

Internet-Based Podcasting: Extension Modules for Farming Tilapia in the Philippines

Technology Adoption and Policy Development/Activity/09TAP02NC

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ABSTRACT

The goal of this investigation was to develop a series of podcasts as specialized, internet-based delivery systems for news and technical developments of interest to tilapia farmers. A student at Central Luzon State University (CLSU) and North Carolina State University (NCSU) was trained on podcast technologies. The team subsequently produced a series of six extension podcasts that conveyed feeding practices demonstrated to reduce costs for growout of Nile tilapia. This includes a description of delayed onset of feeding, 67% daily feeding, 50% daily feeding and alternate day feeding at 100% level that serve as effective management measures to reduce feed costs, which constitutes 60-80% of total production costs of tilapia. Collectively, these procedures are shown to improve incomes of farmers with little impact on fish yield. Four of the podcasts were produced in the English language and two others were modified and translated into tagalog, the primary Philippines language. Another two are currently being translated to tagalog. The podcasts contained vocal recordings using monologue and question and answer format, a series of photographs of tilapia farming and cultivation centers, and a music soundtrack. They also contain a number of figures, graphs, and tables that provide experimental protocols, growout data and cost-benefit analyses so users can see the methodology and advantages of different feeding practices in reducing production costs of tilapia growout in ponds. The podcasts were subjected to review, revised accordingly, and uploaded onto the NCSU iTunesU server to track hits, previews and downloads. The podcasts were provided to the CLSU College of Fisheries Computing Center and to the AquaFish CRSP for website upload. Interest in the podcasts has been excellent with 285 downloads and 444 hits on the NCSU iTunes server over a 2-month period, indicating they are an effective tool for disseminating tilapia culture technologies worldwide. The podcasts were also played to 120 participants from the tilapia farming, aquafeeds, government, and academic communities through two workshops on tilapia feeding strategies and feed manufacturing held in two regions of Central Luzon, Philippines. Participants were highly receptive to this mode of disseminating information and were very pleased to see that some of the podcasts were translated into the local language. Collectively, we demonstrate that podcasting is a viable extension tool for disseminating information to the aquaculture community. 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 the Philippines and the world we anticipate the Podcast will be a highly attractive tool for dissemination of information on farming tilapia and other cultivars.

INTRODUCTION

Podcasting is an internet-based communication method that is increasing in popularity. In Phase I of our AquaFish CRSP, we produced and uploaded the first Tilapia Podcast to a trackable server at NCSU. It received > 250 hits and was downloaded 76 times in a six-month period alone. The reaction to the initial launch of this current and cutting-edge technology at CLSU during a workshop was equally enthusiastic. CLSU recognizes this medium as an effective and low-cost means of sharing news and technical information. They correctly see it as a technologically advanced process in which CLSU is an innovator and a world leader, as opposed to a follower. The use of podcasts is not restricted to owners or users of iPods, and neither an iPod nor any other MP3 player is actually necessary for participants in and beneficiaries of podcasting. Podcasts can be accessed from desktop computers with internet access, and they are extraordinarily portable – they can be distributed on many cell phones or loaded onto “flash drives” or USB “memory sticks” and passed around among friends, including students and farmers. With a podcast, newly updated sound and/or images can be distributed at practically no cost to end users worldwide, and practical applications of this technology as a means of communication are clearly accelerating. At present there is almost no use of podcasting by aquaculture farmers, although the tremendous potential is clearly being recognized, particularly with the younger generation.

Our CRSP group has generated a range of practical improvements in culture methods of tilapia, some of which have increased the potential profitability for farmers. New feeding paradigms have already been widely recognized as having practical utility for Luzon area fish farmers. The essence of one such series of contributions is the reduction of production costs by using moderate feeding strategies, without incurring any significant loss of product value or quantity (Brown et al. 2000, Bolivar et al. 2003, Bolivar et al. 2006; Bolivar et al. 2010). We have additionally found that fishmeal free and lower protein diets provide cost savings for tilapia farmers (Ayoola 2010; Borski et al. 2011).

The NCSU/CLSU group interacts actively with the fish-farming community. Central Luzon State is an agricultural university and the surrounding fish culture areas are populated largely by families that have relatives and friends who have trained or are training at CLSU. The resulting relationship is an unusually healthy and trusting one – farmers welcome academic input and enjoy both extension and social components of campus life. Past activities of our project have included the production of scientific publications and fact sheets in the form of extension pamphlets, and we have also hosted training sessions and workshops at the School of Fisheries’ Freshwater Aquaculture Center at CLSU. Farmers have been involved from the outset in large-scale experimentation and experimental production trials (*e.g.* Bolivar et al. 2006; Bolivar et al. 2010), and the first-hand involvement of farmers in research has a strongly favorable impact on the extension process. Farmers that have volunteered pond space to participate in tilapia production trials are the first to learn of technical advances, and methods that reduce costs and increase profit margins are adopted without additional extension effort. The tilapia farmers in Luzon, Philippines are an ideal group for the advancement of new extension methods. The aquaculture community in this region – the farmers, families, and CLSU fisheries people – are collectively friendly and receptive to innovative academic activities that have a focus on aquaculture.

