeding management) may have contributed to differences in farm productivity.

Given the average survival rate and average growth performance in the pilot projects in Table 3 and assuming a stocking density of 6 PL/m^2, a 500 m^2 pond area can produce the following: 58.1 ± 21.6 kg of *ulang* in monoculture, and 42.4 ± 21.6 kg of *ulang* and 72.6 ± 34.9 kg of tilapia in *ulang*-tilapia polyculture.

Profitability and Income

In an area of 500 m^2, the net profit per cropping was estimated to be positive in both culture systems. The net profits for *ulang* monoculture and *ulang*-tilapia polyculture were PhP9,852.92± 8,8757.27 and PhP8,789.18 ± 7,073.75, respectively (Table 4). It is expected that net profit from the polyculture system 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 the polyculture of *ulang* and tilapia.

Projected Profitability under Maximum Survival Rate and Growth Performance

In *ulang* monoculture, the highest regional average survival rate and growth performance attained in the on-farm trials were 83% and 40 g per piece, respectively (Table 2). Given a stocking density of 6 PL/m^2 and if the highest survival rate was attained across regions, there will be an average additional yield of 18.7 kg in a pond area of 500 m^2 (Table 5). Similarly, if the 40 g per piece growth performance was attained, it will result in an added average yield of 13.3 kg. Overall, the total average yield of 31.9 kg may be gained with high survival rate and growth performance. The regions with relatively low survival rate and growth performance should improve on these two factors to increase profitability.

In the polyculture system, the highest survival rates for *ulang* and tilapia were 74.8% and 86%, respectively. In terms of growth performance, 34 g per piece for *ulang* while 567 g per piece for tilapia. Across regions, if the highest survival rate and growth performance were attained, the added yield will be 26.9 kg and 98.9 kg for *ulang* and tilapia, respectively (Table 6). Because of improved survival rate, the additional yields would result in increased income of PhP4,038.00 for *ulang* and PhP724.33 for tilapia. The additional income was highest at PhP7,183.92 for tilapia and PhP4,029 from *ulang* as a result of improved growth performance.

Prospects of Ulang Culture

Ulang is the only freshwater shrimp that can be bred in captivity and cultured in the Philippines. Although maturation occurs in freshwater environment, larval development still requires a marine environment. The farmer-cooperators believed that there was high economic demand and high profit in the culture of *ulang*. However, they perceived that the market preference was not yet established compared to tilapia and other finfish. Prospective fish farmers were concerned with the availability of postlarvae in their areas and the high production cost. The latter can be addressed through supplemental feeding with indigenous feeds. Controlling the carbon and nitrogen ratio (C:N) in the pond to allow for growth of natural food, such as biofilm and flocculating microbes (Asaduzzaman et al., 2010; Asaduzzaman et al., 2008), may address the need for reducing the dependence of freshwater prawn stock to commercial feeds. *Ulang* culture has gained popularity in Northern Mindanao with the establishment of four hatcheries from 2003-2004 (Dejarme, 2005).

Polyculture of ulang with compatible aquatic species and crops must be explored in the country. A system similar to 'gher' (prawn-fish-rice) culture (Rahman & Barmon, 2012) should be evaluated in addition to exploring the beneficial effects of including tilapia in freshwater prawn culture (Asaduzzaman et al., 2009).

Problems/Constraints

The major problems encountered across regions during the on-farm trials were: a) availability

