Impact Assessment of CRSP Activities in the Philippines and Indonesia

Sustainable Feed Technology/Activity/09SFT06NC

Remedios B. Bolivar
Central Luzon State University
Science City of Muñoz, Philippines

Evelyn Grace T. de Jesus-Ayson and Maria Rovilla J. Luhan
Southeast Asian Fisheries Development Centre – Aquaculture Division
Iloilo, Philippines

Hasan Hasanuddin and Coco Kokarkin
Ujung Batee Aquaculture Center
Banda Aceh, Indonesia

Upton Hatch
North Carolina State University
Raleigh, North Carolina, USA

Kevin Fitzsimmons
University of Arizona
Tucson, Arizona, USA

Russell J. Borski
North Carolina State University
Raleigh, North Carolina, USA

ABSTRACT

A series of activities to promote training and to assess the impact of technologies and management practices aimed at improving incomes for small-scale aquaculture farmers in the Philippines and Indonesia was undertaken. In the first phase a workshop consisting with 66 stakeholders was held to provide additional training on reduced feeding practices and least-cost feed formulations and manufacturing technologies that limit the cost of producing tilapia. A survey was also conducted to assess the current production practices of tilapia aquaculture with particular emphasis on evaluating the adoption rate of reduced feeding strategies developed under the CRSP project. Fifty-eight individuals were interviewed and approximately half used reduced feeding strategies, mostly the delayed onset of feeding practice, where feed costs are reduced with little impact on total yield. Based on the survey data, total feed costs were reduced and net return was improved by 46% when the feed reduction strategy was utilized. Based on these results it would appear that tilapia farmers are adopting feed reduction strategies at a high rate and that this results in improved incomes. Considering the size of the tilapia industry, which is the fourth largest in the world, it would appear CRSP research and outreach has positively impacted the livelihoods of an untold number of families.

In a second phase of this investigation we expanded our training on milkfish integrative production systems and feed management practices and on value-added processing of seaweed and milkfish to various islands in the Philippines, including Mindanao, Palawan and Iloilo. Informal interviews and consultation with farmers, operators, investors, and government personnel revealed 3 major constraints to

production – reliable source and consistent supply of good quality fingerlings, prohibitive cost of feeds, and marketing. An additional concern in some locations was the periodic low water quality associated with milkfish cage clusters that result in emergency harvests. To address these concerns CRSP personnel conducted four workshops that provided information and training on how production and economic efficiencies can be improved through some technical interventions. This included ways to improve feeding strategies and management such as the utilization of alternate day feeding strategies shown through recent CRSP research to reduce feed inputs by as much as 30%. Growers are now currently testing this on farm in production marine cages. Another way is to apply the concept of polyculture or integrated multi-trophic aquaculture in the grow-out of milkfish to increase profit and reduce negative impact to the environment. SEAFDEC – CRSP project personnel provided information on integrative culture systems that incorporate sandfish (sea cucumber), seaweed and rabbitfish into milkfish systems. To enhance women's opportunity to improve household welfare through sale of products in local market, a final workshop provided training on seafood safety; marketing techniques; milkfish processing, deboning and marinating; and on seaweed preparation and cookery. Twenty-five women participated in the workshops with the intent on supplementing their household incomes through local market sale of value-added products and for enhancing household nutrition.

The AquaFish CRSP aquaculture program in Aceh, Indonesia has focused on promoting the adoption of best aquaculture practices for seaweed-shrimp/finfish polyculture systems. These systems involve a more sustainable use of small-scale tambak culture systems that incorporate seaweed (*gracellaria)*, shrimp and fish. The third phase of these studies was to assess the impact training activities had on adoption of seaweed-shrimp/finfish polyculture in Aceh, based on interviews, farm visits and data collection. We found that 100 farmers with around 400 ha of farm area have adopted polyculture practices for shrimp and/or finfish growout in various Aceh communities. This is a relatively new culture practice that has recently been adopted. A marketing agreement has been achieved for purchase of seaweeds, which should provide additional income for fish/shrimp farmers that adopt more sustainable polyculture techniques.

Our fourth objective was to develop additional extension podcast modules to promote impacts of AquaFish CRSP research and outreach activities. The podcast approach is far thriftier, more easily updated, and more efficient than the distribution of printed media. With the continued growth of smart phones, MP3 players, computers and other devices in throughout the world we anticipate the Podcast will be a highly attractive extension tool for dissemination of information on aquaculture. To this end three podcasts were produced and uploaded onto iTunesU to demonstrate how alternate-day feeding can reduce costs of milkfish culture in marine cages and brackishwater ponds. Two of these podcasts reflect translations to Tagalog, the primary Filipino language, and Ilonggo, the primary dialect with in the Iloilo region of the Philippines, where milkfish culture is an important form of livelihood. Four other podcasts highlighting the activity of CRSP programs in other countries are currently under development.

INTRODUCTION

A series of activities were completed to promote additional training and to assess the impact of technologies and management practices aimed at improving incomes for small-scale aquaculture farmers in the Philippines and Indonesia. They included work to promote accomplishments from the previous Aquaculture CRSP as well as our current AquaFish CRSP projects.

AquaFish CRSP work in the Philippines and Indonesia was designed to develop and implement strategies that will improve the cost effectiveness, sustainability and income opportunities of farming fish in the Philippines and Indonesia and the subsequent livelihood of their people. Tilapia and milkfish are the two most prominent finfishes cultured in the Philippines and their culture is expanding rapidly both in inland and coastal regions. Feed is the most costly component of fish farming, representing as much as 80% of total production costs for tilapia and 60-70% for milkfish. Therefore, procedures that reduce the amount of feed or its cost without negatively impacting harvest quality or yield can improve farmers' incomes.

Through delayed onset, alternate day, or sub-satiation feeding, or a combination of the three, research has shown that the amount of feed required to culture tilapia in ponds can be reduced by as much as 50% with little or no impact on the total yield of harvested fish. These practical strategies to improve production efficiency of tilapia can increase the incomes of farmers. Anecdotal information has suggested some farmers are adopting these new feeding strategies in the Philippines, including those who conducted the original research trials on their farms, but the extent to which this has occurred was uncertain, prior to this assessment. This may arise from the lack of farmers' knowledge of alternate feeding strategies. Alternatively, farmers may be utilizing new methods, but this had not been quantified. Therefore, one of the aims of this investigation was to conduct additional training on alternative feeding practices to farmers and to survey households to assess the extent to which new feeding practices are being adopted by the tilapia farming communities. These are critical elements to promoting new technologies developed by CRSP as well as assessing the impacts of the technologies.