Among recent extension efforts, our internet-based computing center at the School of Fisheries has grown increasingly popular. This center at the Freshwater Aquaculture Center is readily accessible and is heavily used by commercial farmers. Our Tilapia Podcasting Workshop was held there in early 2009 for the launch of the first podcast on tilapia aquaculture (AquaFish CRSP investigation 07TAP02NC), and was attended by 77 stakeholders, many of whom were already regular visitors to the facility. For this reason, the computing center will continue to serve as an access site for tilapia podcasts, and we propose to involve CLSU students and staff in production aspects of podcasts. We expect increases in both the rate and quality of new podcasts, especially so as CLSU graduate students and fisheries faculty become

more involved in the technical components of their production. We also expect the networking and sharing of podcasts to grow – as available information begins to build, students and farmers will be able to download podcasts to digital phones and flash cards, to pass them around among interested user groups. Our goal is to develop a library of practical information in ~5-minute components that can be distributed and shared almost effortlessly and at practically no cost in order to keep farmers technologically current.

OBJECTIVES

1. To build on our initial podcasting efforts by providing a complete series of podcast presentations to interested viewers (farmers, aquaculture students, etc.) to cover basic methods and current topics in a short, attractive, and readily accessible format.
2. Produce a series of short tilapia-related podcasts, as the initial installment in a catalog of introductory and more advanced information on tilapia culture methodology and new production technology that incorporate cost-saving feeding practices. These will be laid out on iTunesU via NCSU, as well as at CLSU College of Fisheries Computing Center and AquaFish CRSP website.
3. Train a student at CLSU and NCSU in podcast technology, to participate fully in the technical aspects of production of Tilapia Podcasts, and to build capacity for future podcasting in the host country. The individuals will train both in-person with project personnel and through online activities.
4. Build a database consisting of digitized materials found to be essential for podcasting purposes to include non-copyrighted photographs and background music – preferably representing the work of students, faculty, and farmers associated with the tilapia production community on Luzon Island in the Philippines.
5. As the layout and content of the podcast websites are developed and refined, efforts will be made to publicize and to promote access to it among aquatic farmers worldwide.

RESULTS AND DISCUSSION

This investigation began with a learning process to use standard but unfamiliar software and hardware that are favored for the production of podcasts. To begin producing a podcast a few essential components are needed to include a computer, microphone and software program for audio recording. Additional features that are often used in podcasts are music, images and video. Garage Band, a program that is commonly used on Apple computers, was selected for our podcast production effort. Adding images, music and several other tracks are possible through this software. Although Garage Band is not compatible with PCs, other programs are. The Window's Sound Recorder is the most basic software used for PC podcasting. Audacity is a more advanced and popular podcasting software and is also compatible for the Mac and Linux operating systems (Broida, 2005). A North Carolina State University (NCSU) undergraduate, Katrina Jiamachello (a Caldwell Scholar) and a CLSU MS graduate student (Roberto Sayco) were trained in podcasting at NCSU over a twelve-week period in 2010. Ms. Jiamachello and Dr. Borski produced a simple user-friendly guide on how to produce a podcast using Garage Band.

The team subsequently produced 6 extension podcasts that conveyed feeding practices demonstrated to reduce costs for growout of Nile tilapia. This includes a description of delayed onset of feeding, 67% daily feeding, 50% daily feeding and alternate day feeding at 100% level that serve as effective management measures to reduce feed costs, which constitutes 60-80% of total production costs of tilapia. Collectively, these procedures are shown to improve incomes of farmers with little impact on fish yield. Four of the podcasts are produced in the English language and two others were modified and translated into Tagalog, the primary Philippines language. The podcasts include the following subjects:

1. Alternate-day feeding strategy for reducing costs of Nile tilapia growout in the Philippines (English)

2. Pag-aaral sa pagpapakain na may isang araw na pagitan upang mapababa ang gastos sa pagpapalaki ng tilapia sa Pilipinas (Tagalog) (English translation: Alternate-day feeding strategy for reducing costs of Nile tilapia growout in the Philippines)
3. A 67% subsatiation feeding strategy for reducing costs of Nile tilapia Growout in the Philippines (English)
4. Evaluation of 50% daily feed ration levels versus full daily feed ration on on-farm growout of Nile tilapia in earthen ponds (English)
5. Pag-aaral sa araw-araw na pagpapakain gamit ang kalahati at buong rasyon ng pakain sa tilapia (Tagalog). (English translation: Evaluation of 50% daily feed ration levels versus full daily feed ration on on-farm growout of Nile tilapia in earthen ponds)
6. Delayed onset of supplemental feeding reduces the cost for growout of Nile tilapia in ponds.

