Reaching the Poor Through Aquaculture: The Case of Technology Adoption in Rural Communities at West Central Philippines

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Abstract

Aquaculture is promoted for food security and poverty alleviation in developing countries. This study examines the socio-economic impact of aquaculture technologies extended to calamity-stricken rural communities in Nueva Valencia, Guimaras, representing the marine water fishery and in Dumarao, Capiz, representing the inland freshwater fishery at west central Philippines. The adoption pathway employed in both sites was community-based and participatory. The survey was conducted among cooperators and non-cooperators, randomly selected in equal numbers in two sites with 60 respondents each per site using a pre-tested interview schedule.

Results showed that aquaculture is an acceptable technology both for cooperators and non-cooperators. The venture is a profitable business either done individually or collectively through an association, if managed properly. Milkfish cage culture, however, needs big capital that technology adoption among local fisherfolk (Guimaras) is limited. In contrast, tilapia cage culture enables small farmers/fishers in Dumarao to venture on their own. Dumarao growers were able to innovate using local materials like bamboo poles to make their cages afloat instead of drums or plastic containers as buoys. There were, however, environmental, technological and institutional issues deterring technology adoption in both sites. Climate change and institutional issues were the more prevalent concerns of Dumarao growers. The technological issues like fluctuating market price, cost of feeds, and fry supply were more enunciated in Guimaras.

Keywords: aquaculture, technology adoption, rural communities, marine waters, freshwater

Introduction

The human population dependent on fish as their primary source of animal protein is expected to grow by 2 billion to 8 billion in the next 25 years (van der Zijpp *et al.*, 2007). Meanwhile, world production of capture fisheries has leveled out (FAO, 2007). Reliance on aquaculture for food supply has become even greater with production from 31 to 59 million metric tons since 1995, accounting for almost half (45%) of the world's food fish (Subasinghe *et al.*, 2009; FAO, 2006). Aquaculture does not only bridge the supply and demand gap of aquatic food, but also generates employment, and alleviates poverty (Irz *et al.*, 2007; Subasinghe *et al.*, 2009; Srinivasan *et al.*, 2010; Soto-Zarazúa *et al.*, 2011).

In the Philippines, the aquaculture sector showed increasing production trend and has posted the highest growth (18%) compared with municipal (2.4%) and commercial (1.7%) sectors in 2005 (BFAR, 2006). NSCB (2012) reported in 2009 that among the nine basic sectors in the country, those engage in fishing had the highest (41.4%) poverty incidence, while those in farming come in second (36.7%). Poverty in fishing communities is further exacerbated by the declining catches of municipal fisheries for over the past 20 years (Irz *et al.,* 2007).

Through the Institutional Capacity Development for Sustainable Aquaculture (ICDSA)[1] project of the Southeast Asian Fisheries Development Center Aquaculture Department (SEAFDEC/AQD) aquaculture technologies are taught to rural communities as supplemental livelihood. ICDSA uses multidisciplinary, community-based and participatory approaches in the transfer of technology (Agbayani and Toledo, 2008). The introduction and adoption of technologies, however, affect the different spheres of society- be it social, economic, political, cultural or ethical – in different modes and paces (Daňo, 2007). Conversely, there are also constraints that hinder or retard the uptake of the technology in rural communities. There is a need to examine the socioeconomic impact of the aquaculture interventions in ICDSA sites, particularly in marine and freshwater fishery. Positive outcomes of technology adoption may pave the way not only for livelihood improvement and poverty alleviation in rural communities, but it will also become an essential component of integrated rural development.

This study aims to analyze the socio-economic impact of the transfer and adoption of aquaculture technology among coastal dwellers and farmers in rural communities. Specifically, it aims 1) to document changes over time, resource use and socioeconomic conditions in study sites with the adoption of aquaculture technology; 2) to examine the factors that contribute or impede the acceptability and adoption of technology; and 3) to determine whether there are differences in knowledge of and attitudes among community members (growers & non-growers) and between locations (marine vs. freshwater) towards aquaculture technology adoption.