Milkfish culture is the largest finfish aquaculture industry in the Philippines. As part of the Philippine government's food security and poverty alleviation programs, expansion of milkfish culture is a high priority, both to wean fishers off capture fisheries and to increase income of farmers and fishers alike, whose poverty levels are disproportionately high. Much of the growth in milkfish production is in cage culture in marine or brackishwater coastal areas. Cage culture of milkfish is done at higher densities and with significantly greater inputs of artificial feeds. This practice, however, has led to wastage of artificial feeds and to excessive nutrient loading in receiving waters, exacerbating pollution problems and contributing to periodic fish kills in areas of intensive milkfish culture. It also appears many farmers use substantially more feeds than recommended. Our research results suggest that a reduction of 2-3% below the recommended daily feed ration during the early fingerling stage can produce fish without substantially reduced yields. Moreover, feeding on alternate days rather than the typical daily practice can produce a substantial cost savings in feeds by as much as 50% with limited impact on yield. We have also recently evaluated an integrative milkfish culture system that utilizes co-culture of seaweeds, sea cucumber, and/or rabbitfish with milkfish. The integrative, polyculture system has potential to reduce nutrient overload seen around milkfish culture clusters while simultaneously providing additional income opportunities to farmers through seaweed, sea cucumber and rabbitfish markets. In this investigation we expanded training on alternative feeding practices and on integrative culture systems for milkfish from one location in Guimaras to additional islands where milkfish culture is gaining popularity or is even more prominent, namely in the Mindanao as well as other areas within Visayas regions of the Philippines. Expansion of workshops to these regions has provided wider outreach and training to farmers and communities while enhancing capacity building through the participation of additional local and regional government agencies and other stakeholders in the Philippines.

In Indonesia and the Philippines, interest has heightened in diversifying aquaculture crops, following the realization that intensive shrimp farming practices contributed to the deterioration of water quality in the mangrove coastal habitat. In our recently completed AquaFish CRSP project, we have conducted a series of workshops on incorporating seaweed in the polyculture of shrimp and fish as a more sustainable and environmentally benign, and profitable form of aquaculture. Although some farmers have adopted these polyculture practices, the number of farmers, hectareage, and communities impacted had not been assessed. Therefore, we conducted farmer surveys in Aceh, Indonesia. The project collaborated with the Host Country Institute, Ujung Batee Aquaculture Center, the primary research and extension center in the Aceh province of Indonesia, to collate data and provide a full assessment of the impact of CRSP-funded training programs on alternative and sustainable management practices for shrimp and finfish farming communities of Aceh.

Podcasting is a wide-open, attractive format for digitizing procedures, technologies, pictures, data, and video clips set to music that can accommodate practically any digitized material that is desired. Unlike traditional brochures or fact sheets, it can be updated quickly and easily, and the updates are

distributed automatically; unlike journals, texts, and fact sheets, they do not become obsolete. New advances can be incorporated into updates of old presentations for automatic distribution to holders of free subscriptions. Podcasts are an excellent means to convey information to the public, to include farmers, agribusinesses, extension personnel, congress, USAID and other stakeholders. We have produced of a series of short podcasts to introduce aquaculture technology and other information focused on best management practices and feed reduction strategies for improving the efficiency of Nile tilapia culture, developed primarily in the Philippines. An integral part of these podcasts has been the presentation of specific impacts that target indicators for the new Developmental Themes Advisory Panel reporting requirements of USAID. As a final component of this investigation, we expanded development of podcasts modules beyond those related solely to extending information on cost-effective tilapia culture technologies and best management practices, to conveying information on feeding practices that reduce milkfish production costs and sustainability. We are also in the process of completing several other podcasts that highlight some successes of research at other AquaFish CRSP sites in Southeast Asia, Latin America and Africa.

Collectively, this investigation has addressed two primary goals: 1) the promotion of technologies to improve incomes and livelihood of farmers and fishers, and 2) the assessment of the impact of research conducted under the AquaFish CRSP and previous CRSP programs.

OBJECTIVES

1. Provide training for and assess the impact of technologies and management practices that can improve incomes for small-scale aquaculture farmers in the Philippines and Indonesia.
2. Conduct extension activities and assess the impact of feed reduction strategies on tilapia culture in Central Luzon, Philippines
3. Enhance capacity building, provide training and assess impacts of alternative feeding practices, integrative culture systems, and value-added processing for milkfish production across a broader range of the Philippines.
4. Assess impacts of seaweed polyculture on fish and shrimp farming in Aceh, Indonesia
5. Produce podcast modules to promote outreach and impacts of AquaFish CRSP research in the Philippines, Indonesia and other host country sites in Southeast Asia, Latin American and Africa.

1. Conduct Extension Activities and Assess the Impact of Feed Reduction Strategies on Tilapia Culture in Central Luzon, Philippines

Additional training on alternative feeding practices and least-cost feed formulations and manufacturing technologies that reduce the costs of producing tilapia was provided to farmers, feed manufacturers and extension personnel. A survey of tilapia farming households was also done to assess the extent to which new feeding practices are being adopted by the tilapia farming communities. These are critical elements to promoting new technologies developed by CRSP as well as assessing the impacts of the technologies.

Extension Activities: A workshop on "Tilapia Feeding Strategies and Feed Manufacturing: Meeting Global Challenges" was conducted at the Philippine Carabao Center, adjacent to the Central Luzon State University campus in Nueva Ecija, Philippines in August 2011. This area lies within the primary tilapia aquaculture area of Central Luzon, and CLSU is central to disseminating new technologies to the tilapia industry. 66 people attended the workshop. This included farmers, representatives of the 5 primary tilapia feed manufacturing companies, and government (Bureau of Fisheries and Aquatic Resources) and university research and extension personnel who are key in informing the industry on new culture practices. A series of presentations and discussions on the cost benefits of delayed onset, alternate day,

or sub-satiation feeding was provided. This included presentations by farmers who participated in the on-farm trials that originally demonstrated the improved cost-effectiveness of utilizing delayed and/or reduced feeding strategies over the standard, daily feeding protocol in pond growout of tilapia. Other presentations provided information on hatchery best management practices and the value of utilizing lower cost fishmeal free and low protein diets in growout of tilapia. Various Podcast modules showing the cost-benefit analyses of using delayed or reduced feeding protocols were also shown. This workshop complemented an additional one previously conducted in the Pampangas region of Central Luzon (see investigation 09SFT04NC) where information on cost-effective feeding strategies and diets was also disseminated to farmers and others in the tilapia supply chain.