Scripts were all pre-written prior to recordings. The investigators for podcast production built a database of photographs, figures, tables, and original music for producing the podcasts. The podcasts were configured with photographic images depicting tilapia culture in the Philippines, in order to maintain a high level of familiarity and comfort for the farmers in that area. We also provided figures, tables and graphs of experimental outlines, growout data and cost-benefit analyses so podcast users could see the methodology and advantages of different feeding practices in reducing production costs of tilapia culture in earthen ponds. A logo of the tilapia podcast was created (see below). Original music soundtracks recorded by Dr. Gary Wikfors of the NOAA Biotechnology Branch (Milford, Connecticut), were also incorporated into the podcasts. We also took several approaches in producing the podcasts. The scripts for the podcasts took on two major forms that include a standard monologue and a question and answer format. The question and answer format is attractive because it is likely to keep the audience more tuned in as it breaks up the solidity of one voice seen with monologue-oriented production.



The podcasts have been sent out for review and were uploaded at the NCSU iTunesU site where downloads, and other data for podcasts could be collected (<http://itunes.apple.com/us/itunes-u/tilapia-podcasts/id380416353>). The format for iTunesU changed in the middle of our project so we had to adjust the site such that each of the podcasts is under a general “Tilapia Podcast” theme. Use of the podcast on the NCSU server has been excellent; figures supplied by system administrators indicate that the podcasts received 444 hits and were downloaded 285 times over just a two-month period following their initial upload onto iTunesU (Table 1). Dr. Borski has also received several inquiries about the podcasts from individuals around the world. The podcasts were also provided to the CLSU College of Fisheries Freshwater Aquaculture Center computing facilities and uploaded to the AquaFish CRSP website.

Table 1. Quantification of Tilapia Podcast access from the North Carolina State University iTunesU server over a two-month period after all podcasts were uploaded. Rows indicate the number of “hits” in each month from left to right, while columns indicate the type of “hits” over the seven month period including browses, download previews and downloaded tracks. There were 444 total hits and 285 downloaded tracks over the two-month period from August 2011 – September 2011.

Podcast	Period	Browses	Previews	Downloaded Tracks	Total Hits
NCSU iTunes U	Aug-11	52			52
	Sep-11	24			24
50% Satiation - English	Aug-11		4	15	19
	Sep-11		3	23	26
50% Satiation - Tagalog	Aug-11		5	38	43
	Sep-11		3	18	21
Altermate Day - English	Aug-11		8	16	24
	Sep-11		10	17	27
Alternate Day - Tagalog	Aug-11		5	16	21
	Sep-11		4	16	20
Delayed Feeding	Aug-11		7	23	30
	Sep-11		5	13	18
67% Satiation	Aug-11		5	23	28
	Sep-11		4	22	26
Book Reviews	Aug-11		10	27	37
	Sep-11		10	18	28
	Total	76	83	285	444

The series of podcasts as extension tools were further disseminated at two January 2011 workshops sponsored by AquaFish CRSP (09SFT04NC and 09SFT06NC): 1) “Tilapia Feeding Strategies and Feed Manufacturing” held at Bacolor, Pampanga and attended by 47 individuals, and 2) “Tilapia Feeding Strategies and Feed Manufacturing: Meeting Global Challenges” held at CLSU, Science City of Munoz and attended by 66 participants representing farmers, and aquafeed company, government, and academic personnel. All were highly receptive to this mode of disseminating information and were very pleased to see that some of the podcasts were translated into the local language.

CONCLUSION

This investigation further demonstrated the practical utility of podcasting as a means of disseminating detailed technical information on aquaculture to appropriate user groups in Luzon Island and the world.

A series of podcasts were produced using different formats to demonstrate the utility of delayed feeding and various feed reduction strategies in enhancing production efficiency of tilapia culture in ponds that can improve incomes for farmers. The podcasts were configured with music and a library of photographic images depicting tilapia culture in the Philippines. They also incorporated a number of figures, graphs, tables that provided experimental outlines, growout data and cost-benefit analyses so users could see the methodology and advantages of different feeding practices in reducing production costs of pond tilapia culture. The series of podcasts were played to over 100 individuals representing the tilapia farming, academic, government and industry communities. The tilapia podcasts were uploaded onto the NCSU iTunes website, CLSU-FAC computing facility and on the AquaFish website. The large number of downloads and hits on the tilapia NCSU iTunesU site indicate the podcasts are an effective tool for disseminating tilapia culture technologies worldwide.

