Training of Trainers
Programme

3-7 August 2009

Strengthening capacity of small holder ASEAN aquaculture farmers for competitive and sustainable aquaculture

NACA Secretariat, Bangkok

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Preface

In ASEAN countries, aquaculture is an important activity and several thousands of small farmers are engaged in this activity to earn their livelihood. Fish being a major animal protein source in ASEAN countries, greater importance is attached to ensure good quality safe fish and its products availability to all sections of the population. ASEAN Foundation plays critical role in ensuring development of all its members through cooperation. This project entitled "Strengthening the capacity of small holder ASEAN farmers for competitive and sustainable aquaculture" has been supported by the foundation to accomplish the ASEAN vision of 2020. The project objectives are to improve the competitiveness of ASEAN aquaculture small holders in the domestic, regional and global markets, to improve sustainability of their farming systems, to make them adopt responsible farming practices and improve their profitability.

Five ASEAN countries, namely, Cambodia, Indonesia, Philippines, Thailand and Vietnam were chosen as the representative countries. Based on the interest expressed by each country and the inception workshop that was held as part of the project activities, following five commodities were chosen:

(a) In Cambodia, snakeheads contribute to the food and economy of people immensely and they were cultured in cages and ponds for several decades. In 2005, Cambodia banned the culture of this species as farmers were using seeds collected from the wild and fed them with fresh fish caught from wild. n order to develop better feed management practices and explore the culture of snakeheads using other feed resources, Cambodia chose snakeheads as the commodity for research under the project.
(b) Tilapia being the most rapidly growing and widely cultured commodity, Thailand decided to work with farmers engaged in farming of tilapia in cages as well as ponds
(c) Sea weed cultivation has contributed immensely in providing livelihoods to several farmers in Philippines. However, with the increasing quality requirements in the international markets, farmers are facing many challenges with the declining environmental qualities that are contributing for the increasing crop failures and declined profitability. To address these problems, Philippines decided to work with farmers engaged in sea weed farming.
(d) Indonesia has made good progress in breeding of groupers and sea bass and several small farmers are engaged in culturing these species both for local as well as export market. As the livelihood of several farmers is dependent on these species culture, Indonesia preferred to work on groupers and sea bass as the commodities.
(e) Vietnam has demonstrated its entrepreneurial approach in developing market for various aquatic products. Shrimp farming is widely practiced in the country, but like in many other countries, the activity has been affected by the disease problems. Hence, Vietnam chose to work with shrimp.

The training of trainer session was organized to build the capacity of national project partners who in turn would train the farmers locally using the acquired knowledge. Based on the needs assessment carried out on each commodity, the training program was designed taking in to consideration of the needs as well as the overall goal of the project. The training program included technical aspects related to the culture of commodities, marketing, access to information, organization of farmer groups, mainstreaming of gender, coping strategies with various environmental changes and ways to reduce negative impact by adopting good culture practices.

The training program was attended by seventeen participants from five countries and they were trained by sixteen experts drawn from various organizations. Participants had an opportunity to discuss the lecture in the context of their country situation and the commodities they have targeted. Each of the countries also presented the needs assessment carried out and based on that participants were given additional support needed to design their own training programs. They were also given an opportunity to visit the Asian Institute of Technology and gain knowledge about the activities carried in developing tilapia breeding and culture technology to meet the market necessities.

In this volume, lectures presented by experts are included in unedited form for usage. At the end of the project, these lectures along with the training needs assessment reports, training manuals developed and the lessons learnt would be compiled together for wider dissemination. For any additional information on the lectures, please contact them directly using the e-mail address provided.

Aquaculture successes in Asia, contributing to sustained development and poverty alleviation[1]

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Abstract

Aquaculture though considered to have over a 2500 year history, mostly practiced as an art, it began to be transformed into a modern science in the second half of the 20th century. Within a period of 25 years or more it had begun to impress upon as a major food production sector, having recorded an annual average growth rate of nearly eight percent in the last two decades, as often purported to be the fastest growing primary production sector. Currently, aquaculture accounts for 50 percent of the global food fish consumption.

The sector has been and continues to be predominant in developing countries, particularly in Asia, which accounts for more than 85 percent of the global production. Asian aquaculture is by and large a small scale farming activity, where most practices are family owned, managed and operated. The sector has provided direct and indirect livelihood means to millions, as significant proportion of which is rural, and for some Asian nations it is a main source of foreign exchange earnings. Furthermore, it has contributed to food security and poverty alleviation and is considered to be a successful primary food sector, globally.

Introduction

Fish/ aquatic food organisms have been inextricably linked with human life over millennia. Indeed, it is even suggested that the prime impacting factor on the evolution of the human brain, which has made us what we are today, is linked to our early ancestors depending on aquatic food sources as the main form of nourishment that provided ample quantities of n-3 and n-6 series highly unsaturated fatty acids. *Homo sapiens* in the recent history went through agricultural and industrial revolutions which gradually impacted on our life modalities including food sources. Science began to have a profound influence on our life styles and gradually the life expectancy increased and the ability to combat epidemics of various forms and sorts developed and began to impact on the rate of growth of human populations. In the early years of the post-industrial revolution period the early philosophers such as Malthus held a grim view of the sustenance of the growing human population and suggested that gains in food production will not be able keep up with the latter (Malthus, 1985). He suggested that there will be a constant tendency in all animated life to increase beyond the nourishment prepared for it', that would result in an inevitable number of "positive checks" (e.g. starvation and deaths) occurring when mouths outnumbered food production.

Impacts of science on our life have changed the above view. Indeed some economists (Boserup, 1981; Simon, 1981) have suggested that man is a resource and the greater the population the more likely it is likely that invention and innovation will flow and food will not become a limiting factor. Of course the latter position is not universally accepted either, especially in the context of the notion that there is a limit to the capacity in the

[1] This is a reproduction of a Chapter in the forthcoming book; **Success Stories in Asian Aquaculture** (ed. S.S.De Silva & F.B. Davy, Springer-IDRC-NACA.

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biosphere, in that it is essentially a closed system and continuing sustainable gains in food production cannot be taken for granted.

In this opening Chapter an attempt is made to set the scene for the treatise as a whole. Accordingly, the importance of aquaculture in the current context of population growth, food demand, poverty and malnourishment prevailing globally, and its role in contributing to human food basket is brought to focus. The growth of the aquaculture sector is traced and the public perceptions associated with aquaculture development in respect of its sustainability are discussed. The importance of public perceptions in current development activities and on aquaculture is considered, and finally an attempt is made to answer the simple question whether aquaculture is a success.

Contemporary situation

The human population has grown from 1.5 to 6.4 billion from 1900 to now, and is predicted to increase to 9 billion by year 2050, barring major calamities that could occur. Not surprisingly, the fact remains that malnourishment, defined as human beings daily calorie intake is less than 2200 KCal, is probably one of the challenges if not the biggest challenge facing the globe, with an estimated 840 million being in a state of malnourishment (WEFP, 2007). The situation is even more burgeoning as nearly 80 to 85% of these malnourished people live in the developing world, accounting for 16% of the world's total burden of disabling illness and premature death, measured in disability-adjusted life-years (Murray and Lopez, 1996). Fish, however, is not primarily a source of calories. On the other hand, fish accounts approximately 20 percent of the animal protein intake, the contribution being even higher in developing countries, particularly those of Asia.

Table 1: The relative contribution from capture fisheries and aquaculture to the GDP in some selected Asian countries and Chile, S. America

Country	Capture	Aquaculture
Bangladesh#	1.884	2.688
PR China#	1.132	2.618
Indonesia#	2.350	1.662
Lao PDR#	1.432	5.775
Malaysia#	1.128	0.366
Philippines#	2.184	2.633
Thailand#	2.044	2.071
Vietnam*	3.702	4.00
Chile@	2.17	2.63

from RAPA, 2004;@- from De Silva & Soto, 2008;
* Vietnam Net Bridge

Over the last half century or so fish are also becoming an increasingly important traded commodity, by passing many traditionally traded commodities (Kurien, 2005). Moreover, in a significant number of Asian countries the contribution of aquaculture to the national GDP has superseded that from capture fisheries, indicating the growing importance of aquaculture to those countries (**Table 1**).