IMPACT ASSESSMENT

METHODS

A survey was conducted in 2011 to assess the current production practices of tilapia aquaculture with particular emphasis on the feeding strategies involved in the AquaFish CRSP project. The project focused on research at the Freshwater Aquaculture Center (FAC) at Central Luzon State University (CLSU) led by Dr. Remedios Bolivar of CLSU in collaboration with Dr. Russell Borski of North Carolina State University (NCSU). The project's central research goal hypothesis was investigation of the feasibility of reduced feeding as an improved management strategy that reduces costs of tilapia culture and can improve incomes of farmers. The results of the research were disseminated to private and public aquaculture sectors through CLSU training sessions, presentations and individual interactions.

The survey was led by Drs. Remedios Bolivar of CLSU and Upton Hatch of NCSU and conducted by CLSU and NCSU interviewers using a structured interview methodology with tilapia managers and owners in the major tilapia growing region centered in the Pampangas area. Data from 58 completed responses were compiled into a database and a summary of these results is presented in Table 1. The selection of survey participants was largely based on past interaction with CLSU extension personnel, activities and training workshops. The database and discussion of these results are organized into sections on respondent socio-demographics, farm characteristics, and management practices. The number of survey observations was adequate to provide an assessment of current production practices, and evolving use of reduced feeding strategies, of the typical Philippine tilapia producer in the dominant growing region. The supply chain analysis of Drs. Wilfred Jamandre of CLSU and Upton Hatch of NCSU, that was a separate investigation of this project, clearly demonstrated the dynamic growth and evolving nature of tilapia production in the Philippines. Philippine tilapia producers pursue a growing array of production and marketing strategies to meet this growing demand.

RESULTS AND DISCUSSION

Socio-demographics (Table 1). The region covered by the survey was concentrated in Pampangas but also included a few respondents from Bulucan and Nueva Ecija; The respondents included 33 owner-operators, 23 caretakers, one family member and one hired professional manager; 47 were male and 11 were female. Average age of owners was 47 with a range of 28 to 71; age of operators and caretakers was 43 with a range of 18 to 72. The typical tenure status was traditional ownership (40), but leasing was also common (14) and there were 4 respondents who managed ponds under both of these arrangements. Share tenant status (kasama) was thought to be a possibility, and the project team prior to conducting the survey interviews expected such respondents, but none were present in the final completed data set. Lease cost in Philippine pesos (Php/ha/crop) ranged from 7,000 to 20,000; experience of survey respondents with tilapia farming averaged 10 years and ranged from 1 to 25. Eight respondents used a *P. vannamei* polyculture and one used catfish.

Farm Characteristics (Table 1). Pond area owned or managed by the respondents averaged about 5 ponds totaling 17 ha and most ponds (approx 80%) were between 1 and 10 ha; the entire farm was approximately 21 ha. Three were under 1 ha - the smallest farm was only one pond of 0.3 ha. There were 9 respondents with 10 or more ha; the farm with the greatest area was 282 ha and the most ponds were 50. In summary, the socio-demographic profile of the typical respondent was a male in his 40's who lived in the Pampangas region and owned and operated a 20 ha farm that had 5 ponds averaging approximately 3 ha each.

Water source was an irrigation canal (31) or river (20), pond depth averaged 1.7 m, and soil type was either clay (45) or clay-loam (13). Salinity during low tide was 0, but at high tide there were 22 farms that had non-zero pH measurements that were typically in the 3-8 pH range. The ponds with these higher high tide salinity measurements often used polyculture of P. *vannamei* and tended to stock *T. mossambica.*

Management Practices (Table 1). The FaST strain of tilapia dominated (41) and BFAR-GetEXCel (11) and GIFT (6) were also used; most purchased their fingerlings from private sources (53) and only 5 depended solely on raising and stocking their own fingerlings. Density averaged about 50,000 per ha, size was typically 22 (grading size); average price per fingerling was 0.39 PhP and ranged from 0.34 to 0.50.

The average harvest yield was 5,000 kg/ha comprised of 200 g fish and accomplished in a 5-month culture period. The size at harvest ranged from 4 to 7 per kg and averaged 4.9 per kilogram or about 205 g. According to the supply chain analysis of Wilfred Jamandre and Upton Hatch, this size range targets local live markets (150-200g) and only the largest (250g and above) have potential to be marketed through higher volume urban grocery market outlets. The analysis found that fish destined for the latter market were often culled and re-stocked into specialized finishing ponds at lower stocking densities to increase average size demanded by this rapidly growing market opportunity. The lower ranges in the culture period and average sizes obtained from assessment survey respondents may indicate this culling strategy. A large array of production and marketing constraints were mentioned by respondents. Climate related fish kills (26) and typhoons (8) were the most common mentioned. Ten suggested predation from turtles was their most important source of yield loss. Also mentioned were: fish disease from fungi, water quality, availability, cost and quality of fingerlings, feed and market and finance issues.

Almost half the farmers (28 of 58) had adopted the CRSP-CLSU reduced feeding strategy. Respondents typical feeding schedule was completed in 5 months with a range of 4 to 6 months. Of those farmers using reduced feeding, the majority employed the delayed feeding strategy; the most common delay was a week and the average was about 2 weeks; there was one farmer who delayed feeding for a month and two who used a 45 day delay. Reduced daily feeding with an alternate day strategy and percent daily reductions of 50% and 67% were additional possibilities included in CRSP-CLSU research, training sessions and the assessment survey; three survey respondents used these strategies. One used 50% feeding for 2 months and another for 3 months; another respondent used alternate day for 2 months; no respondents used 67% reduced daily feeding. In summary, about half the farmers were willing to try the CRSP-CLSU reduced feeding regimens and the most common was 2-week delayed feeding.