Material and Methods

Study Sites

The study was conducted in four villages (barangays) in Western Visayas, central Philippines where aquaculture was introduced to calamity stricken rural communities with differing culture environments under the ICDSA project. The sites were in Nueva Valencia, Guimaras, representing a marine water area and in Dumarao, Capiz, representing a freshwater area (Figure 1). Each study site is composed of two villages (Sto. Domingo and Magamay in Guimaras; Codingle and Tamulalod in Dumarao). The villages in Guimaras were selected based on its location (adjacent villages) and size of the community.

[1] ICDSA protocol is discussed extensively in Agbayani, RF and Toledo, JD. 2008. Institutional capacity development for sustainable aquaculture and fisheries: strategic partnership with local institutions. In K. Tsukamoto, T. Kawamura, T. Takeuchi, T. D. Beard, Jr. and M. J. Kaiser, eds. *Fisheries for Global Welfare and Environment, 5th World Fisheries Congress 2008, pp. 435–448.*

Nueva Valencia is a third class coastal municipality of Guimaras province. It is considered a tourism capital and major fishing ground of the province. It has the highest number of fishers among the five municipalities of Guimaras. In 2006, an oil spill[2] stretching over 15 miles and reaching 50-75 in width affected the rich fishing ground, the mangroves, and other marine life of Nueva Valencia. As a consequence, about 5594 families were directly or indirectly affected and the total losses of the municipality were estimated at PhP 237 million (Provincial Government of Guimaras and PEMSEA, 2012).

Dumarao is an inland 2nd class municipality of Capiz province. It is the 4th leading rice-producing municipality of the province. About 23.7 ha of agricultural lands spanning four villages were submerged with water due to unfinished dam construction in 2006. The river expanded approximately from 2-4 m to 50-100 m in width and became deeper from 2 m to 5-8 m in depth. The submerged land cost PhP 526,844 and most (72%) of the 36 affected farmers were from Barangay Tamulalod[3]. One of the affected villages was excluded from the assessment and validation for concerned parties did not file claims on time.

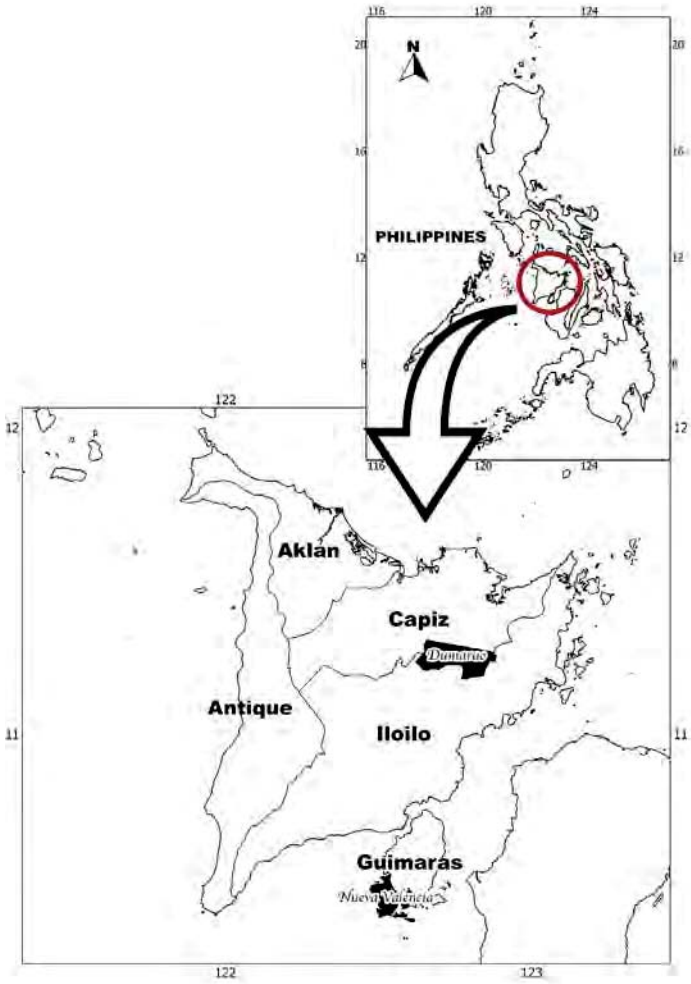

Figure 1. Study sites.