Recently McMichael (2001) recognized three consecutive eras over the past and coming centuries, showing the changing balance between cereal-grain production and population growth (Figure 1). Furthermore, he summarized the contemporary situation under seven headings, of which the pertinent points are as follows:

(1) The proportion of the world population that is hungry and malnourished is slowly declining. However, because of the continuing growth in population the absolute number of hungry and malnourished people is not obviously declining and one-quarter of them are aged below 5 years,
(2) *Per capita* food production has increased over the past four decades but those gains in yield were achieved via intensive inputs of energy, fertilizer and water, and at the expense of soil vitality and groundwater stocks,
(3) An estimated one-third of the world's arable land is significantly degraded, a significant proportion of it (20%) occurring during the 1980s and 1990s,
(4) *Per capita* grain production (which accounts for two-thirds of world food energy) has plateaued since the mid-1980s,
(5) The annual harvest from wild fisheries peaked at about 100 × 10^6 $year^{-1}$ in the 1970s, and has subsequently declined by about 20 %,
(6) Aquaculture now accounts for approximately one quarter of the world's total fish and shellfish production and

(7) The promise of genetically-modified food species, while potentially great, is subject to resolution of concerns about unexpected genetic and ecological consequences.

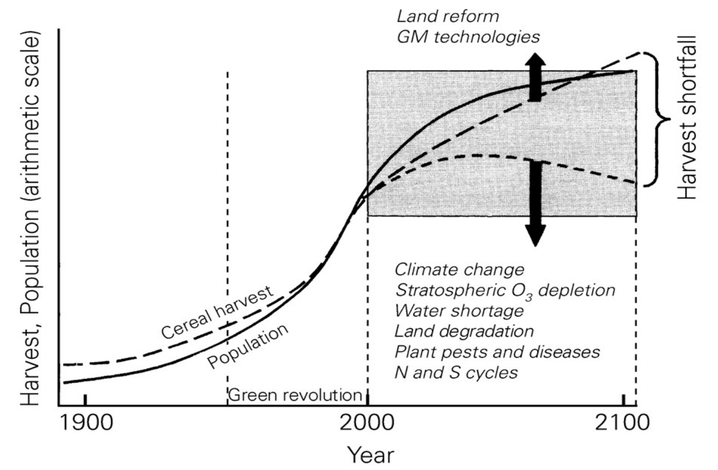

Fig. 1. Schematic representation of three consecutive eras over the past and coming centuries, showing the changing balance between cereal-grain production (– –) and world population size (c). Over the coming century there will be tension between yield-enhancing science and policies ( ) and yield-diminishing environmental forces ( ). GM, genetically-modified.

Based on the above McMichael proceeded to address issues of climate change impacts on food production, as well as the associated scenarios on biofuels production for example.

Fish and human nutrition

Humans and fish have been inextricably linked for millennia, not only as an important animal protein source, providing many millions of livelihood means and food security at large but also from an evolutionary view point. Indeed, one school of thought has suggested that the development of the human brain, and hence what humans are today, has also been linked to food sources rich in n- 3 (DHA, EPA) and n- 6 (AA) PUFAs - literally fish constituting a major part of the diet of our ancestors. In this regard a large quantum of evidence has been brought forward to show that *Homo sapiens* evolved not in a savannah habitat but in a habitat that was rich in fish and shellfish resources (Crawford *et al*., 1999).

The fish production patterns and consumption patterns have changed over the last 30 to 40 years, with both production and consumption being predominant in developing countries (Delgado *et al*., 2003). Fish, all aquatic products, are easily digested, and though perishable are easily processed into various forms avoiding wastage. Most importantly, fish constitute one of the main animal protein sources of the developing world, containing all essential amino acids, thus providing an affordable nutrient source to most rural, impoverished communities. Fish also provide an excellent source of essential fatty acids, the highly unsaturated acids of the n-3 and n-6 series [e.g. DHA- docosahexaenoic acid, 22(6n-3); EPA- eicasopaentonic acid, 20(5n-3); AA- arachidonic acid, 22(4n-6)] although the amounts of the specific fatty acids present in fish differs markedly between species, and in general between those of marine and freshwater origin. Fish also provide essential micro nutrients in the form of vitamins, mineral (e.g. best sources of iodine and selenium) and some co-enzymes (Q 10), amongst others. Increasing quantum of evidence is becoming available on the health benefits of fish consumption, with clear evidence being brought forward with regard to its impacts on common diseases such as cardio vascular related ones (de Deckere *et al*., 1998; Horrocks and Yeo, 1999; Connor, 2000; Ruxton *et al.,* 2005 amongst others).

It is in this respect that there is an increase in fish consumption in the developed world, whereas in the developing world, in all probability, the driving forces with regard to increased consumption are its affordability and availability. There is clear evidence that both in the developing and developed world fish consumption is on the increase and more so in the former (Delgado *et al*., 2003).

Traditional fish food supplies

Traditionally, the great bulk of the food fish supplies (conservatively estimated at about 85-90 %) were of marine origin and it still is but its share is declining. Historical developments of the industrial fisheries, which essentially were a post-World War 2 development, have been aptly documented in the past (FAO, 2007). Importantly, now for over four decades, about 25 percent of the industrial fish landings are reduced into fish meal and fish oil, currently approximating 25 million tonnes per year, and form the basis for the animal feed industry, including some cultured aquatic species/ species groups such as shrimp and carnivorous marine finfish in the main.

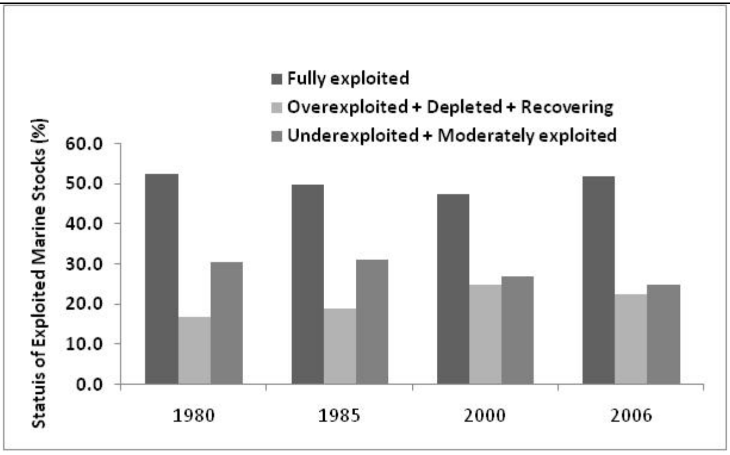

Figure 2. The status of exploited marine fish stocks (based on FAO, 2007)

Until the late 1960s it was thought the seas were bountiful and harbored unlimited amount of fish resources. This notion is now known to be proven erroneous. The intensification of fishing has resulted in the depletion of stocks, perhaps some beyond recovery, and the number of potential stocks that could be added to the fish basket is known to be meager. It is almost universally accepted that the average maximum fish production that could be obtained from the oceans is around 100 x 10^6 tonnes per year.

Fish food needs

Although the production from the marine capture fisheries has plateaued the demand for fish has grown over the years, resulting from an increased global population, exacerbated by increased consumption in some nations/ regions. The estimates of food fish needs for the future, even at the current rate of consumption, are high. **Table 2** summarizes the fish food needs up to 2020 based on the average of different estimations that are available. In summary, the World will need an extra 40-60 x 10^6 t of food fish by 2020.

Table 2. Estimation of fish food needs by 2020 based on the current per caput consumption rates

Continent	Population (x 1000)*			Fish supply / demand		
	2005	2020	Increase (%)	Per caput 2001 (kg)**	Current (t)***	Demand 2020 (t)****
Africa	905936	1228276	35.6	7.8	7,066,301	9,580,553
Asia (ex..China)	2589571	3129852	20.9	14.1	36,512,951	44,130,913
Europe	728389	714959	-1.8	19.8	14,422,102	14,156,188
L. America & Caribbean	561346	666955	18.8	8.8	4,939,845	5,869,204
N. America	330608	375000	13.4	17.3	5,719,518	6,487,500
Oceania	33056	38909	17.7	23	760,288	894,907
China	1315844	1423939	8.2	25.6	33,685,606	36,452,838
World	6464750	7577889	17.2	16.3	105,375,425	123,519,591

*Source:*UN; **Source: FAO; ***2005 population x 2001 per capita supply;
****2020 population x 2001 per capita supply

Aquaculture

Aquaculture is purported to be an age old practice that commenced in China. However, its significance to the contribution to "human food basket" is of only three to four decades old only. There is universal acceptance that aquaculture has matured to be an important contributor to meet human food fish demands, and is often mooted as the fastest growing primary production sector.