LITERATURE CITED

- Ayoola, A. 2010. Replacement of Fishmeal with Alternative Protein Source in Aquaculture Diets. M.S. Thesis. North Carolina State University. 129 pp.
- Bolivar, R.B., C.L. Brown and E.T. Jimenez. 2003. Feeding Strategies to Optimize Tilapia Production in Ponds. Book of Abstract. Aquaculture 2003. Louisville, Kentucky, USA. p. 26.
- Bolivar, R.B., Jimenez, E.B.J. and Brown, C.L. 2006. Alternate day feeding strategy for Nile tilapia grow out in the Philippines: Marginal cost-revenue analysis. *North American Journal of Aquaculture*, 68: 192-197.
- Bolivar R.B., Vera Cruz E.M, Jimenez E.B.T, Sayco RMV, Argueza R.L.B, Ferket P.R., Stark C.R., Malheiros R, Ayoola A.A., Johnstone W.M., Picha M.E., Holler B.L., Won E.T., and R.J. Borski. 2010. Feeding reduction strategies and alternative feeds to reduce production costs of tilapia culture. Technical Reports: Investigations 2007-2009, AquaFish Collaborative Research Support Program. Oregon State University. Vol 1. p 50-78. (309 pp)
- Borski, R.J., Bolivar, R.B., Jimenez, E.B.T., Sayco, R.M.V., Arueza, R.L.B., Stark, C.R., and Ferket, P.R. 2011. Fishmeal-free diets improve the cost effectiveness of culturing Nile tilapia (*Oreochromis niloticus*, L.) in ponds under an alternate day feeding strategy. p 95-101. *In* Liping L. and Fitzsimmons K. (eds.). Proceedings of the Ninth International Symposium on Tilapia in Aquaculture. April 21-24. Shanghai, China. 407 p
- Broida, R. 2005. *Create Your Own Podcast*. CBS. <http://reviews.cnet.com/4520-11293_7-6246557-1.html?tag=rb_mtx;wp_body>.
- Brown, C.L., Bolivar, R.B., Jimenez, E. T., and Szyper, J.P. 2000. Timing of the onset of supplemental feeding of Nile tilapia (*Oreochromis niloticus*) in ponds. p. 237-240. *In*: Fitzsimmons, K. and Filho, J.C. (eds.). *Tilapia Aquaculture in the 21st Century*. Proceedings from the Fifth International Symposium on Tilapia Aquaculture. September 3-7. Rio de Janeiro, Brazil. 682 p.

Development of Alternatives to the Use of Freshwater Low Value Fish for Aquaculture in the Lower Mekong Basin of Cambodia and Vietnam



Feed Technology and Policy Development for Fisheries Management

Technology Adoption and Policy Development/Activity/ 09TAP03UC and 07TAP01UC

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ABSTRACT

The fisheries resources in Cambodia and Vietnam is faced with drastic decline due to the rapid increase in population and illegal fishing activities - many captured fisheries resources have been largely overexploited as well as the increasing competition and conflict between the use of low value/trash fish for feeding and human consumption. The project entitled “Development of Alternative to the Use of Freshwater Low-Value Fish for Aquaculture in the Lower Mekong Basin, Cambodia and Vietnam: Implications for Livelihoods, Production and Markets” will focus on the balancing of social, economic and environmental/natural resources needed between human consumption and aquaculture feeds based on the development of feed and feeding strategies for other fish species. The cost-effective and high-performing compounded AquaFish Snakehead Formulated Feed (ASFF) was developed to have less reliance on using small-size fish and which would have lower environmental impacts. Up to 40% of small-size fish/trash fish were replaced by new AquaFish Snakehead Formulated Feed, other plant ingredients replaced for fishmeal and enzyme or attract supplementation in diet for optimum growth and survival of the snakehead. However, this new CRSP formulated feed technology was less adopted by snakehead farmers in Cambodia than in Vietnam due to some extent.

INTRODUCTION

Mekong River is one of the most productive aquatic resources in the world. Mekong River is the main source of fisheries resources in Cambodia and Vietnam. Particularly in Cambodia the seasonal and permanent wetlands cover more than 30% of Cambodia. The fisheries sector has for many years contributed significantly to the employment and livelihoods of the poor, to food security, and to GDP and foreign exchange balance. Cambodia’s fisheries provide full-time, part-time and seasonal employment for up to 6 million people and the fisheries sector contributes very significantly to domestic food security, providing over 81.5% of the animal protein in the national diet and also forming a critical source of essential vitamins and micro-nutrients.

In addition, the capture fisheries production in Cambodia is estimated to be worth around US\$200-300 million per year at the point of landing and fisheries harvesting, processing and trade contributes 8-12%

of GDP. The value of fish exports has been estimated to be as high as US\$100 million per year (SPFF 2010-2019).

Fish are also part of Cambodia's cultural heritage. The complex and enduring linkage between fisheries and many aspects of the region's history, as shown by the archaeological finds of fish processing and trade through the region and the incorporation of fish scenes into the historic temples of the country, demonstrates the continuity of the importance of the sector both domestically and throughout the South East Asia region. The aquatic environment and the associated rich diversity of species also constitute a very important part of both the national and global natural heritage.