Monthly feeding was accomplished with a staged approach using fry mash, pre-starter, starter, grower and finisher feed formulations. Typically each stage lasted about one month. In the first month all farmers used fry mash (13kg/ha), but depending on growth results, feed availability and marketing strategy, many farmers followed different patterns of formulation use. In month 2, only about 20% used pre-starter; most skipped pre-starter and used about 35 kg/ha of starter. In month 3, most farmers moved to grower formulation with a 62 kg/ha average feeding amount. By month 4, almost all farmers (85%) were feeding grower, averaging 85 kg/ha. Most farmers (72%)) harvested and marketed the crop in month 5, using an

average of 70 kg/ha with an even split between grower and finisher. The farmers that waited until the 6th month to harvest their ponds may have faced an array of impediments. In the previous section, the constraints that farmers mentioned to interviewers were typically related to climate, predation, and financial/marketing problems. The total cost of feed (210,116 Php/ha/crop) was predominantly for grower (54%) and finisher (21%).

Over ¾ of the farmers (79%) used fertilizer and of those 90% purchased inorganic fertilizers with an average total cost of 1,435 PhP/ha/crop. The most common formulation was 16-20-0 used by 31 farmers at an average rate about 1.55 bags per ha and a price of 950 PhP/bag. The second most used fertilizer was 46-0-0 by 18 farmers with an average rate of 1.02 bags/ha and a cost of 1,032 PhP/bag. A small number of respondents also used 21-0-0 or 14-14-1.4.

As discussed above, 48 respondents hired labor and the average cost was 2,770 PhP/ha/crop.

Thirty six farmers reported using chemicals; the most common was lime. Also used were: zeolite, sodium, dolomite, probiotics, and deocare. Total average chemical cost was 1,358 PhP/ha/crop.

Table 1. CRSP Assessment Survey Descriptive Statistics: Philippines. Tilapia. 2011.				
Item	Range		Average	Number
	Min	Max		
Owner-Operator				
Owner				
Age (yrs)	28	72	47	
Gender				47 Male 11 Female
Operator				
Age (yrs)	18	72	43	
Gender				53 Male 5 Female
Experience (yrs)	1	25	10	
Water				
Pond				
Area (ha)	0.3	282	17	
Size (ha)	0.1	10.4	2.8	
Water Source				
Well				6
Irrigation Canal				28
Well + Canal				3
River				20
Harvest				
Weight (kg/ha)	1,857	8,800	5,195	
Avg size (#/kg)	4	7	4.9	
Price (PhP/kg)	49	70.5	61.4	
Culture period (mo)	4	6	5.1	
Stocking				
Species Strain				
GIFT				6
BFAR-GetEXCel				11
FaST				41
Fingerling				
Source				
Own				5
Private				53
Size (Sorting Screen)				
22				49
20				6
17				3
Density (000/ha)	35	71	49	
Cost (PP/kg)	0.35	0.5	0.40	
Feed				
Method				
Daily full feeding				31
50% daily				
Months 1 & 2				1
Month 3				1
67% daily				0
Alternate day				
Last 2 months				1
Delayed				

Table 1. CRSP Assessment Survey Descriptive Statistics: Philippines. Tilapia. 2011.				
Item	Range		Average	Number
	Min	Max		
7				11
14				7
21				4
30				1
45				2
Schedule				
Month 1				
Type[1]	1	1	1	
Amount (kg/ha)	1.0	40.0	13.0	
Month 2				
Type	1	4	2.6	
Amount	4.5	120.0	34.4	
Month 3				
Type	3	4	3.7	
Amount	7.1	150.0	62.0	
Month 4				
Type	3	5	4.1	
Amount	14.3	166.7	84.7	
Month 5				
Type	3	5	4.4	
Amount	14.3	166.7	70.0	
Month 6				
Type	3	5	4.6	
Amount	17.9	138.9	59.9	
Total Feed Cost			210,116	
Fry Mash	429	35,880	8,350 (4%)	
Pre-starter	3,384	21,000	10,595 (5%)	
Starter	4,107	163,567	32,612 (16%)	
Grower	16,311	270,000	114,183 (54%)	
Finisher	12,321	88,889	44,376 (21%)	
[1]1=fry mash; 2=pre-starter; 3=starter; 4= grower; 5=finisher				
Fertilizer				
Use fertilizer				
Y				46
N				12
Type				
Organic				5
Inorganic				40
Both				1
Formulation (NPK)				
16-20-0				31
Amount (bags/ha)	0	6	1.55	
Price (Php/bag)	1,000	890	951	
46-0-0				18
Amount (bags/ha)	0	5	1.02	
Price (Php/bag)	1,070	1,000	1,032	
21-0-0				2
Amount (bags/ha)	0	2.19	1.09	

Table 1. CRSP Assessment Survey Descriptive Statistics: Philippines. Tilapia. 2011.				
Item	Range		Average	Number
	Min	Max		
Price (Php/bag)	780	680	730	
14-14-14				5
Amount (bags/ha)	0	2	.86	
Price (Php/bag)	1,370	1,370	1,370	
Total fertilizer cost (PhP/ha/crop)			1,435	
Labor				
Family				10
Hired				48
Cost (PhP/ha/crop)	0	15,000	2,770	
Chemicals				
Chemical use				
Y				36
N				19
Type				
Zeolite				2
Sodium				9
Dolomite				4
Lime				22
Probiotics				2
Deocare				2
Total chemical cost (PhP/ha/crop)			1,358	

Effects of Reduced Feeding Management Strategy. Table 2 summarizes the comparison of traditional daily full feeding with the CRSP CLSU reduced feeding regimens. Following the survey results discussion above, a focus on the comparison of the farmer management systems used by farmers who adopted reduced feeding with those farmers who continued to use daily full feeding will provide insights into the benefits and costs of the reduced feeding regimen. The effects on production, cost and net returns are all a major focus of the survey and its analysis.