Importance in narrowing the supply and demand gap

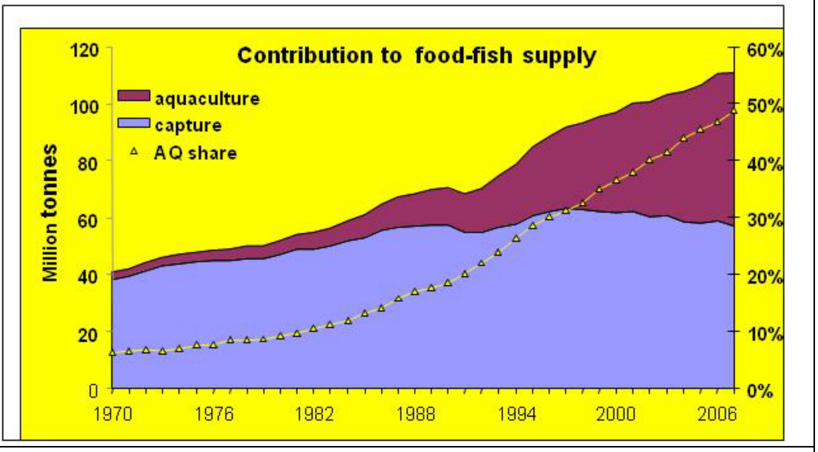

Figure 3. Contribution from capture fisheries and aquaculture to fish production and the percent contribution of the latter to consumption

In the wake of the plateauing of the traditional fish supplies it is generally accepted that the short fall in food fish needs has to come from aquaculture. Aquaculture within the short span of three to four decades has continued to increase its importance in the food fish production sector, and is estimated to account for 50 percent of the global food fish consumption (**Figure 3**), and tantamount to approximately 35 percent of the global fish production/ availability.

Key features of the aquaculture sector

The great bulk of aquaculture production occurs in Asia, and with in Asia in China. Freshwater finfish culture contributes most to overall production (**Figures 4 and 5**). In general, the great bulk of aquaculture production is based on commodities that command a farm gate price of less than US$2.00 kg^{-1}, and all in all, over the years, the price of aquaculture produce has retained static and or declined marginally, in stark contrast to other food commodities. From a value view point the most important cultured commodities are the salmonids and shrimp in temperate and tropical regions, respectively. From a value view point the most important cultured commodities are the salmonids and shrimp in temperate and tropical regions, respectively.

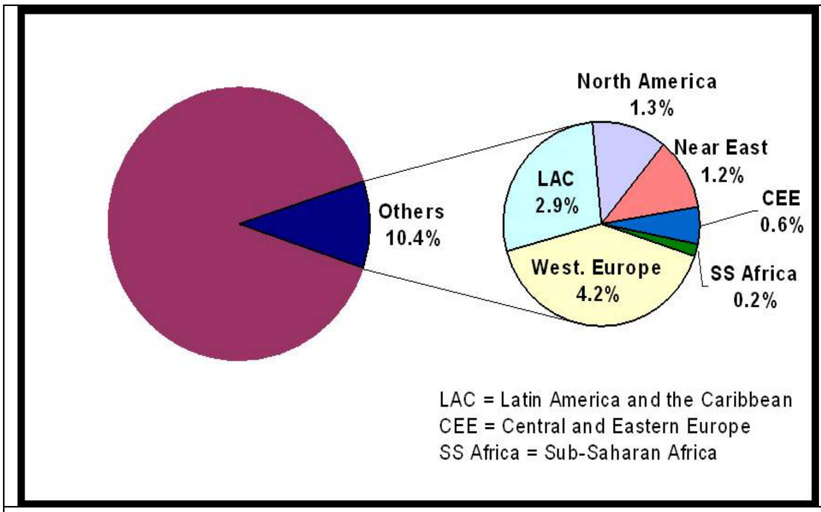

Figure 4. Aquaculture production (2005) in relation to the geographic areas (from De Silva and Soto, 2009)

In Asia, the epi-center of aquaculture production, the traditional practices tend to be largely small scale operations, often farmer owned and managed, and often clustered in an area that is conducive to aquaculture. Aquaculture practices are integrated with other primary production practices, particularly in Asia, such as rice farming. The rural dominance of aquaculture, particularly in Asia, has been emphasized in detail earlier and by many. In this regard aquaculture in some regions is the backbone of rural economies and provides many millions of livelihood opportunities (Edwards *et al*., 2002).

Needless to say that in the last decade or so many a rural aquaculture farming practice has changed, the changes being primarily in response to market demands, traditional and new. Notable examples in this context are the tra catfish (*Pangasianodon hypophthalmus*) and rohu (*Labeo rohita*) farming sectors of the Mekong, Vietnam and Ayeyarwaddy, Myanmar deltas, respectively.

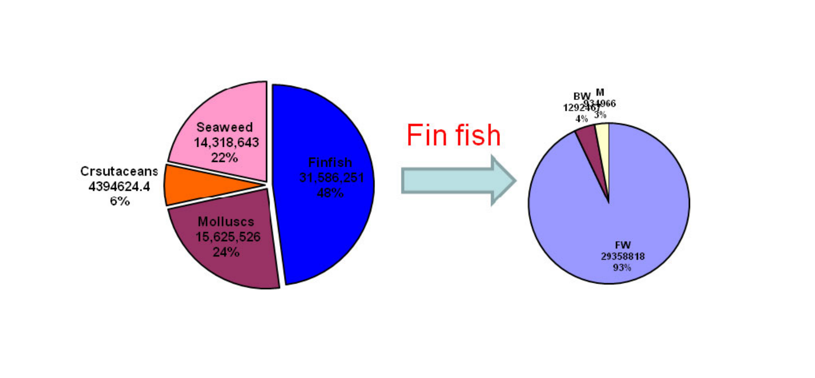

Figure 5. The proportion of the major aquaculture commodities (based on 2005 production, FAO Stats, 2007; from De Silva and Soto, 2009)

These have remained rural, intensive and have flourished to cater to export niche markets, and gone on to generate thousands of additional livelihood opportunities, particularly for women, in the associated processing sectors (Aye et al., 2007). Inevitably such developments have also highlighted on the difficulties of defining small scale aquaculture, as explicitly as one could. For example, a shrimp an farming practice in one ha could result in an optimal annual yield of approximately 8 to 10 tonnes, as opposed to a catfish farming practice in the Mekong delta that could yield 400 to 600 tonnes.

Growth phases in aquaculture

As pointed out earlier the aquaculture sector has grown fast, averaging almost 7-8 per annually, over the last two decades, significantly higher than any other primary production sector (De Silva, 2001). It will be naïve to expect that an almost exponential rate of growth could be maintained indefinitely, and evidence is coming forth in that the globally the rate of growth of the sector is declining (**Figure 6;** also see De Silva and Hasan, 2007). In Figure 6 the rate of growth of human population is superimposed, and some degree of similarity in the trends in apparent. Indeed, if the trends in absolute increase in aquaculture production and growth in human numbers are considered the trends appear to be comparable (**Figure 7**).

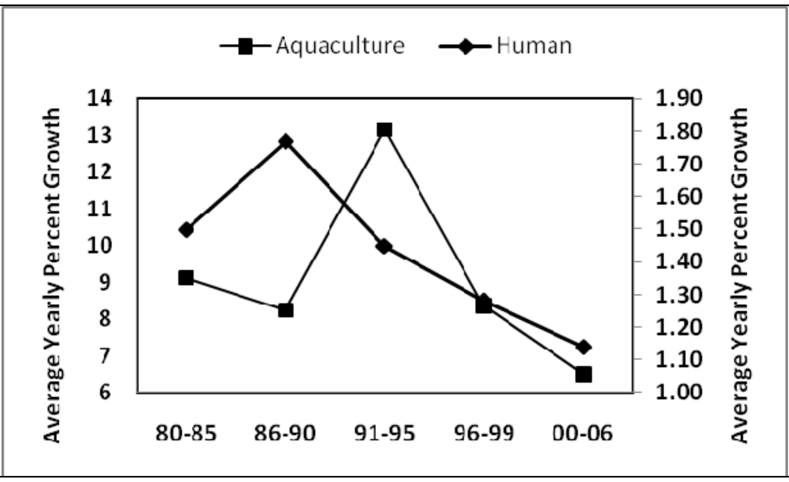

Figure 6: Trends in aquaculture production, based on percent average change in production per year in each of the five-year periods, 1985 to 2005 together with that of human population growth

A detailed analysis of the some of the above trends has also been provided earlier (De Silva, 2001), when it was pointed out that although there is a global decline in the rate of growth, in some regions such as in Latin America and Africa the rate is on the increase, albeit the overall contribution to global aquaculture production is still relatively small from these continents. However, this also indicates that there is a high potential for aquaculture growth in these regions. Overall, therefore, although the rate of growth in the aquaculture sector is decreasing the absolute production continues to increase. What is crucial is to recognize that there will be a limit to this growth and sustaining the optimal production when it reaches that point.