However, the fisheries resources in Cambodia and Vietnam is faced with the drastic decline of fisheries resources due to the rapid increase of population and illegal fishing activities, many capture fisheries resources have been largely overexploited and, as a result, development of aquaculture has been encouraged to provide the protein, income, employment and export earnings to substitute the natural fisheries resources. In Cambodia, for example, freshwater aquaculture production has increased rapidly over the last two decades, with an average growth rate of 16.3%. In 2004, aquaculture represented 8.3% of total inland fisheries production (So, et al. 2005). In Vietnam, the annual growth of aquaculture has been about 10-13% during the last decade. The Mekong Delta region of Vietnam often contributes about 55-60% of the total aquatic production and more than 60% of total aquatic production for export of the whole country (Sinh 2005). Such a development trend implies that sufficient feed for aquaculture production will be available. One source of feed is low value/trash fish¹. There is a general lack of accurate information on how much low value/trash fish is presently used in Cambodia and Vietnam, but a conservative estimate of 25% for livestock and aquaculture feed has been put forward (FAO-APFIC 2005). The uses of low value/trash fish are diverse and include: (1) local consumption (e.g. fresh, dried); (2) direct feed (e.g. livestock, high value species aquaculture); (3) fish meal production (e.g. poultry, aquaculture); and (4) value-added products (e.g. fish sauce).

There is increasing demand and trade in the region for low value/trash fish for both aquaculture and animal feeds. In Cambodia, for example, it has been estimated that at least 62 freshwater low valued or small-sized fish species are used to feed inland aquaculture. These fish species represent both adult species that are commonly used as food fish, and also juveniles of commercially important fish species. Cage culture uses as much as 50% low value/trash fish in the total feed (So, et al. 2005). In Vietnam, at least 11 species of freshwater, and increasingly a number of marine, low value/trash fish are used to feed inland aquaculture. The price of low value/trash fish has tripled since 2001 and it is predicted to continue to rise as aquaculture expands (FAO-APFIC 2005). The use of artificial fish-based feeds and/or fresh fish resources have further increased pressure on wild fish stocks. Inevitably, a dangerous spiral has evolved where the demand for low value/trash fish for aquaculture feed has supported increased fishing pressure on already degraded resources. It is predicted that as aquaculture grows, it will be difficult to meet the demand for low value/trash fish. There is a general concern that the rapid expansion of aquaculture may ultimately be constrained by the dependence on low value/trash fish and fish meal, popularly referred to as the "fish meal trap". The Asia-Pacific countries may need to increase imports of fish meal from the global market for the aquaculture industry, or replace these with other feed materials. There is a need to address the increasing demand for low value/trash fish by aquaculture by improving feeds for aquaculture through changing over from direct feeding to pellet feeding and reduction of fish meal content by substitution of suitable ingredients in pellets.

¹ Low value/trash is defined as fish that have a low commercial value by virtue of their low quality, small size or low consumer preference. They are either used for human consumption (often processed or preserved) or used to feed livestock/fish, either directly or through reduction to fish meal/oil (FAO-APFIC 2005).

There is also increasing conflict between the use of low value/trash fish for feed and for human consumption. In some cases, such feeds are comprised of fish species traditionally used as cheap food for people and this allocation of fish resources to aquaculture may result in negative impacts of food security and livelihoods. It is the economics of the different uses of low value/trash fish in different localities that direct the fish one way or the other. There are also trade-offs between direct food benefit and the indirect employment and income generation opportunities afforded by feeding to aquaculture. It has been argued that it would be more efficient and ethical to divert more of the limited supply to human food, using value-added products. Proponents of this suggest that using low value/trash fish as food for domestic consumers is more appropriate than supplying fish meal plants for an export, income-oriented aquaculture industry, producing high-value commodities. On the other hand, food security can also be increased by improving the income generation abilities of poor people, and it can be argued that the large volume of people employed in both fishing and aquaculture has a beneficial effect. This raises some important questions regarding the social, economic and ecological costs and benefits of aquaculture, its sustainability and future trends.

In relation to the above-mentioned challenging issues, the project entitled “ Development of Alternative to the Use of Freshwater Low Value Fish for Aquaculture in the Lower Mekong Basin Cambodia and Vietnam: Implications for Livelihoods, Production and Markets” was implemented. The focus of this project is equally on the aquaculture of carnivorous fish and the management of lower value/trash fish.

The objectives of this investigation aimed to (1) apply the research results and disseminate appropriate technology to the end-users of aquatic resources and aquaculture practitioners, (2) train farmers in the project sites on farm made feeds and benefits of using alternative feed technology, (3) improve feeding practices and promote adoption and change behavior over alternative feeds, and (4) provide scientific-based strategy and information for policy makers to develop policy on aquaculture and aquatic resource management.

METHODOLOGY

This is an activity type of investigation to disseminate information and technology to the end users in form of workshops, conference organization, outreach documents and training sessions. However, the information and technologies can be sent effectively to the farmers, unless we understand on what’s the problems encountered by farmers, what’s information/technologies farmers needed to overcome the problems, and what is the best way to educate them to solve the problem. Therefore, The Participatory Rural Communication Appraisal (PRCA) was conducted to understand the general characteristic of the farmers in the project sites to develop effective communication channel. Seven provinces, namely Prey Veng, Kandal, Kampong Cham, Kompong Chhnang, Pursat, Battambang, and Siem Reap province were selected for the targeted project sites to transfer the AquaFish Snakehead Formulated Feed.