[2] MT Solar 1 tanker carrying 2.7 million liters of bunker fuel sunk in marine waters a few km from Nueva Valencia.
[3] Source: Result of Survey and Validation of CIP claimants - Oct 2-13, 2006.

Technology Transfer

The adoption pathway used in both sites was community-based and participatory although the aquaculture interventions vary in each site. The community is represented by an organized group or Peoples Organizations that chose among themselves the members that would undergo the training. Table 1 shows the profile of the peoples' organizations (POs) whose members were the major participants and beneficiaries of the project.

Thirty trainees or six trainees each from five small-scale fishers' association[4] of Nueva Valencia's four villages were trained at SEAFDEC's Mariculture Park at Igang Marine Station. The trainees cultured milkfish in three 10 m x 10 m x 6 m net cage with a stocking density of 24,000 fry per cage for six months. After the successful runs, each association operated their own milkfish cage culture in their respective villages. Harvest and post-harvest handling were part of the training including value-adding activities, e.g. deboning of milkfish, for members. Petron[5] funded the project as part of its support to rehabilitation and ecological recovery program of Guimaras. Included in the fund support was the social preparation of POs to which a non-government organization with expertise in entrepreneurial development and institutional capability building was hired for the purpose.

Table 1. Profile of peoples organizations involved in ICDSA[1] projects in study sites.

People Organization	Location	Number of members			Existing livelihood projects	Year registered
		Male	Female	Total		
Sto. Domingo Fisherfolk Association	Sto. Domingo, Guimaras	27	19	46	• Milkfish cage culture • Gasoline trading	2005; DOLE[2]
Magamay Small Fisherfolk Association	Magamay, Guimaras	79	50	129	• Milkfish cage culture	2009; DOLE
Dumarao Fishfarmers Multi-purpose Cooperative[3]	Dumarao, Capiz	24	6	30	• Tilapia cage culture	2008; CDA[4]

[1]Institutional capacity development for sustainable aquaculture; [2]Department of Labor and Employment; [3]Not all members are residents of Barangay Tamulalod and Codingle; [4]Cooperative Development Agency

[4] Only Sto. Domingo and Magamay associations were included in this study.
[5] Petron Corporation chartered the tanker.

The Provincial Government of Capiz funded the ICDSA project in Dumarao. About 25 participants from different villages attended the season-long training in 2007. Eight net cages (4 m × 4 m × 1.5 m) were installed and stocked with tilapia, catfish and freshwater prawn (ulang) in a demonstration farm in Badbaran River. The Acting Officer of the Municipal Agriculture Office formed the participating community-members into Dumarao Fish Farmers Multi-Purpose Cooperative (DFFMPC). The demonstration farm was turned over to DFFMPC and the proceeds of their harvest were re-invested and rolled-over for operations. The members opted to focus on tilapia for they found it more viable in their area compared to other species. It was noted that technical support from the local government office was minimal in the absence of trained staff on fisheries and aquaculture.

Methods

Field surveys were conducted in 2010-2012 among 30 non-cooperators and 30 co-operators/adopters each per site using a pre-tested interview schedule. Cooperators/adopters refer to members of an organized group or individuals who benefited or adopted the technology after the season-long training. The non-cooperators are those who compete with the use of water resources in the area. The respondents were randomly chosen from a list of fishing households provided by local officials for non-cooperators and from the associations, in the case of cooperators. Secondary data such as ICDSA reports on Dumarao and Nueva Valencia season-long training and results of ICDSA mini-workshop, among others, were gathered and reviewed. Key informants were the Village Heads and officials, Association/Cooperative Heads, Municipal Agriculture Office staff, technicians, and a family of fishers.

Production data were gathered among adopters of technology in project sites. Cost-benefit analysis was used to determine the viability of the enterprise. Mann-Whitney U Test was used to determine the differences between Guimaras and Dumarao co-operators on the constraints and benefits gained from technology adoption. Focus group discussion was used to validate gathered data.

Results

Most (27%) respondents were in the age bracket of 48-58; the youngest, 18 and the oldest, 73. All had formal education and 77% of them were married. Most (40%) Dumarao co-operators reached college level while majority (57%) of Guimaras co-ooperators only attained elementary level. Likewise, majority (43%) of Dumarao co-operators were farmers, mostly (60%) from Barangay Codingle. In Guimaras, the co-operators were mostly (50%) fishers and the majority (67%) were from Barangay Magamay.