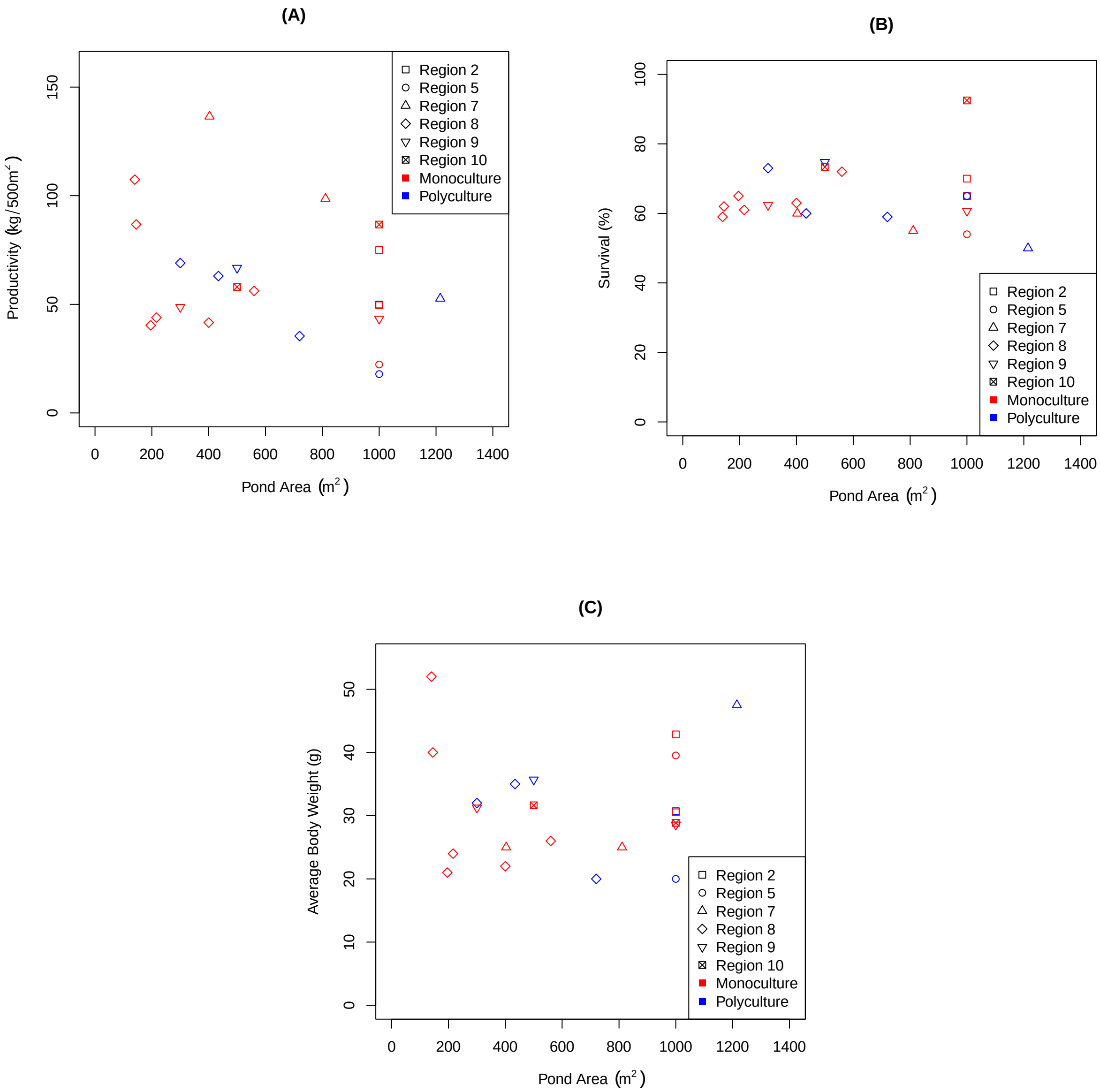

Figure 2. Plot of (A) *ulang* productivity (kg/500m^2), (B) survival rate (%), and (C) average body weight at harvest (g) per pond area (m^2) area from the pilot sites.

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

	Ulang Monoculture	*Ulang* -Tilapia Polyculture	
		Ulang	Tilapia
Overall			
Culture period (days)	144.3 ± 16.4	145.38 ± 10.84	
Survival rate (%)	65.0 ± 9.1	58.8 ± 15.2	76.5 ± 11.7
ABW at harvest (g)	31.2 ± 8.5	28.1 ± 5.8	191.3 ± 95.3
Number of pieces per kg	34 ± 8	38 ± 8	6 ± 3
Region 2			
Culture period (days)	150.0 ± 0.0	150 ± 0.00	
Survival rate (%)	67.5 ± 2.5	65.0 ± 0.0	65.0 ± 0.0
ABW at harvest (g)	36.7 ± 6.2	30.7 ± 0.0	190 ± 0.0
Number of pieces per kg	28 ± 5	33 ± 0	5 ± 0
Region 5			
Culture period (days)	151.0 ± 0.0	151.00 ± 0.00	
Survival rate (%)	54.0 ± 0.0	65.0 ± 0.0	86.0 ± 0.0
ABW at harvest (g)	39.5 ± 0.0	20.0 ± 0.0	426.0 ± 0.0
Number of pieces per kg	25 ± 0	50 ± 0	2 ± 0
Region 7			
Culture period (days)	135.0 ± 15.0	150 ± 0.00	
Survival rate (%)	57.5 ± 2.5	50.0 ± 0.0	55.0 ± 0.0
ABW at harvest (g)	25.0 ± 0.0	25.0 ± 0.0	118 ± 0.0
Number of pieces per kg	40 ± 0	40 ± 0	8 ± 0
Region 8			
Culture period (days)	132.0 ± 11.2	134.7 ± 10.9	
Survival rate (%)	63.7 ± 4.2	64.0 ± 6.4	84.7 ± 2.5
ABW at harvest (g)	30.8 ± 11.4	29.0 ± 6.5	181.0 ± 11.9
Number of pieces per kg	36 ± 11	37 ± 9	6 ± 0.0
Region 9			
Culture period (days)	158.0 ± 1.0	157.0 ± 0.0	
Survival rate (%)	61.6 ± 0.8	74.8 ± 0.0	86.0 ± 0.0
ABW at harvest (g)	29.9 ± 1.3	35.7 ± 0.0	166.7 ± 0.0
Number of pieces per kg	34 ± 2	28 ± 0	6 ± 0
Region 10			
Culture period (days)	166.50 ± 13.50	151.00 ± 0.00	
Survival rate (%)	82.91 ± 9.58	23.5 ± 0.0	66.3 ± 0.0
ABW at harvest (g)	30.25 ± 1.39	26.3 ± 0.0	86.7 ± 0.0
Number of pieces per kg	34 ± 2	38 ± 0	12 ± 0