Over the last four to five decades the aquaculture sector has gone through some notable phases. The latter phases could be related to changes in global aspirations in respect of development goals, commencing with the world wide acceptance of the Bruntland Report (UNEP, 1987).

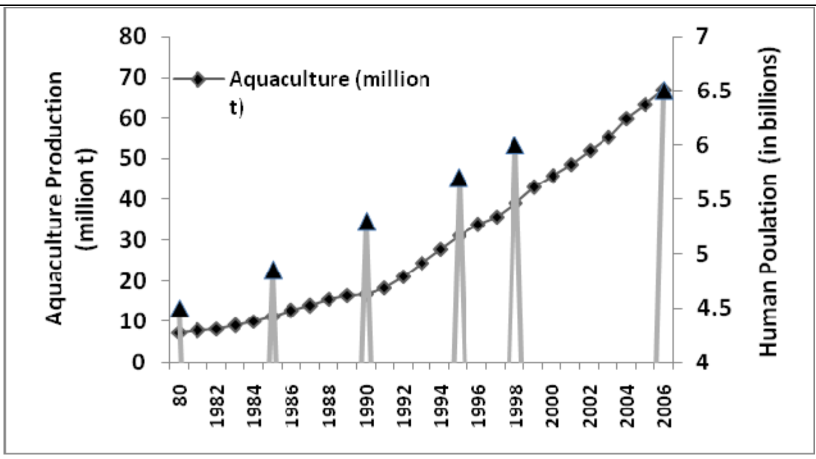

Figure 7: The trend in aquaculture production (FISHSTAT, 2007) over the years and the corresponding human population numbers (data source: http://geography.about.com/od/obtainpoulationdata/a/worldpoulation/htm).

The progress of the sector therefore, had to accede to public well being in a holistic sense, and had to work towards a more prudent use of primary resources, such as land and water, and be much more conscious of environmental impacts arising from the sector's developments. A schematic representation of the conceived phases of aquaculture growth is presented in a schematic form in **Figure 8**.

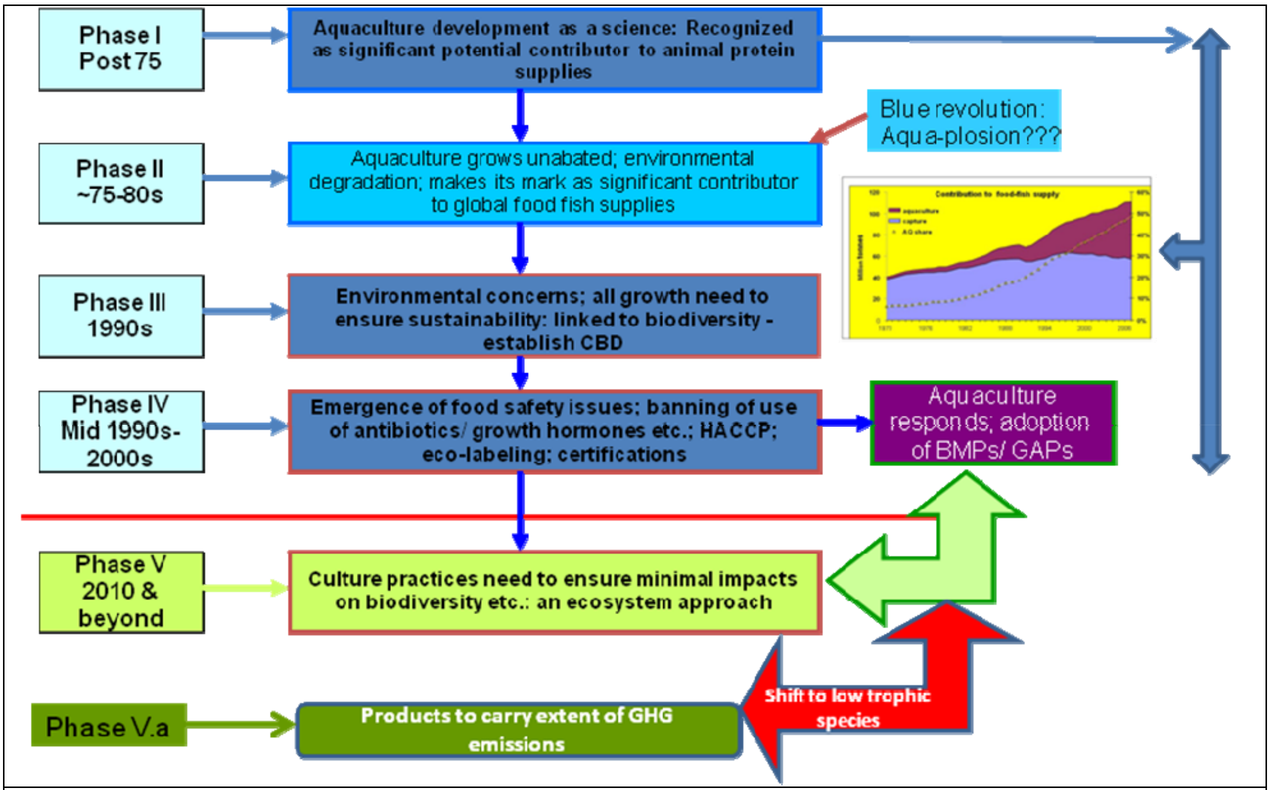

Figure 8. A schematic representation of growth phases of modern aquaculture

The question therefore arises, is the sector capable of complying with global aspirations and what adjustments are needed to meet such a compliance. The present attempt to document the "Success Stories" in aquaculture is one such manner of demonstrating to a global audience that aquaculture could comply with global aspirations and continue to contribute significantly to the human fish food basket.

Public perceptions on aquaculture

Aquaculture is a relatively new primary production sector, from the view point of its significant and important contribution to the human food basket. However, this gaining of importance happened to occur when the world as a whole became conscious and realized that all developments, be it in the primary production sector or elsewhere, have to be sustainable and environmentally minimally perturbing, and have to comply with increasing food quality and nutritional needs. Consequently, the sector has had to encounter much more stringent public, scrutiny and "policing". The current scenario is such it is not only important that present day food quality demands are met but equal importance is being laid on the manner it was produced, including societal responsibility and equity.

Many public groups reckon that aquaculture is unsustainable and environmentally degrading (Naylor *et al*., 1998, 2000; Aldhous, 2004; Allsopp *et al.*, 2008). However, most of these perceptions revolve around shrimp and salmonid aquaculture, two practices that contribute less than 10 percent to overall global production and in value approximately 16 percent, and more often than not fail to consider its contribution as a food source, an avenue for providing millions of livelihood opportunities and contributing to the national and global trade. Of the major objections to aquaculture development which is based on excessive use of fish meal and fish oil in the feeds for shrimp and other cultured marine carnivorous species/ species groups. It has been shown that very significant proportions of the primary resource used for reduction into fish meal and fish oil is being channeled for production of animals that are not human food sources De Silva and Turchini, 2008). What is perturbing is that such aspects have not received the attention of these groups who advocate the channeling of the biological resources used for fish meal and fish oil production for direct human consumption; on many an occasion a level playing field has not been lacking in many of these advocacies.

The most commonly highlighted aspects of aquaculture that are supposedly impacting on its sustainability are, dependence on fish meal and fish oil in aquaculture feeds, overly dependence on exotic and or alien species and negative influences on biodiversity. All of the above are refutable to varying degrees, but that is not to conclude that all aquaculture developments have been sustainable and environmentally friendly.

Aquaculture is even to date has to live with the notion that shrimp farming was the prime cause for mangrove destruction, even though there is mounting information that shrimp farming per se accounted for less than five percent of global mangrove destruction. Equally, alien species in aquaculture- the dependence on which is not different to any extent on all human food production sectors (De Silva *et al*., 2008)- is often highlighted as a environmentally destructive element primarily induced through aquaculture. Here again the evidence is variable and on occasions refutable and in more often than not explicit evidence on cause and effect is lacking.