Table 2. CRSP-CLSU Assessment Survey: Production, Cost, and Net Return Estimates. Daily Full Feeding vs. Reduced Feeding. Philippines. Tilapia. 2011.				
Item	Feeding Strategy			
	Daily Full	Reduced	Change	
			Amount	Percent
Production				
Yield (kg/ha/crop)	5,195	5,359	164	3
Average Size (#/kg)	4.9	4.0	0	0
Culture period (months)	5.0	5.1	0.1	2
Total Revenue				
Total Revenue (PhP/ha/crop) (Price = PhP 61)	316,895	326,899	10,004	3
Input Cost (PhP/ha/crop)				
Feed	210,116	183,103	-27,013	-13
Fertilizer	1,435	1,409	-26	-2

Labor	2,770	3,238	462	17
Chemical	1,358	2,054	696	51
Fingerlings	19,460	19,460	0	0
Total Cost				
Total Cost (PhP/ha/crop)	235,139	209,264	-25,875	-11
Net Returns				
Net Return (PhP/ha/crop)	80,435	117,635	37,200	46

The survey had 27 respondents who used reduced feeding and the most common regimen was 2-week delayed feeding, used by 20 farmers. Over 5 MT were produced per hectare per crop for both regimens with reduced feeding resulting in a small increase of 164 kg or a 3% yield increase. Based on a relatively small sample size, these results should be interpreted to indicate no evidence that these yields are different in terms of total weight harvested, which is supported by previous experimental trials. The average size was slightly smaller for reduced feeding.

CRSP-CLSU on farm trials show that reduced daily feeding and alternate day feeding profoundly reduce feed costs with little impact on yield relative to full daily feeding. However, the sample size in this survey was very small for a comparative analysis to the on-farm research trials. Nevertheless, it appears some farmers are adopting the practice.

In light of the evidence above that reduced feeding will not affect harvest weight but could have negative effects on average size, an examination of cost is crucial in assessing the strategies overall economic and financial advantages. These data indicate a 13% reduction in feed cost amounting to over 27,000 PhP savings per hectare per crop, definitely a strong incentive to adopt a delayed feeding strategy. Fertilizer use also somewhat declined by around 2%. Labor showed an increase largely due to the fixed nature of many labor arrangements used by owners who hire labor and managers for their ponds. Chemical costs increased. Stocking densities were not different for the reduced feeding regimens, thus fingerling cost was unchanged. Overall, total cost decreased by 11% with the delayed feeding strategy.

Because some cost are not included, net returns as used in this report might be better viewed as change in net returns, not an absolute estimate of total net returns. That is, the analysis concentrates on aspects of the management regimen that are expected to be different; other costs, e.g. lease debt financing, marketing, are not investigated. Overall, we found that net returns increased by 46% with the delayed feeding providing a net return of almost 37,200 PhP/ha. These results are in line with the expectations of farm trials conducted by the CRSP-CLSU team. Their central hypothesis that reduced feeding could result in lower costs without reducing yield is supported by survey responses. The potential economic effects of smaller sized fish with delayed feeding cannot be assessed within the scope of the survey.

CONCLUSIONS

Table 3 summarizes the performance indicators for the CRSP project in the Philippines, much of which has already been discussed. Participation of local farmers was encouraging and assessment visits, interviews and survey have indicated encouraging production results, shedding light on project accomplishments. Approximately half of the farmers surveyed used reduced feeding strategies and their responses supported previous on-farm production trials that showed the cost of feed can be reduced with little impact on total yield. It appears through these surveys that farmers have adopted reduced feeding strategies at a high rate and that they are also showing a substantial increase in net returns with this management practice. Hence, CRSP research and extension appears to have been effective in improving farm management practices and the potential income of tilapia farmers in the Philippines. Since, the effectiveness of alternate day and subsatiation daily feeding protocols in reducing production costs was demonstrated later than the delayed feeding practice, it is possible that these procedures may be adopted

with greater frequency in the future. Additional and more extensive surveys should be conducted throughout Central Luzon to grasp the full impact of CRSP research on the tilapia community and its estimated 15,000 ha of farms.

Table 3. Assessment Indicators for CRSP-supported Technologies: Reduced Feeding in Philippines. 2007-2011.

Participation	
CRSP supported technology	Survey indicated about ½ of farmers were using reduced feeding.
Interviewed/surveyed	58 survey respondents in Pampangas, Nueva Ecija and Bulucan districts.
Production	
Yield	Reduced feeding did not reduce yield in terms of weight but may have affected size
Area (ha)	Survey indicated about ½ of hectares were managed using reduced feeding.
Household consumption and nutrition	No change
Resources and Cost	
Time	No change
Purchased Inputs	
Fixed	No change
Variable	
Labor (PhP/ha/crop)	+17%
Fertilizer	-2%
Feed (PhP/ha/crop)	-13%
Chemical (PhP/ha/crop)	+51%
Stocking (PhP/ha/crop)	No Change
Returns	
Gross (PhP/ha/crop)	No change
Net (PhP/ha/crop)	+46%
Risk Management	
Biological	No change
Economic	Reduced feeding decreases dependence on most expensive purchased input - feed

2. Enhance Training, Capacity Building and Impacts of Alternative Feeding Practices and Integrative Production Systems for Milkfish Culture in the Philippines.

We expanded our training on integrative production systems and feed management practices for milkfish culture from Guimaras Island (Investigation 09MNE02NC) to Mindanao island where milkfish culture predominates, e.g. Panabo City and Tababuli-Digos, Davao or on Palawan island (Visayas region) and to Palawan island where the industry is beginning to emerge.

The Mariculture Park (MP) was conceptualized by the Philippines Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR) in view of its recognition of the potential of mariculture in increasing aquaculture production and its contribution in meeting targets set in the Comprehensive National Fisheries Development Plan (2006-2025). The objectives of the Mariculture Parks Program include the following: 1) provide employment and an alternative source of livelihood for marginalized and sustenance fisherfolk; 2) develop an area with appropriate infrastructure that will allow fishermen, fish farmers and investors to operate cost-effectively and securely; 3) develop skilled and technically capable fisherfolk to support the mariculture industry; and 4) promote the use of environment-friendly inputs and farm management practices. From the first MP established by BFAR at Samal Island in Davao in 2001, there are as of April 2011, 63 operational mariculture parks, with seven to be launched. BFAR pr
ovides the infrastructure and technical assistance while local government units provide the legal framework and support for the establishment of MPs in their respective areas. Only a few of the MPs established by BFAR has attracted more than 50 locators with about half still being operated by BFAR or local government units (LGUs)as demonstration sites. Nevertheless, production from marine fish cages and fishpens dramatically increased from 4,282 MT in 2001 to over 87,000 MT in 2010 with corresponding increase in production value from P648 million to P8.4 billion. Because of this intensification, it has become imperative to develop more sustainable methods that limit nutrient input in the environment. Indeed, some of these MPs are experiencing poor water quality (low oxygen, high nitrogen, and high sulfides in sediments) and higher risks of crop loss.