Table 3. Comparison of yield per unit area between monoculture and polyculture systems.

	Ulang Monoculture	*Ulang*-Tilapia Polyculture	
		Ulang	Tilapia
Pond area per cooperator (m^2)	500	500	
Yield (kg/500 m^2)	58.1 ± 21.6	42.4 ± 21.6	72.6 ± 34.9

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

Table 5. Effects of (a) high survival rate and (b) high growth performance on productivity, profitability and viability of *ulang* monoculture by region.

Items	Region						Average
	2	5	7	8	9	10	
(a) Yield effect at 83% Survival (kg)	16.4	34.7	19.1	22.5	19.2		18.7
(b) Yield effect at 40 g ABW (kg)	6.7	0.0	25.9	4.3	18.6	24.3	13.3
(c) Total (kg), (a) + (b)	23.2	34.7	44.9	26.8	37.8	24.3	31.9
(d) Revenue effect (added income in 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

Table 6. Effects of (a) high survival rate and (b) high growth performance on productivity, profitability and viability of *ulang* polyculture by region.

Items	Region						Average
	2	5	7	8	9	10	
(a) Yield effect at 74.76% *ulang* and 86.00% tilapia survival (kg)							
(a.1) *ulang*	9.0	5.9	18.6	9.4		40.5	13.5
(a.2) tilapia	20.0		18.3	1.2		8.6	9.1
(b) Yield effect at 34 g *ulang* and 567 g tilapia ABW							
(b.1) *ulang*	9.8	30.6	16.1	12.9		6.6	13.4
(b.2) tilapia	76.7		84.7	103.7	111.4	112.5	89.8
(c) Total (kg), (a) + (b)							
(c.1) *ulang*	18.8	36.5	34.6	22.2		47.1	26.9
(c.2) tilapia	96.7		103.0	104.9	111.4	121.0	98.9
(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

of post-larvae in the region, b) water quality and availability, c) presence of predators, and d) technical know-how of the farmer-cooperators. Many farmer-cooperators experienced difficulty in obtaining the required postlarvae within their areas. Because of the distance from the sources to the regional project sites, mortality was high especially during transport. It was recommended to conduct follow-up trials with the same farmer-cooperators along with the establishment and rehabilitation of hatcheries in each region to sustain the supply of postlarvae.

Summary and Conclusion

This study was conducted to explore the viability of *ulang* culture in Regions 2, 5, 7, 8, 9, and 10 in the Philippines, and identify the challenges and opportunities in improving the livelihoods of small-scale fisherfolk. The growth performance, in terms of average body weight at harvest, survival rate, and profitability and viability of *ulang* production in two culture systems (monoculture and polyculture) were compared. Since *ulang* culture is still on its early development stages in the country, piloting on-farm trials was conducted with technical assistance from the regional teams organized by the WorldFish and in partnership with DOST, BFAR and SUCs.

Several lessons learned during the conduct of the study are as follows:

1. The identified beneficiaries of the project should be required to attend the technical trainings. It was observed that during the start of the study, the participants in the training were not the identified beneficiaries. This became a drawback

because technical information still had to be passed on to the actual beneficiaries.

2. The aquaculture expert must speak and understand the language of the beneficiaries. Because of language barrier, the technicians misinterpreted some recommendations, which resulted in poor implementation of technical interventions. This could be addressed by utilizing the services of local experts. However, regular and clear dialogues between the consultants, beneficiaries and aquaculture technicians could immediately solve the problem.

3. The postlarvae must be available year-round. Even with the market demand for *ulang*, suppliers of postlarvae could not provide postlarvae to only few pond owners. Also, small-scale growers who would like to venture into *ulang* culture were discouraged by the high cost of production including acquiring the postlarvae by volume from distant sources. If this problem persisted, there could be 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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