Two types of data were gathered, primary and secondary data. Primary data was collected through interpersonal interview by using the structured questionnaires which designed to understand the general characteristic of the respondents and the most effective communication channel. Secondary data was collected by reviewing related literatures relevant to fish process technologies and existing practical aquaculture technologies which have been successfully implemented by AIT Aquaculture Outreach Program and JICA Aquaculture Development Program in Cambodia. The review aimed to use the technological know-how and knowledge on local fermented feed made for small scale aquaculture development practiced in Cambodia to transform into the printed media for dissemination.

Orientation within the investigation team members was conducted to internalize the team members to be aware of the project document and understand the requirements needed to be accomplished by the members in the process of project implementation.

Inception workshop was conducted at IFReDI to provide awareness to the government fisheries officers, NGOs representatives, local communities, and other relevant stakeholders on AquaFish CRSP Project implementation, especially, to the other relevant stakeholders whose work related to aquaculture development sector as well as to hold consultation among the participants for their suggestions and recommendations.

Consultation meeting with different team members from three investigations in IFReDI was conducted to provide opportunity to all members implementing the AquaFish CRSP projects in IFReDI to be aware of the process and procedure and also the goals and objectives of the whole project. The consultation established a link of each investigation in terms of its activities, planning, and implementation.

Orientation meeting of all US PIs and HC PIs was conducted in Phnom Penh City. The orientation brought all the US PIs and HC PIs to fully understand the process and procedure of the project implementation. Several issues were discussed during the orientation such as: the activities plan, procedure, time frame, budgetary, and reporting system of each investigation, and set out the mechanism for improving communication within the project teams. It was recommended to use Yahoo Messenger or Skype as communication channel among the team members.

Consultation meeting with local fisheries authority was conducted at commune council, in the Lvea Eam District, Kandal Province to explain the main objective of the investigation and overall project implementation arrangement.

Focused group discussion was conducted to generate information among the snakehead fish culture to obtain first hand information on the nature of snake fish culture and problems that farmers encountered during the culture period such as fingerlings, feed, feeding strategy, as well as disease occurrences.

Consultation meeting with commune council leader, village leader, local fisheries officers and fish farmers was conducted to create criteria for selecting farmers for adoption pilot. Thirty (30) poor and active farmers were selected for CRSP home made feed adoption pilot.

RESULT

The main objective of the investigation is to transfer information, technologies and know-how from research results of the project to the fish farmer and end-users of aquatic resources users in both Cambodia and Vietnam. The Investigation was implemented and achieved the following result:

1.1 Institutional Capacity Building:

Conducted two trainings to build the capacity of the team members, (1) Training on “Development of Questionnaires and Design” and (2) Training on “Data Encoding and Analysis”. The team members were trained on the job to design questionnaires and do pre-testing of data collection method as well as encoding collected data into data form of SPSS computer program. These trainings were designed to strengthening and improving the institutional capacity of the Inland Fisheries Research and Development Institute staffs to learn from the data collection to data entries and analysis.

1.2 Awareness Raising and Technology Transfer:

1.2.1 **Awareness Raising:** carried out public awareness activities in the form of Inception Workshop, Impact Assessment Seminar, Information/Communication Monitoring and Evaluation Workshop, and Poster on Freshwater Small-Size Fish Species in Lower Mekong Basin Cambodia-Vietnam.

- **Inception Workshop:** Conducted inception workshop at IFReDI to provide awareness on AquaFish CRSP project activities. More than 40 participants from both national and provincial government fisheries officers, NGOs representatives, local communities, and other relevant stakeholders participated. The workshop aimed to provide awareness and hold consultation among the participants, particularly the stakeholders whose work related to aquaculture development sector as well as to receive their suggestions and recommendations.
- **Impact Assessment Seminar:** organized seminar to provide awareness to fisheries officers, researchers, local authorities, fish farmers, as well as policy makers to understand the impact of using trash fish for snakehead culture and the reduction of utilization of trash fish by substituting with the rice bran and cassava meal 20-40% with the CRSP formulation of home-made feed. The workshop provided awareness-raising on the important role of small-size fish in daily protein intake of local people and the competition between the human being and the aquaculture industry in Vietnam. The workshop also informed on the diversity of freshwater small-size fish species in Lower Mekong Basin Cambodia and Vietnam. This investigation raised awareness on new alternative snakehead formulated feed developed by AquaFish CRSP.
- **Information/communication monitoring and evaluation workshop:** Conducted workshop on Information/communication Monitoring and Evaluation to 41 participants from different stakeholders such as target snakehead fish farmers, local fisheries officers, and researchers to understand the effective use of printed media as channel to transfer information and technology to targeted farmers.
- **Poster:** Published 5,000 copies of 1st series Poster on Freshwater Small Size Fish Species in Lower Mekong River Cambodia-Vietnam (Photo 7. Poster). The message in this poster is to provide awareness to the audiences on Freshwater Small-Size Fish species diversity in the lower Mekong River Cambodia and Vietnam.