Adopters and Dispersal of Technology

Tilapia cage culture in Dumarao was small-scale. Most growers owned one cage with size ranging from 4 x4 m to 4 x 10 m (Table 2). All had positive income since they had pre-agreed price and harvest arrangements to avoid competition. Harvest was sold locally, along the road. Adopters claimed that the technology provided opportunity for them to use their submerged farmlands for aquaculture venture. They ranked tilapia cage culture second (33%) to farming (55%) as the most important household occupational activity

that contributes to their household income, particularly those in Brgy. Tamulalod. They maintained that farm goods can be used as collateral for loan, but not fish harvest. However, 44% of them conceded that fish farming is not laborious compared to farming. They also ranked fish farming second (34%) to fishing (50%) as a source of food.

It was noted that initial adopters of tilapia cage culture were Dumarao's better off residents. These were not sustained when operations were relegated to hired labor. Similarly, the PO's aquaculture venture was not sustained. The water depth in culture area became shallow during 2010 long dry spell. The PO also had organizational problems leading to its demise as a group. Nonetheless, the adopters, who were also members of the cooperative, increased to fifteen (5 in Tamulalod; 10 in Codingle), but the number reversed in the latter part of the survey. Some adopters innovate using excess surface water for backyard pond. Two cooperators became hatchery operators (one for commercial scale and the other, for personal use). Informants claimed that the technology spread to six other villages with some adopters serving as resource persons. Two fertilizer dealers of the municipality addressed the growers' feed needs. Others developed interest on other species that an on-site demonstration on induced spawning of catfish was facilitated. Most (83%) of Dumarao respondents claimed that the tilapia production volume was not enough to meet community fish requirements.

Milkfish cage culture in Guimaras showed varied results (Table 3). Only Sto. Domingo fisherfolk association gained profits in its two production runs. The harvest was sold in Iloilo fishing port where it competed with other fish species for higher price. The Sto. Domingo PO retained small portion of their harvest for retail to members. Some members deboned the milkfish, gaining higher profit. The PO's share of the production income was 20% while the 80% went to the four technicians (caretakers) who divided it equally among themselves Compared with Dumarao, most (56%) of them claimed that aquaculture is better than farming. Only two private investors aside from the PO's own venture were adopters of the technology in the area. Private investors hired trained PO members as technicians. Nonetheless, Village Heads (Brgy. Magamay and Sto. Domingo) were not inclined to grant permit for new entrants on cage culture claiming that water bodies within their control were small. Culture operations of POs were on hold for lack of funds.

There was a heightened interest on aquaculture as a source of added income among members of Sto. Domingo PO. They were awaiting for the approval of their proposed sea cucumber grow-out culture which they submitted to a non-government organization for funding. Some of its members also showed interest for the seeding of their coastal waters with sea cucumber to enhance its productivity. They claimed that it is easy for them to monitor the growth of sea cucumber and oversee the area for their coastal area is just small.

Factors Affecting Adoption

The aquaculture issues in two sites are generally classified into: 1) environmental issues, 2) technical issues, and 3) institutional issues. The freshwater culture operation in Dumarao was most affected by climate change. The growers experienced high water temperature; low

water level, and profuse growth of giant water lettuce during long dry spell in 2010. But during rainy season, they had to live through flooding, and the siltation, thereafter. Dumarao growers were also in quandary whom to deal with regarding their problems on the unfinished dam construction for it is affecting their culture operations. The local government unit could not address their problems claiming the project was not turned-over to them. Both sites had similar technical issues such as cost of feeds, market, and fry supply, among others, but these were significantly ($p<0.001$) pronounced in Guimaras than in Dumarao (Table 4). In terms of benefits, the technology as a source of cash income was highly significant ($p<0.01$) among Dumarao growers. Resource utilization on the other hand is significant in Guimaras co-operators.

Attitude Towards the Technology

The respondents showed positive attitude towards aquaculture. Majority of them claimed that existing culture operations did not affect their own activities (59%) or the water quality (75%) of their marine/freshwater resource base. Most of them (81%) believed that their resource base is an open access, but only 41% respondents liked to limit the number of cages to avoid congestion and pollution. This sentiment, however, was not shared by 72% Dumarao respondents.