Irrespective of the correctness and or the authenticity and or the biases of the varying range of arguments it is incumbent on all aquaculture developments to take notice of the public concerns and act accordingly- aquaculture developers cannot be complacent. The onus is on the sector to demonstrate to the public and policy makers equally and convincingly that aquaculture developments are sustainable and it could proceed in a socially and environmentally responsible manner, with in the societal guidelines, and still continue to be dominant and an important provider to human food basket, millions of livelihoods and income generation, and in turn contribute to food security and global poverty alleviation.

Is aquaculture a success?

Success can have many definitions, and equally interpreted in many ways. **Success** may refer to the achievement of one's aim or goal; (*business*) financial profitability, a person who achieves his or her goals or a level of social status, achievement of an objective/goal; the opposite of failure. On the other hand, what is considered a success for one person, a community, a nation, or region and or a combination there of in respect of a policy, achievement, a development may not be considered a success by others. Indeed even a consensual success at one point could be treated as failure by others, downstream, and is of particular relevance to aquatic resources related developments.

If one were to assess the success of aquaculture from a purely food production, providing employment and or livelihoods opportunities and rural development and financial gain viewpoints it has to be conceded that aquaculture has been a success thus far. However, as pointed out in the foregoing section this success as well as its long term sustainability is questioned by some, in more instance than one the arguments being based on shrimp and carnivorous marine finfish culture of salmonids. It is in the above context that the other Chapters in this treatise set out to demonstrate the successes of specific aquaculture practices, which have collectively contributed to achieving significance as a food production system.

Development and success go hand in hand with public policy as well as attitudes. Accordingly, there is a need to address decision makers in the wake of increasing use and importance of coastal and inland waters is timely for a number of different reasons. Stabilization of wild fish catches has led to an increased dependence on aquatic farming, which is being seen as the next best alternative to meet the short fall in demand for aquatic foods. Such developments if done on an *ad hoc* basis will soon be counterproductive and could have long term negative impacts on sustainability, and will go to prove the stance of the current skeptics on aquaculture as food production sector contributing to poverty alleviation. There is a need for decision makers to be made aware that such *ad hoc* developments are not the solution to the problem, but developments based on lessons learned from past successful experiences, suitably modified and adapted is a more effective way to proceed. It is regrettable that such "show casing" under one banner is hard to find. The present initiative aims to fill this gap in the interim and then carry forward the strategy in the long term in respect of aquaculture.

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Bio-security and Health Management in Aquaculture

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Abstract

Intensive aquaculture practices tend to provide a platform for the emergence of serious pathogens, while global trade in live aquatic animals and their products offer avenues for trans-boundary spread of pathogens. To ensure good bio-security plan at the national level it is very important that countries establish and implement practical national aquatic animal health strategies. Implementation of a comprehensive national aquatic animal health strategy would significantly assist in minimizing the impact of aquatic animal diseases and prevent introduction of exotic pathogens to the country. Farm level Biosecurity refers to approaches taken to prevent, control and eradicate serious diseases of concern to the cultured species. Biosecurity measures implemented at the farm level should have the broad objective of preventing the entry, establishment, proliferation and spread of dangerous pathogens. Farm level biosecurity can be broadly defined as sets of standard practice that will reduce the probability of pathogen introduction to the culture system, its amplification in the culture environment and cultured host leading to disease outbreak and subsequent spread. To achieve, fool proof bio-security, it is necessary to understand all the routes by which the pathogen gains entry into culture units and the farm level component causes (risk factors) which favor its amplification to levels sufficient to cause disease outbreaks.

Introduction

Globally, capture and culture fisheries contribute significantly towards food security, poverty alleviation, economic development and supporting livelihoods. The global aquaculture production in 2006 was estimated at 56.7 million tones, valued at 86.2 billion USD. Aquaculture contributes approximately 50-55 percent of the global food fish consumption and this sector is the fastest growing food producing sector. Over 92 percent of aquaculture production occurs in Asia, dominated by smallholder farmers. In most nations in Asia the contribution from aquaculture to the GDP has by-passed that from capture fisheries, and continues to be so. Asian small-scale aquaculture has the potential to meet the growing global demand for food fish and to contribute to the growth of national economies, at the same time providing support to sustainable livelihoods of many rural communities, contributing significantly to food security and poverty alleviation. The sustainability of the small-scale aquaculture sector is socially and economically important to many countries in Asia, including India. However, with increasing impacts of globalization small-scale aquaculture farmers need access to scientific knowledge, financial and technical services and market information in order to sustain their livelihoods and compete in modern market chains. The demand for quality and responsibly produced and certified aquaculture products is predicted to increase substantially in coming years. Present market trends are imposing several constrains on small aquaculture farmers and the social and economic implications of current direction in many rural communities are expected to be potentially severe. It is generally accepted that aquaculture needs to be developed in a manner that is economically, socially and environmentally sustainable. There are several challenges that need to be holistically addressed in order to promote sustainable aquaculture development. The present paper focuses on just one of the challenges - aquatic animal health.

International trade

Intensive aquaculture practices tend to provide a platform for the emergence of serious pathogens, while global trade in live aquatic animals and their products offer avenues for trans-boundary spread of pathogens. The risk of pathogen transfer is generally considered greater for movement of live aquatic animals than for movement of dead product. Irrespective of disease risks involved, aquaculture and global trade will continue to intensify and expand. The WTO-SPS Agreement sets out the basic rules for food safety and animal and plant health standards. The basic aim of the SPS Agreement is to maintain the sovereign right of any government to provide the level of health protection it deems appropriate, but to ensure that these sovereign rights are not misused for protectionist purposes and do not result in barriers to international trade.

Aquatic Animal Health

Infectious diseases are still considered as one of the serious challenges to sustainable aquaculture in many parts of the world, including Asia. In Asia, diseases of aquatic animals and bio-security measures for managing risks of aquatic animal disease outbreaks have received less attention than livestock diseases. This is despite the fact that Asia is a major exporter of aquatic animal products annually worth several million US$. Aquaculture (e.g. shrimp, scampi, carp and catfish) already makes a significant contribution to rural development, poverty reduction, food security, economic development and trade throughout Asia, and can make further substantial contributions.

The epidemic spread and devastating impacts of aquatic animal diseases such as epizootic ulcerative syndrome (EUS) in freshwater fish; viral nervous necrosis (VNN) in marine fish; white spot syndrome virus (WSSV) in penaeid shrimps; white tail disease (WTD) in *Macrobrachium rosenbergii* and the emerging Taura syndrome virus (TSV) and Infectious myonecrosis virus (IMNV) in *Penaeus vannamei;* in Asia have clearly demonstrated the vulnerability of aquaculture systems to infectious disease emergencies. More recently, the widespread mass mortalities of koi and common carp in Indonesia and Japan due to infection with koi herpes virus (KHV) have re-emphasized the impact that emerging diseases can have on local economies and sustainability of the aquaculture sector. The increasing globalization and trade volume of the aquaculture sector has created new mechanisms by which pathogens and diseases may be introduced or spread to new areas. Known and unknown disease problems may arise quickly in any country's aquaculture sector, often with serious economic, social and ecological consequences, but may be difficult or impossible to eliminate once established.
Some of the key disease control strategies applied globally include;

- Preventive and prophylactic strategies (e.g. vaccination)
- Specific pathogen free (SPF) and specific pathogen resistant (SPR) based aquaculture systems
- Implementation of national aquatic animal health strategies
- Biosecurity programs
- Epidemiological approaches
- Risk analysis and management
- Rapid diagnostics
- Early warning surveillance
- Co-operative industry-wide efforts

Bio-security

Biosecurity is a new term for an old concept. There is no single definition for biosecurity. However, biosecurity can be defined as a set of standard scientific measures, adopted to exclude pathogens from culture environment and host and, more broadly, to limit pathogen establishment and spread. Some concepts vital for biosecurity are identification of pathogen entry routes, quarantine and screening of hosts introduced in the system, disinfection at defined critical control point, restricted access and identification of risk factors which favour pathogen establishment and spread. A biosecure system could therefore be based on specific pathogen-free stocks, including enclosed, reduced water-exchange/increased water-reuse culture systems, biosecure management practices, and co-operative industry-wide disease control strategies.