Two 5-day survey cum informal workshops on cage culture of milkfish and other species that included interviews with farmers/operators, investors, local government officials and BFAR and Regional Fisheries Training Center (RFTC) personnel was conducted in the Panabu City MP and Tagabuli Bay Park from June 27-July 1 and August 7-13, 2011, respectively. These workshops included the participation of 30 milkfish farmers, operators and technicians. The project examines the technological, environmental, socio-economic and financial components of the operations of the mariculture parks and is outlined in greater detail in the workshop reports submitted. Almost all of the cages are stocked with milkfish. Interviews and consultations revealed 3 major constraints to production – reliable source and consistent supply of good quality fingerlings, prohibitive cost of feeds, and marketing. An additional concern at Tagabuli Bay Park was the periodic low water quality associated with milkfish cage clusters that result in emergency harvests.

To address these concerns SEAFDEC personnel provided information, including that established through AquaFish CRSP research on how production and economic efficiencies can be further improved by some technical interventions. First, is the establishment of multispecies marine fish breeding center and satellite hatcheries, which will consequently produce a stable supply of fry and fingerlings and lower their cost. Second is to improve feeding strategies and management such as the utilization of alternate day feeding strategies shown through recent CRSP research to reduce feed inputs by as much as 30%. To help address the issue on feed costs, RFTC XI Director Andrew Ventura announced that RFTC will set up demo production cages, using alternate day feeding strategies with production runs currently in progress. Additionally, a discussion of the advantages of on-farm feed production using locally-available cheap

inputs was provided. E.G. Ayson informed the group of the study being conducted by R. Bolivar in CLSU in collaboration with R. Borski and his team in NCSU using fermented chicken as protein source. The use of fermented milkfish by-products from processing/value adding activities as replacement for fishmeal is being tried by one enterprising farmer/investor, which is reportedly 30% cheaper than commercial feeds and results in comparable, if not better growth and survival. Third, is to apply the concept of polyculture or Integrated Multi-trophic Aquaculture (IMTA) in the grow-out of milkfish to increase profit and reduce negative impact to the environment. SEAFDEC personnel provided information on integrative culture systems that incorporate sandfish (sea cucumber), seaweed and rabbitfish into milkfish systems.

Two additional workshops on milkfish culture technologies and best management practices to include integrative culture systems and feeding strategies were conducted in Palawan in Peurto Princessa and Narra. We had originally planned to conduct these in Leyte. However, due to the relatively pristine condition of Palawan, the rapid emergence of coastal seaweed, milkfish and marine finfish culture, and the limited training available in the region, BFAR was particularly interested in building capacity and the training in sustainable culture techniques. They BFAR training center helped sponsor the workshops. Twenty-one and 37 individuals participated in these workshops, which were met with considerable enthusiasm. Drs. E.G. Ayson, F. Ayson, M. Luhan and R. Borski and others presented information on gender awareness; milkfish and finfish nursery and growout, feeding strategies, and integrative culture systems.

We also conducted additional workshops on value-added processing of seaweed and milkfish in Leganes, Iloilo (Visayas region) geared to women to enhance their continued participation in aquaculture and opportunity to improve household welfare through sale of products in local markets. Maria Luhan conducted the one-day training workshop that included initial lectures on seafood safety; marketing techniques; milkfish processing, deboning and marinating; and on seaweed preparation and cookery. Recipes were provided. This was followed by skills enhancement exercises in milkfish deboning and practicums on utilizing seaweeds to make crackers, tortillas, salads, and other items that can be marketed locally and/or consumed by households. Twenty-five women participated in the workshops with the intent on supplementing their household incomes with through local market sale of value-added products and for enhancing household nutrition.

3. Assessing Impacts of Polyculture Training on Fish and Shrimp Farming in Aceh, Indonesia

The AquaFish CRSP aquaculture program in Aceh, Indonesia has focused on promoting the adoption of best aquaculture practices for seaweed-shrimp/finfish polyculture systems. These systems involve a more sustainable use of small-scale tambak culture systems that incorporate seaweed (*gracellaria)*, shrimp and fish and that were destroyed in the 2004 tsunami. Based on interviews, farm visits and data collection, this section will provide an assessment of the program's economic impact.

MATERIALS AND METHODS

Visits were made and interviews (20 farmers) conducted during August 2010 and August 2011 at UBAC in Banda Aceh; ACIAR (Australia Centre International Agriculture Research (ACIAR) Samalanga demonstration site in Bireun District; Lancang in Pidie District; Trengadring Multi Species Hatchery in Pidie Jaya District; and Bayu in Aceh Utara District. Negotiations were conducted in Medan and Pidie by Kokarkin, Hasanuddin, Hatch and Fitzsimmons with a buyer and farmers to facilitate a seaweed purchase

agreement in August 2011. These negotiations were successfully concluded and the agreement commenced in October 2011.

The performance criteria used in economic impact assessment will center on the extent to which future incomes of small-scale aquaculture farmers in Indonesia will improve through the seaweed polyculture system recommended by the CRSP UBAC program. Has the project has put in place a system that will facilitate farmer's ability to augment their incomes and family nutrition?
The discussion will proceed with a general description of the existing fish farming system that the polyculture of seaweed will need to complement, followed by some observations on seaweed polyculture. The existing system imposes constraints on the opportunity for seaweed polyculture, but it also provides an opportunity to benefit farmers not only through its own culture but also on positive interaction with the existing system. That is, an evaluation of the economic contribution of seaweed polyculture must be analyzed not solely in the cost and returns to seaweed, but of equal importance the effects on the cost and returns to the other crops in the polyculture system. This contribution can be viewed as a pond management strategy that reduces both biological and economic risk. Benefits of biological risk reduction are largely related to potential disease and water quality improvements and economic risk management is addressed through portfolio diversification that ameliorates potential yield and price fluctuations.