Table 2. Cost-benefit analyses of tilapia cage culture of sample respondents in Dumarao, Capiz.

Technical Assumption	A	B	C	D	E
Size of cage	4x4x4m	4x5x4m	4x10x4m	4x5x4m	4x6x4m
No. of cages	1	1	2	8	2
Total stock	1,000	2,000	2,000	7,000	2,000
Production/m^2 (kg)	4.68	5.5	1.0	1.66	2.29
Net income	3,382	3,649	5,302	3,143	3,372
Total operating cost	4,118	7,531	4,298	28,657	9,798
Total investment cost	757	1,160	2,000	11,950	3,372
ROI (%-depreciation excluded)	447	315	265	26	64.85

Table 3. Cost-benefit analyses of milkfish cage culture of fisherfolk associations in Nueva Valencia, Guimaras.

Technical assumption	Brgy Sto. Domingo PO		Brgy. Magamay PO	
	1st run	2nd run	1st run	2nd run
Size of cage	10x10x6m	10x10x6m	10x10x6m	10x10x6m
No. of cages	1	1	1	1
Total stock	20	20	20	20
Production/m^2 (kg)	42.05	44.25	27.97	33.67
Net income	31,945	20,736	-84,527	-105,165
Total operating cost	417,803	458,584	381,502	418,308
Total investment cost	134,509	134,509	134,509	134,509
ROI (%-depreciation excluded)	47.50	30.83	-125.38	-78.18

Table 4. Cooperators' difficulties and benefits in adopting the technology by location (n=60).

Variables	Guimaras	Dumarao	Mann-Whitney U	Z
1.Difficulties				
Supply of fry	33.71	25.57	302*	-1.976
Credit	41.92	17.67	77.5***	-5.606
Feeds	38.69	21.60	183***	-3.996
Harvesting	37.24	23.00	225***	-4.301
Market	37.83	22.43	208***	-4.123
2. Benefits				
Source of cash income	24.22	35.58	267.5**	-2.759
Utilization of resource	34.81	21.65	184.5*	-3.159

***= p<0.001; **=p<0.01; *= p<0.05

Discussion and Conclusion

The findings showed that adoption of aquaculture technology is acceptable to both farmers and fishers and even for non-growers as long as it does not impinge on their own activities in the same resource base. This implies that zoning and corresponding enforcement are two important factors that will avert future conflicts on resource use and help ensure sustainability of the venture. This also necessitates pro-active local legislation on resource allocation especially in Dumarao where fishery management is still wanting, more so in aquaculture.

The venture showed positive income either operated as an individual or cooperative undertaking. In the latter, the organization must be stable and well-managed. The size of membership may have affected members' participation in culture operation. Group size proved to be unwieldy, and the lack of social preparation affected PO's success (Baticados *et al.*, 1998). Unless income from culture operation is substantial, fishers will remain fishing. The milkfish cage operation in Guimaras is a cooperative venture, thus, the sharing of benefits is spread to all members. Failure on their cage operation might cause disintegration of PO membership. Thus, there is a need for their organization to diversify operation that requires less capital, e.g. sandfish culture or value-adding activities. This is to cushion the impact of the venture's poor performance on members. Interchangeably, other modes of partnership must be explored that would pay for opportunity loss of the adopters.

The spread of technology is faster among fishers/farmers requiring low capital investment. Thus, it should be given as an option to rural folks if viable in the area.

The effect of climate change is more felt in freshwater culture operation than in marine culture operation affirming ADB's disclosure (ADB, 2005). The involvement of LGUs is important both in legislation and in facilitating solutions to articulated concerns of adopters.

Aquaculture indeed provides food security and income to rural communities. However, the transfer of technology requires an adoption pathway that is easily and effectively understood by the

beneficiaries. In the transfer of technology, the experts must be able to anticipate, identify, and make a follow-through on the transferred technology. If feasible, he/she should facilitate in addressing issues or concerns of adopters. Because of climate change, small-scale growers should be informed of an array of aquaculture livelihood options feasible to the locality to enable them to make wise decision on the technology appropriate for their skills, interest, and affordability.

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Suggested Readings

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