Most likely all farmers want to operate a biosecure system. However, the extent to which the principles of biosecurity can be applied strongly depends on the type of culture system. Biosecurity may be easy to adopt and implement in land based systems which are under cover and in closed aquaculture systems. On the contrary, applying principles of biosecurity in small-scale, extensive, open farming systems may be difficult. Open farming systems with regular water exchange and with little, if any, control over pathogens or carriers entering the pond, still contribute to the major share of fish and shrimp produced in Asia. Discussions on bio-security can be considered at two levels; national and farm.

Bio-security at the National level

Intensive aquaculture practices tend to provide a platform for the emergence of serious pathogens, while global trade in live aquatic animals and their products offer avenues for trans-boundary spread of pathogens. To ensure good bio-security plan at the national level it is very important that countries establish and implement practical national aquatic animal health strategies. Implementation of a comprehensive national aquatic animal health strategy would significantly assist in minimizing the impact of aquatic animal diseases and prevent introduction of exotic pathogens to the country. The following section provides a brief insight into some of the key components that are essential in a national strategy to ensure bio-security at the national level.

Competent Authority (CA):

A CA as mentioned in the OIE’s *Aquatic Animal Health Code* means the National Veterinary Services, or other Authority of a Member Country, having the responsibility and competence for ensuring or supervising the implementation of the aquatic animal health measures recommended in the OIE’s *Aquatic Animal Health Code* (e.g. issuing health certificates, disease surveillance and reporting, quarantine, risk analysis, zoning). Key institutions identified under the CA should have the capacity and expertise to develop national policy and legislation and support implementation of various elements contained in the national strategies on aquatic animal health management and bio-security. The CA must ensure effective networking and communication with relevant institutions and stakeholders for the purpose of implementing effective national aquatic animal health strategies.

Legislative Support:

Legislative support in the form of written legal documents outlining the powers of CA to facilitate implementation of national aquatic animal health strategies, is very important. The laws in aquatic animal health should cover aquatic animal movement, import-export, quarantine and health certification procedure, destruction of diseased stock, compensation, etc. Countries that have environmental or conservation policies or regulations, which impact upon the movement of live aquatic animals, must take these policies and regulations into consideration when framing separate aquatic animal health protection legislation. Legislation that covers aquatic animal health issues must also clearly address jurisdictional responsibility and ensure that it is consistent with international standards and obligations (e.g., the OIE‘s *International Aquatic Animal Health Code* and the World Trade Organization’s *Agreement on the Application of Sanitary and Phytosanitary Measures* (SPS Agreement)).

National Advisory Committee:

The National Advisory Committee for Aquatic Animal Health is a forum for communication and coordination among government, academia, industry, private sector and other concerned groups for consideration of issues of aquatic animal health, disease control, and welfare. The objective of establishing a national advisory committee is to provide a formal mechanism to drive the process of national strategy development and implementation. Members of such a committee should have a broad understanding of the concept of health management. They should be also aware of the negative consequences of not having a national strategy on national economies, trade and livelihood of fish farmers. Among others, the benefits of having national committee include:

- It highlights the importance a country places on aquatic animal health;
- It provides a formal framework and process to drive the development and implementation of national strategy;
- It identifies roles and responsibilities of different stakeholders;
- It ensures some degree of implementation of aquatic animal health programmes
- It provides for wider participation and ownership to different institutions

National List of Diseases:

The National List of diseases is a tool to collate and disseminate information on diseases of national importance for the purpose of developing national disease control strategies, and complying with regional and international disease reporting requirements. Having a National List of diseases, allows the development of national strategies (e.g. surveillance, contingency planning) around some of these diseases. While developing a national list, considerations must be given to some of the following key criteria:

- Cultured and traded species in the country
- Economic impact of diseases on farmers and national economy
- Diseases exotic to the country
- Diseases present in neighboring countries in view of shared water sheds and porous land boarders; and
- Existing international (OIE) and regional (QAAD) disease lists

Surveillance and Disease Reporting:

Surveillance is defined as a systematic collection, analysis and dissemination of health information of a given population of aquatic animals and is an ongoing process involving handling of health information from different sources, including surveys. Surveillance is not same as surveys. Passive (general) surveillance is the collection, analysis and dissemination of existing disease information. It includes all the routine disease investigation activities that may be undertaken in a country/state such as field investigations of disease incidents and results of laboratory testing. It is important that passive surveillance is undertaken on a continuous basis throughout a country/state and that the disease information produced is effectively captured, analyzed and used for mounting an early response. Active surveillance (targeted surveillance) refers to active collection of disease data following a structured surveillance design, often targeting specific diseases. Active surveillance collects specific information about a defined disease or condition so that its level in a defined population can be measured or its absence reliably substantiated. Disease surveillance should be an integral and key component of all national aquatic animal health strategies. This is important for early warning of diseases, planning and monitoring of disease control programs, provision of sound aquatic animal health advice to farmers, certification of exports, international reporting and verification of freedom from diseases. It is particularly vital for animal disease emergency preparedness. Information generated from surveillance systems must be housed in a national database, from where the CA will be able to make use of the surveillance data for the purpose of implementing national disease control programs or for meeting regional and international disease reporting obligations.

Implementation of surveillance systems will directly and indirectly contribute to improved disease diagnosis, better research collaborations, reliable advice to primary producers, capacity building at the level of extension workers and primary producers, development of an early warning and emergency preparedness system.

Disease reporting and information sharing can go a long way in minimizing the impact of serious aquatic animal health emergencies. By international agreement, diseases listed by the OIE should be reported by member countries and are subject to specified health measures that are intended to limit disease spread and assure sanitary safety of international trade in aquatic animals and their products. The NACA/FAO/OIE Quarterly Aquatic Animal Disease (QAAD - Asia-Pacific) reporting system lists all diseases listed by the OIE plus diseases of concern to the region. The information generated through the regional reporting system, participated by 21 countries, provides information on important diseases in the Asia-Pacific region and also serves as an early warning system for emerging pathogens (e.g. KHV, TSV).

Emergency Preparedness and Contingency Planning:

A disease emergency exists when a population of aquatic animals is recognized as undergoing severe mortality events, or there is otherwise an emerging disease threat where urgent action is required. Infectious disease emergencies may arise in a number of ways, including: introductions of known exotic diseases, sudden changes in the pattern of existing endemic diseases, or the appearance of previously unrecognized diseases.

A contingency plan is an agreed management strategy and set of operational procedures that would be adopted in the event of an aquatic animal disease emergency. This should be developed during “peace time” (i.e. not at time of emergencies). When there is an emergency, the response should proceed according to the plans that have been developed. For effectively dealing with aquatic animal health emergencies, governments should have the capability to develop contingency plans and build the required operational capacity to effectively implement the plan. Through a well-documented contingency action plan agreed upon by all major stakeholders, it would be possible to minimize the impact of an aquatic animal disease emergency. Mere establishment of contingency plan without appropriate skills and capacity development would be of little value.

The aim of early warning is to allow the recognition of a potential threat and a rapid detection of a disease emergency. For establishing an effective early warning program, a strong technical capability is fundamental in the areas of disease diagnostics, disease surveillance, epidemiological analysis, aquatic animal health information systems, national and international disease reporting and information communication and sharing. Early response is identified as all actions that would be targeted at rapid and effective eradication/containment/mitigation of an emergency disease outbreak. The responses may be of different types depending on the disease agent and the likely impact. Operational capabilities at different levels (farm/village/province/national) is vital to mount an effective early response.

Quarantine and Health Certification:

Quarantine is defined as maintaining a group of live aquatic animals in isolation with no direct contact with other aquatic animals, in order to undergo observation for a specified length of time and, if appropriate, conducting tests and treatment, including proper treatment of the waste waters. Quarantine process involves pre-border, border and post-border activities including, pre-movement certification, movement, confinement on arrival, checking during confinement, releases, and subsequent monitoring as appropriate. The purpose of applying quarantine measures is to facilitate trans-boundary trade in living aquatic animals, while minimizing the risk of spreading infectious diseases. An effective system of quarantine measures also increases protection of surrounding resources (e.g., harvest fisheries, non-exploited species and other components of the environment).