RESULTS AND DISCUSSION

Current aquaculture system. The existing aquaculture system has centered on shrimp, milkfish and tilapia. Cultural practices (BMP's) for these fish and seafood crops and their combinations in various polyculture systems are relatively established. However, optimal stocking and feeding rates have not been extensively researched under local conditions; most of these recommendation and actual farmer practices are based on trial and error and tilapia production in other locations. In addition, optimal feeds, *e.g.* optimal protein level, and product quality have not been studied. Consequently, although farmers are reasonably satisfied with the benefits to aquaculture, they felt they could benefit from more research that documents the best stocking densities, feeding rates and feed quality and also marketing opportunity. fish is an extensively cultured, inexpensive source of fish protein for local markets and its culture has a long consistent history of successful production and marketing. Shrimp culture has experienced severe disease problems with white spot virus; there generally have been few disease problems with milkfish or tilapia. Common shrimp harvest size ranges from 20-40/kg and tilapia are sold at about 400-500g. Typical stocking of tilapia and milkfish is in the range of 2,000-3,000 per ha; feeding at these densities will be 200 kg/ha/crop with a typical price of 6,000 -10,000 rupiah per kg based on feed quality. This feeding rate results in final harvest of about 550kg total (tilapia and milkfish). Seed are often from seed collectors who capture wild stocks.

Tilapia culture is still evolving both in production and marketing sense. Hired labor is generally not used. Neighbors help each other harvest and each farmer does the various tasks during the season on his own. Harvest labor is the only task that requires a substantial effort in a constrained period of time. Sales are almost totally to brokers; however, some farmers rent stalls in local markets with some success. The consumer expects the seller to clean fish as requested. Current 2011 prices per kg are approximately 15,000 rupiah for black tilapia (*nilotica*), 8,000 for red tilapia (*mozambica*) and 15,000 for milkfish. The possibility of cross breeding existing strains with Tilpaia *honorum* has been suggested to increase male population, but not rigorously tested.

Issues and observations. Although initial community demonstration racks for seaweed drying were provided by the AquaFish CRSP, the number of racks has been inadequate. The minimum quantity that the market will purchase is 15 MT as a truckload from a buyer/assembler in Medan. This load provided by the Aceh producers will assist in augmenting product from other sources in the Medan area to reach

the minimum size that the buyer/assembler will need to achieve to sell his product on international markets using a freighter load of 500 MT. For the Aceh farmers to participate successfully in this market supply chain, the capacity of seaweed drying racks is inadequate and expanding this capacity was an important element of buyer arrangement recently concluded.

Seaweed marketing and processing. Although AquaFish CRSP has recently completed additional training on drying and preparation of seaweed, farmers may need more instruction and experience with post-harvest processing and inventory activities. Processing involves weighing, drying, cleaning and packaging and inventory considerations will require storage capacity and time delay to obtain sufficient product to meet minimum buyer load size. These inventory issues will result in a lag before production receipts are received. Polyculture with seaweed will not be an economic success unless this minimum market size can be reached and farmers learn how to prepare seaweed for market efficiently. These processing and inventory requirements are substantially different processes than most fish culture farmers are familiar with.

This forward contracting system for seaweed will depend on establishing trust between farmers and brokers. A forward contracting system will stabilize price for farmers and quantity/quality for brokers; neither the buyer nor seller have any established history or relationship that underlies confidence that both ends of contract will be met. With the help of a trusted government entity, e.g., UBAC, to initiate the process, an evolving market maturation process will lead to eventual functioning of the market without public sector facilitation. Assurance to buyers that the minimum quantity/quality will be available on a consistent basis is crucial on the demand side and price stability is crucial on supply side for Aceh seaweed producers.

Odor. The relationship between seaweed culture and odor in fish harvested is a concern to farmers and consumers that should be investigated more thoroughly. Best management practices need to be established and explained to farmers that minimize odor problem related to seaweed in polyculture ponds. There seems to be some confusion among farmers, extension and researchers, as to the exact context and process that is occurring as it relates to negative odors of fish and shrimp harvested from seaweed polyculture ponds. Several observations were provided that indicate the odor in fish and seafood marketed from polyculture ponds need serious scrutiny. Seaweed start to die within 1-2 months of the culture cycle; at this time, it is not possible to remove affected seaweed due to damage to shrimp/milkfish/tilapia. The odor is mostly a problem in fish – milkfish and tilapia, and particularly milkfish – not shrimp. Several hypotheses are being suggested that should be investigated: that (1) shrimp are able to move under seaweed or mangrove roots to remain unaffected and (2) as long as seaweed coverage in pond area is under 30%, dyeing seaweed and resulting odor in fish, is not likely to occur. These suggestions and others should be investigated to gain farmer's greater confidence in seaweed polyculture.

Shrimp virus. White spot virus in shrimp may be mitigated by polyculture with seaweed and tilapia. This virus, carried by crustaceans, has decimated shrimp culture in the Aceh area. The possibility that these polyculture systems reduce disease risk in shrimp is a major potential benefit to farmers. It is suggested that tilapia in pond canals and polyculture of shrimp with milkfish and seaweed in pond may have excellent disease management benefits. Also, there is evidence that rotation of pond, *i.e.* not growing same species in same pond each crop cycle, is also a potential strategy to reduce white spot damage.

Some farmers overstock in anticipation of losses due to oxygen deficiency related to dying seaweed. Because, in general, shrimp die early in cycle (1-2 months), overstocking may be appropriate because feed will not have been wasted on shrimp that are not eventually harvested. Polyculture with shrimp also mitigates damage of white spot by allowing farmers to continue with fish crops if shrimp are severely

damaged. Although lower shrimp stocking density is yet another potential solution to the white spot virus, these lower densities will likely reduce net returns to the shrimp culture substantially. It might be possible to increase stocking densities of the fish polycultures with the lower shrimp density, but the returns to milkfish and tilapia have been substantially lower than shrimp. The obvious conclusion from this discussion is that more research on BMP's to mitigate white spot is needed.

Current status of seaweed culture. Seaweed polyculture has an excellent opportunity to be incorporated into and provide several important benefits to the existing aquaculture system. However, this potential contribution is only beginning to materialize. Efforts to address several marketing and production constraints have been initiated, but results from these efforts are still pending. Reducing risk and uncertainty inherent in these constraints undercuts attempts to increase adoption and farmer risk attitudes are both expected and addressing them is key to establishing seaweed polyculture as an accepted alternative for aquaculture farmers.

Current production constraints are generally related to seaweed polyculture interaction with other aspects of the polyculture system, e.g., yield, odor, shrimp virus. Support is needed to initiate and continue applied research and extension on (1) relationship between white spot virus and other polyculture (tilapia, milkfish, and seaweed); (2) interaction of odor and crops in polyculture system (tilapia, shrimp, milkfish, and seaweed) and (3) continuous updating of appropriate polyculture BMP's, e.g., species mix, stocking densities, complementarities.
Post-harvest processing and marketing issues are clearly constraining, and are as important as production constraints in establishing Aceh farmer's long-term viable competitive position in the seaweed market supply chain. These are activities that farmers are generally not aware of or well skilled in. The post-harvest chain of events – drying, weighing, cleaning, packaging, storage, selling, and transport – each involve challenges.