1.2.2 Technology Transfer: Two forms of communication channel, Interpersonal and Printed Media (Poster/Leaflet), were used to transfer technology to the fishermen and other aquatic resources users in the targeted project sites.

- Organized training on Farmer Field School (FFS) to the key fish farmers of the seven provinces of targeted project sites. The training provided opportunity for the fish farmers to get hands on to how to make traditional fish feed by the most successful fish culture farmers in Kandal Province. 26 key fish farmers participated in the training, of whom 11 are female.
- Organized Training of Trainer (ToT) to 21 participants, (3 participants from each province), from seven targeted province project sites. The training designed to build the capacity of the trainees to become a Trainer and also the Extension Worker in order to train other farmers who are interested in adoption of alternative feed for their fish culture. These 21 Trainers/Extension Workers will play a very important role in the dissemination and transferring of AquaFish Snakehead Formulated Feed developed by Investigation III to the fish farmers in Project phase 2 after this new Formulated Feed is confirmed and adopted by pilot farmers.
- Organized training on “Fish Feed Technology” and “Snakehead Alternative Feed” to 30 selected fish farmers for technology adoption pilot. The training was designed to educate

the farmers to understand and have the know-how on CRSP home-made feed for snakehead fish and feeding methodology.

- Organized training on “Logbook Fish Measurement” to 30 selected fish farmers’ pilot for feeding and grow rate record keeping.
- **Poster:**
 - Published 20,000 copies of 1st and 2nd series Poster on Freshwater Small Size Fish Species in Lower Mekong River Cambodia-Vietnam. The message in this Poster is to provide awareness to the audiences on Freshwater Small-Size Fish species diversity in the lower Mekong River Cambodia and Vietnam.
 - Published 10,000 posters on “How to Make and Use of AquaFish CRSP Home-Made Feed for Snakehead” and distributed to selected fish farmers and snakehead fish farmers in 6 provinces around the great lake and along the Mekong River.

1.2.3 Institutional Research Collaboration: This project “Development of Alternative to the Use of Freshwater Low Value Fish for Aquaculture in the Lower Mekong Basin Cambodia and Vietnam: Implications for Livelihoods, Production and Markets” provided opportunities for international travels to participate in international conferences and workshop which this opportunity has not only built institutional and staffs capacity but also established networking and linkages between and among the research institutes, universities, and development institutions around the world.

DISCUSSION

The main goal of this investigation is for sustainable freshwater aquaculture development and innovative fisheries management systems in the Lower Mekong basin region of Cambodia and Vietnam. This main goal takes into account that the main driver of this project is the continued expansion of aquaculture and its dependency on capture fisheries for low value/trash fish for feed. It also takes into account that: capture and culture fisheries continue to play an important role in the food security, poverty alleviation and economies of both countries; the strong interdependency between capture fisheries and aquaculture; management of these two sub-sectors cannot be carried out in isolation of each other; there is increasing local and intra-regional trade for low value/trash fish products; and there is increasing competition and conflict between the use of low value/trash fish for feed and human consumption.

Balancing of social, economic and environmental/natural resource needed between human consumption and aquaculture feeds are based on the development of feed and feeding strategies for other fish species, further on-farm trials of feed formulations, policy and technology for trade and value-added product development for low value/trash fish, development of farm made feeds, improved management strategies for capture fisheries, and policy development for sustainable aquaculture and capture fisheries.

Investigation 09TAP01UC in the first phase of this project (*Implementation Plan 2007–2009*) had problems due to underestimating that the new technology for snakehead formulated feed will be developed by the first year of the project implementation. But the development of AquaFish Snakehead Formulated Feed took longer time than our expectation. This investigation in the second phase of the project (*Implementation Plan 2009–2011*) is continued to develop the new technology for snakehead formulated feed with cost-effective and high performing compounded feeds that had less reliance on using trash fish and which would have lower environmental impacts. The study designed to determine the capacity of trash fish that could be replaced by new AquaFish Snakehead Formulated Feed, other plant

ingredients replaced for fishmeal and enzyme or attract supplementation in diet for optimum growth and survival of snakehead.

The new AquaFish CRSP developed technology for snakehead formulated feed was commercialized by more than 10 snakehead feed producers in Mekong Delta Vietnam with remarkable results, proven and adopted by the farm trials and farmers pilot adoption as well as snakehead farmers in general.