Health Certificate is a certificate issued by the Competent Authority of the exporting country attesting to the health status of a consignment of live aquatic animals. A Health Certificate is a legal document which is used especially for the purpose of applying quarantine measures in trans-boundary trade of live aquatic animals and their products, for minimizing the risk of spread of infectious diseases. Health certification is also one of the strategies aimed to protect the natural environment and native fauna from the deleterious impacts of exotic species and/or diseases. Because of the diversity of species, the purposes for which the aquatic animals are being traded (import-export, local market), and other variable factors, HC should be comprehensive and be able to accommodate all the required information. Model health certificates are provided in the OIE Code

Import Risk Analysis:
The importation of live aquatic animals always involves a degree of disease risk to the importing country. Import Risk Analysis (IRA) is the process by which hazards (e.g. pathogens) associated with the introduction of a

particular animal are identified, the paths and likelihood of introduction and establishment are described, consequences are defined and management options are assessed. The results of these analyses are communicated to the Competent Authority and stakeholders (Importer/exporter). Typical risk analysis process involves four components: hazard identification, risk assessment, risk management and risk communication. Import decisions based on scientific risk analysis will minimize the risk of introducing exotic pathogens to the country.

Zoning:

Zoning is a program for delineating areas within countries on the basis of aquatic animal disease status. The advantage of zoning is that it allows for part of a nation's territory to be identified as free of a particular disease, rather than having to demonstrate that the entire country is free. In the past, outbreaks of disease could impact on trade from the entire country, but by zoning, restrictions may only apply to animals and products from the infected area. Zoning is particularly helpful for diseases where eradication is not a feasible option.

Bio-security at farm level

Biosecurity refers to approaches taken to prevent, control and eradicate serious diseases of concern to the cultured species. Principles of biosecurity are normally considered for only dangerous pathogens. For any disease to occur, the pathogen should be able to gain entry into the culture system, through air, water, or land. Biosecurity measures implemented at the farm level should have the broad objective of preventing the entry, establishment, proliferation and spread of dangerous pathogens. Farm level biosecurity can be broadly defined as sets of standard practice that will reduce the probability of pathogen introduction to the culture system, its amplification in the culture environment and cultured host leading to disease outbreak and subsequent spread. To achieve, fool proof bio-security, it is necessary to understand all the routes by which the pathogen gains entry into culture units and the farm level component causes (risk factors) which favor its amplification to levels sufficient to cause disease outbreaks. In the case of serious pathogen disease outbreak (e.g. WSSV), damage control should be the only post-outbreak goal. Isolation of affected farm, removal of hosts, effective disinfection programs, early warning systems and co-operation of processors in avoiding contamination would help to contain the spread of the pathogen.

Good biosecurity programs with external and internal barriers are vital to maintaining healthy animals and to reducing the risk of acquiring diseases in a farm. External barriers prevent the spread of pathogens onto and off a farm. Internal barriers prevent the spread of the pathogen within a farm. Adoption and implementation of principles of good bio-security program can minimise the probability of pathogen introduction considerably. Pathogens, which are endemic and well established in diverse hosts find their way into farms, despite the best bio-security measures. It is well known that mere presence of pathogen (necessary cause) alone will not lead to disease outbreaks. Identification of farm level component causes (risk factors) through epidemiological studies and their effective management would help prevent disease outbreaks despite the presence of the necessary cause.

Application of principles of biosecurity will depend on the types of culture systems. It may be easy to adopt and implement in land based systems which are under cover and in closed aquaculture systems. The practicalities of applying principles of biosecurity in open farming systems may be difficult and needs to be viewed from a different perspective. Identification and quantification of relative risks associated with each possible route of pathogen entry into the farms through epidemiological studies help to target resources only to the main risks, to make biosecurity measures cost effective at the farm level.

Bio-security principles for preventing pathogen entry

Possible pathogen carriers include infected hosts (e.g. seed, broodstock, vectors, intermediate hosts, reservoir hosts), non-host biological carriers (e.g. birds, dogs, insects, other predators, human beings) and fomites (e.g.

water, vehicles, buckets, shoes, nets, clothing). Pathogen carriers could enter the culture system through waterborne, airborne and overland transport routes. Waterborne transport may include contaminated water (e.g. pond effluents, processing plant effluents) and natural hosts in water. Airborne transport (e.g. migratory birds, insects, wind) of pathogens is a concern in open farming systems without cover. Overland transport (e.g. human beings, animals, vehicles, farm equipment) is often the most common route of introducing the pathogen to the culture system.

Several generic approaches are available to prevent the entry of pathogens and their carriers to the pond and the farm. Pathogens entering through the waterborne route can be minimised through (a) site selection to avoid contaminated sources, (b) water use reduction, (c) closed systems, (d) water treatment, (e) screens and filters at water intake point, (f) use of disinfectants, (g) reservoirs, and (h) switching over to ground water and subsurface wells. Risks from airborne route can be reduced by (a) siting the farm away from other farms and aquaculture waste dumps, (b) placing covers over the ponds, (c) indoor rearing, (d) bird deterrence programme, and (e) control of insects. Pathogens gaining access overland can be prevented by (a) screening of hosts used for culture, (b) placing restrictions on visits and access by installing perimeter fencing, (c) adopting strict sanitary measures for visitors, farm staff (foot dips, hand hygiene, protective clothing) and vehicles (wheel dips), (d) placing restriction on movement of farm tools and equipment (nets, buckets, aerators, etc), and (e) by restriction on movement of cultured organism between ponds and farms.

Implementing strict biosecurity measures at the farm level can be very expensive and may not be feasible in open farming systems. Identification and quantification of relative risks associated with different pathogen carriers and routes of entry through epidemiological studies would help to target resources to the main risks, in order to make biosecurity measures cost effective at the farm level. Biosecurity measures will be adopted at the farm level only if they are shown to be effective in preventing the occurrence of the disease and at the same time cost effective for the farmer.

Approaches to promote adoption of biosecurity concepts by small-scale farmers

Lapses in farm level biosecurity can be seen at every stage of the culture operation in many countries of the Asian region especially in low-input, extensive farming systems. These may include: improper pond preparation, lack of water treatment, stocking of unscreened seed, sharing of farm equipment and labour between ponds, unrestricted access, and absence of disinfection programmes. Lapses in biosecurity, following a disease outbreak (e.g. improper disposal of WSD affected shrimp, release of contaminated pond effluents, lack of post outbreak considerations) could have major negative consequences to ponds and farms in the vicinity.

Awareness and capacity building of farmers on farm-level biosecurity concepts should be taken up on priority. System specific and cost-effective, better management practices (BMPs) incorporating principles of biosecurity should be developed, demonstrated and validated.

Conclusion

Strong national commitment and continuous awareness and capacity building at producer, disease support and decision making levels are critical for ensuring effective implementation of an effective biosecurity program. Countries should consider strengthening national aquatic animal health networks, make effective use of the existing information (e.g. research publications, reports of research institutions, reports in meetings and conferences, reports of private sector laboratories), improve communication between Competent Authority (CA) and aquatic animal health personnel, build capacity and awareness on diagnosis, develop and implement BMPs and implement simple and practical surveillance systems.

Knowledge at the bottom of the pyramid

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Abstract

Commonsense and curiosity are considered as the two essential requirements for a researcher. While the culture and beliefs determine the extent of application of these two inherent qualities available with every individual, in recent years, it is recognized that agricultural development would become a success only when farmers are encouraged to use these inherent qualities aptly and encourage them to develop technologies appropriate to their resources and environment.

Innovation is defined as something new that has been started and practiced successfully by farmers on their own initiative. New is defined as something unknown to the locality, but not necessarily new to the world. Innovation is a strategy adopted by all living organisms including human race. Necessity is the mother of all innovations and innovation is the foundation for survival and sustainability. As the livelihood necessities of the poor being high, they are compelled to constantly innovate to improve their livelihoods. When the farmers are given knowledge and skills, they do not adopt the technology, but they adapt it, based on the resources available as well as economic viability.

Innovations of farmers have laid good foundation for aquaculture development in many Asian countries. In both China and India where aquaculture has long history and tradition, the role of farmers in innovating culture practices and seed production techniques are highly visible. There is need to bring change in the mindset of research and development personnel who have specialized in transfer of technology model for the past two-three decades to farmer participatory research. However, it should be noted that "Research by farmers" in the field can't replace laboratory research by researchers. However, isolated research by researchers without partnering with farmers will not bring desired benefits to farmers.

Development involves application of research findings in the field. Each farmer's resources, environment and social conditions being different, it is essential that each of them apply the technology and modify it to suit to their conditions. Farmer participatory research concept is gradually becoming popular in view of the increasing success in all places of its application by understanding the spirit of innovation.