Marketing agreement. Although at the end of the CRSP project seaweed had not been marketed, arrangements were in place for a buyer/assembler to purchase one 15 MT truckload of dried, cleaned, packaged seaweed weekly. Approximately 400 ha of seaweed are ready for harvest and at least 20 farmers are prepared to be part of the arrangement. The incentive for the buyer is based on his need to provide a minimum freighter load of 500 MT; this volume requirement has been difficult to obtain from nearby producers in Medan. The buyer will provide the transportation and a small loan to assist in buying materials and paying a labor cost to expand drying rack capacity. The loan will be paid through payments, subtracting 25% of debt from receipts due to farmers. It is anticipated that both of these levels of participation will expand dramatically once profitability is demonstrated.

A farmer representative was designated who will play a key role in the arrangement's potential success; the buyer will deal exclusively with this individual. Sales transactions will be undertaken by the representative. In addition, this representative will be responsible for managing the weighing, drying, cleaning, packaging and storage. The seaweed will be stored in 25 kg bales until the minimum quantity is reached for scheduled deliveries. As success is demonstrated, other seaweed growing areas in Aceh are expected to begin harvesting and additional representatives will be needed in these other locations. Success of this representative will be important in determining whether this marketing arrangement is sustainable and whether other representatives will perform this function as production capacity expands.

The process was initiated in October and is currently still operating at a mutually acceptable level. UBAC plans to provide farmer assistance after the CRSP project termination. If this arrangement is successful, it will provide a mutually beneficial opportunity in assuring that the buyer can meet freighter minimum volume and quality and that the farmers will have an additional income source with a very low input cost.

CONCLUSIONS

Table 4 summarizes the major performance indicators for the CRSP-UBAC program that has been already discussed in detail in earlier sections of this report. Overall, participation of local farmers was encouraging and assessment visits, interviews and survey have indicated encouraging production results, shedding light on project accomplishments and challenges. An estimated 100 farmers and 400 ha of farm area have adopted seaweed polyculture due in large part to the effort of AquaFish CRSP-UBAC program. A marketing agreement has been achieved for purchase of seaweeds, which should provide additional income for fish/shrimp farmers. Household consumption of nutritious seaweeds and the potential to market foods locally has been enhanced through post harvest training in processing, seaweed cookery, and value-added product development. Future work should be directed at optimizing polyculture systems and continued training in processing, inventory, and marketing activities.

Table 4. Assessment Indicators for CRSP-supported Technologies: Reduced Feeding in Philippines. 2007-2011.

Participation	
CRSP supported technology	100 estimated farmers have seeded seaweed in their ponds.
Interviewed/surveyed	20 farmers interviewed in Bireun, Pidie, Jaya and Utara districts.
Production	
Yield	1 MT/ha[1]
Area (ha)	400 ha of seaweed is available for harvest.[1]
Household consumption and nutrition	Small amount may be consumed in household.
Resources and Cost	
Time	High - harvesting, drying, cleaning and packaging
Purchased Inputs	
Fixed	Drying racks/tables – buyer loan
Variable	
Labor (PhP/ha/crop)	Labor cost increased substantially
Fertilizer	0
Feed (PhP/ha/crop)	0
Chemical (PhP/ha/crop)	0
Stocking (PhP/ha/crop)	Transplants from previous crop
Returns	
Gross (PhP/ha/crop)	Additional income from polyculture or fallowed pond
Net (PhP/ha/crop)	Increased cash income – increased labor time and cost
Risk Management	
Biological	Seaweed polyculture can mitigate biological risks associated with tilapia, shrimp and milk fish culture systems
Economic	Portfolio diversification of products from pond reduces vulnerability to price fluctuation

4. Podcasting to Promote Impacts of AquaFish CRSP Research and Outreach Activities

A database of raw materials, pictures, and graphs were assembled for the development of 3 podcasts on milkfish culture. Specifically, the podcasts disseminate work showing the effectiveness of alternate day feeding in reducing feed costs by as much as 30-56% for growout of milkfish in sea cages and brackishwater ponds. One of the podcasts are produced in the English language and two others were modified and translated into Tagalog, the primary Philippines language, and Ilonggo, a primary dialect in the Iloilo, Visayas region of the Philippines. The podcasts are as follows:

1) Alternate-Day Feeding Strategy for Reducing Cost of Milkfish Culture in Brackishwater Ponds and Marine Cages in the Philippines (English)
2) Pag-aalaga ng Bangus sa tubig alat at tabsing sa pamamagitan ng pagbibigay ng pakain batay sa halinhinang araw ng pagpapakain (Tagalog) (English translation: Alternate-Day Feeding Strategy for Reducing Cost of Milkfish Culture in Brackishwater Ponds and Marine Cages in the Philippines)
3) Alternate-Day Feeding Strategy for Reducing Cost of Milkfish Culture in Brackishwater Ponds and Marine Cages in the Philippines (Ilonggo)(Only the verbal language has been translated from English to Ilonggo)

Scripts were all pre-written in an interview style prior to recordings. Original music soundtracks recorded by Dr. Gary Wikfors of the NOAA Biotechnology Branch (Milford, Connecticut), were also incorporated into the podcasts. Podcasts were reviewed by the team, modified where appropriate and then uploaded at the NCSU iTunesU site where downloads, and other data for podcasts will be collected (http://itunes.apple.com/us/itunes-u/milkfish-aquaculture-alternate/id499954016).

We are also in the process of completing several other podcasts that highlight some successes of research at other AquaFish CRSP sites in Southeast Asia, Latin America and Africa.
Due to the tight schedules amongst the US PI and host country PIs it has been difficult to arrange travel for collection of resources for development of the podcasts. Albeit more difficult, this is now being handled electronically. A new student has also been trained in podcasting to replace the one previously involved in production. One podcast is largely written and will be assembled, reviewed and uploaded shortly (Southeast Asia: Determining the Environmental Performance of Marine Shrimp Culture using Life Cycle Assessment). Others (Mexico, Africa, Southeast Asia) are at different stages toward completion, which we anticipate will occur over the next 45 days.