Thirty (30) snakehead farmers were trained on new CRSP AquaFish homemade feed in Lvea Em District, Kandal Province in Cambodia for farmer adoption pilot. The farmers can replace their trash fish by rice bran and cassava up to 30-40%. However, the farmer adoption rate was high during the first month after stocking fish and most of snakehead farmers stop feeding their snakehead with CRSP home made feed after three months due to: (1) their fish getting big after three months and can eat trash fish with grinding, (2) the cost of rice bran and cassava the same as cost of trash fish, and (3) homemade feed pay more cost on gasoline for engine to grind and labor cost to mix the feed.

On the other hand, the new CRSP AquaFish Snakehead Formulated Feed and Homemade Feed were publicized for broader fish farmers, aquaculture practitioners, and commercial uses through printed materials such as poster, leaflet, trainings, extension workers as well as workshop to disseminate this new CRSP AquaFish Snakehead Formulated Feed technology to peer and relevant researchers to achieve the overall objective to transfer the adoption of new feed technology to the end users.

CONCLUSION

The project addressed a critical gap in terms of institutional capability of Inland Fisheries Research and Development Institute (IFReDI) to implement information and communication interventions targeted at specific users of fisheries resources who are causing fisheries resources degradation problems that affect fisheries and aquaculture productivity, profitability, and food security. The project has built not only institutional and staff capacity but also established networking and linkages between and among the research institutes, universities, and development institutions around the world.

The project addressed urgent fisheries resources degradation problems which are related to improper uses of feed technology in aquaculture development and other agricultural activities around the Great Lake, in particularly, and in the Lower Mekong River Basin Cambodia and Vietnam, in general. More than 20,000 of farmers are aware of Freshwater small size fish species diversity through the publication of poster. The project provided awareness on the importance of balancing use of freshwater small size fish in the Lower Mekong River Basin in Cambodia and Vietnam. The project has established effective linkages between researchers and communicators. The research results were applied to develop appropriate technologies to disseminate technical information and provide awareness and better understanding of the importance of low value fish, feed meal technology and feeding practices to the fish farmers which significantly reduce dependence on capture trash fish for feed and feeding in aquaculture activities.

The project produced more impact and benefit to farmers and users of aquatic resources after the new AquaFish Snakehead Formulated Feed and homemade feed has been tested, proven, and adoption by farm trials and farmer adoption pilot. The adoption of new CRSP AquaFish formulated feed and homemade feed led to reduction of the utilization of small size fish for snakehead culture in both Cambodia and Vietnam.

ANTICIPATED BENEFITS

These investigations provided direct and indirect benefit to different stakeholders such as: group of fish feed producers, fish farmers, aquaculture specialists, extension workers, and the people who live in

Mekong Delta. Especially, women, children, and elders whom often involved in fish made feeds and fish feeding practices.

More than 1,000 fisheries officers, NGOs representatives, local authorities, and other stakeholders worked related to aquaculture, fish farmers, and fishermen in the lower Mekong basin of Cambodia and Vietnam were aware and informed on the project implementation. Moreover, 47 of fish farmers in Cambodia were trained on farm made feeds, feeds and feeding strategies and 21 of key fish farmers were trained in a training of trainers to become extension workers. More than 20,000 farmers were aware and gained knowledge on species diversity and composition of freshwater small size fish in Mekong River Basin of Cambodia and Vietnam through the CRSP Poster. More than 10,000 fish farmers and aquatic resource users received relevant information and appropriate technologies on CRSP AquaFish Snakehead Formulated Feed and homemade feed technology. However, the new CRSP AquaFish formulated feed and homemade feed technology will continue to be widely disseminated to other fish farmers, aquaculture practitioners, feed makers, and other aquatic resource users in Cambodia and Vietnam even though the project finished.

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8. LITERATURE CITED

DoF (2004). Fisheries Development Action Plan (FDAP- 2005-2008). Department of Fisheries, Phnom Penh.

- FAO (2005). APFIC regional workshop on low value and “trash fish” in the Asia-Pacific region, Hanoi, Viet Nam, 7-9 June 2005. Food and Agriculture Organization of the United Nations, Bangkok. RAP Publication 2005/21.
- Fisheries Administration (2009). Strategic Planning Framework for Fisheries (SPFF) 2010- 2019.
- Sinh, L.X. 2005a. Management and development of aquatic resources in freshwater wetland areas of the Mekong Delta of Vietnam: Can we adjust to a new situation? Proceedings of the National Workshop on Environmental Economics and Evaluation of the wetlands, Vietnamese Association of Environmental Economics, Hanoi, 4-6 May 2004, p.76-97 (Vietnamese).
- Sinh, L.X. 2005b. Issues relating to sustainable farming of catfish (*Pangasius* spp.) in Vietnam. Paper presented at the workshop “Socioeconomics of selected species for sustainable development of aquaculture” organized by the Oceanic Institute, Hawaii, USA, 17-19 October, 2005.
- So N, Thuok N (1999). Aquaculture sector review (1984-1999) and outline of national aquaculture development plan (2000-2020). Ministry of Agriculture, Forestry and Fisheries, Department of Fisheries, Phnom Penh, Cambodia. 72 pages.