Background

"Innovation is celebration," said Dr. A.P.J. Abdul Kalam, former President of India, during the inauguration of the Convention of National Innovation Foundation (NIF). The NIF, established by the Government of India, is probably the first organization that recognizes, honours and promotes innovations at the grass root level. The keynote address delivered to the convention by Dr. R.A.Mashelkar, former Director General of India's largest science organization, CSIR (Council of Scientific and Industrial Research), adequately highlights the need for such an organization and recognition. In his address, he said '... **today we are honouring those unsung heroes who are not scientists, but whose creativity is no less than that of the scientists. They are not scientists and**

they do not work in our formal laboratories like the National Physical Laboratory; they work in the laboratories of life. They are not formally trained in scientific analysis, but their powers of observation, analysis and synthesis are no less than those of formally-trained scientists.' The annual platform created to scout the innovation has been attracting more and more people with each year passing. This clearly reflects the unexploited potential of billions of people who continue to innovate on a daily basis to improve their livelihood.

Why do researchers innovate

Researchers innovate essentially as part of their job responsibilities. In many parts of Asia, jobs are not chosen based on the likes and dislikes and often one is compelled to accept a job for survival as there are not many choices. As a result, often those who may not have the passion for research also enter into research career and in many cases; such persons reach the top position to manage the research institution because of various reasons. The impact in such a situation can only be left to imagination.

Dr. R.A.Mashelkar, an able scientist who grew up studying under the streetlights of Bombay managed the country's largest scientific institution, known as the Council for Scientific and Industrial Research and has brought changes in such a way that knowledge is protected and flourished. The workshop organized by the Network of Aquaculture Centers in Asia-Pacific (NACA) and the Food and Agriculture Organization of the United Nations (FAO) to identify the research priorities for Asia noted that leadership is the major issue confronted in the management of many scientific institutions in Asia. As a result, there is a mismatch between research on aquaculture and aquaculture production of various countries (Chua and Tech, 1990).

Why do farmers innovate?

It is said that innovation is a strategy adopted by all living organisms. Man being the known intelligent living creature has also been innovating for survival. Enormous wealth of knowledge created in agriculture by farmers is an example that farmers have been innovating to develop technologies that would help them to produce food essential for survival. However, education created different classes in the society and agricultural education, in particular, segregated graduates from farmers to live in an isolated environment to innovate on issues that do not truly reflect the field problems. Increased population and famine made people in power to search for easy solutions that would help produce adequate amount of food. In the process of glorification of the research of educated persons, the innovations of farmers were completely ignored and often it was ridiculed that how an illiterate farmer can innovate. However, farmers continue their innovation on everyday basis for survival and to improve their livelihood systems. Sir Peter Mademeyer, a Nobel Laureate in his book entitled "An Advise to Young Scientists" considered common sense and curiosity as the basic qualities essential for researchers. Farmers having abundance of these two qualities have been innovating and will continue to innovate as it is a basic necessity (Chambers, 1980).

Evolution of farmer participatory research

Farmers undertake innovations as a necessity driven by economy to earn the livelihood necessities (Reij. and Bayer, 2001; Bibbs and Edward, 1981) Hence, whatever knowledge intelligent farmers gain either from researchers or development agents are always tested and verified before it is integrated into their farming operation. Even after integration, these intelligent farmers continue innovations year after year in order to make sure that operation efficiency of the activity is improved and economic loss does not occur (Chambers. Pacey, and Thrupp, 1989: Yohannes 1998). This basic principle adopted by farmers has sustained aquaculture development in many parts of Asia with some countries having several centuries of history in aquaculture.

Increasing population pressure and livelihood necessities have made farmers to adopt some of the farming practices invented by researchers or imported by them from elsewhere to address the problems encountered (Nandeesha, M.C. 2007). Green revolution technologies adopted in India and in several other parts of Asia are the best examples to show how farmers addressed food security concerns in the last century. Unfortunately, those technologies called for heavy usage of chemical fertilizers and pesticide. Such practices caused enormous amount of damage to the environment and ecology of the local areas. Health hazards including increasing incidence of some of the most incurable diseases like cancer are attributed to the heavy usage of pesticides in parts of India like Punjab and Kerala.

Recognizing this major environmental impact from usage of high amounts of inorganic fertilizers and pesticides, the FAO initiated a major programmed on Integrated Pest Management (IPM) through farmer participation in Indonesia. The basic philosophy of the IPM is to recognize the innovative potential of farmers and to educate them on the process of self-discovery based on the knowledge of the ecology of paddy fields. Farmers are encouraged to conduct simple experiments that will help them understand the benefit of wise use of knowledge not only in solving problems that they have been encountering, but also in finding new applications to improve the environment and economy. Indonesia, with the active participation of both men and women in large-scale field trials, over several years have shown the benefits of education and innovation by farmers. There are several farmer field schools (FFS), which started as learning centers and have now been transformed into action research centers where farmers undertake their own research program to solve location- specific problems. The success of Indonesian experiments encouraged the IPM concept to be applied to several other crops including vegetables, cotton, etc. Considerable success has now been achieved to conclusively prove that it is possible to produce agricultural crops without the heavy use of inorganic fertilizes and pesticides. It is likely that this century will witness the gradual return of large areas into organic farming activities over a period of time. Bangladesh experimented the concept of IPM through the Cooperative for Assistance and Relief Everywhere (CARE), an international non- governmental organization (NGO) which operated several projects and created several thousands of FFS in various parts of the country to promote the concept of IPM. Most interestingly, CARE also carried out sustainability studies in areas where the project was implemented and withdrawn. Such sustainability studies have shown that while some farmers went back to the earlier farming practice of using pesticides, etc., in several areas one of the most sustained activities that was witnessed was the rice-fish farming activity. In fact, since farmers were able to get the dual economic benefits of saving money on pesticides and increasing profits from the culture of fish in rice fields, other farmers have been influenced to continue this new activity.

In all the areas where the concept of IPM has been promoted, the basic principle used is the discovery process and innovations by farmers. The work carried out with several thousands of farmers particularly in Bangladesh, Indonesia, the Philippines and several other Asian countries demonstrated that when the farmers are given confidence, they are able to undertake innovations and find solutions to the problems with least cost and most efficiently.

Shrimp farming in Asia

What was experienced in Agriculture due to intensive use of fertilizers and pesticides is now experienced by the shrimp culture industry. Intensification of the culture practices with least regard to environment resulted in several problems including the emergence of various diseases. As a result, small and marginal farmers had to face many challenges. This resulted in the loss of livelihood to several thousands of farmers all over Asia. In the other presentations in this TOT, you would hear about how this shrimp farming has been gradually recovered through farmer innovation process. In this talk, the focus would be on how to mobilize the farmers and get them engaged in research with some examples that clearly demonstrate the past proven track record of farmers in innovations.

Promoting farmer participatory research and participatory technology development

To promote farmer participatory research or participatory technology development, there has to be major change in the organizational culture to facilitate the process. These include

(a) Flexibility in the implementation plans so that necessary changes could be brought according to the field necessities.

(b) Decentralized decision-making process in order to ensure that field staff does not have to wait for the decision always from the top.

(c) Regular evaluation of the activities in order to make necessary changes

(d) Regular evaluation of field staff to assess their plans, commitments and goals

(e) Log term strategies to involve staff and build their capacity

(f) Searching development of new technical options or opportunities.

(g) Efficient development of the system for collection of information, analysis and storage.

(h) Sufficient allocation of finance and human resources for intervention.

As could be visualized for the list of above requirements, unless there is change in the way of thinking process and promotion of grass root people involvement in the innovation process, it would not be possible to promote farmer participatory research.

Networking

In order to have effective exchange of information and facilitate the process of sharing of information, it is very important that there is effective networking by the facilitator. Such networking with research, development and farmer organizations helps not only to avoid duplication of efforts, but probably distribution of efforts and sharing of knowledge to improve the efficiency of operation. Hence, networking with all such intuitions would bring greater benefits. Here are some examples for such useful institutions.

- Research organizations
- Development institutions
- Farmer organizations
- Other relevant institutions

Role of field staff

The field staff needs to have clear understanding about their role to prevent themselves carrying out the work or dominating the process.

As a facilitator: In developing participatory action learning session

As a net worker: Assist in developing link with fry traders / hatchery owners

As a teacher / trainer: Assist people whenever they need clarification or support in better understanding the situation.

As a co researcher: In helping to set up the trial

As an advisor or consultant to help the farmer in the investigation process

Communication and understanding perception capability of the staff

This particular attribute will have greater influence on the project outcome. It is suggested that there should be

- Two way communication /discussion with participants
- Listening carefully, objectively and neutrally
- Understand the underlying cause, research
- Observe and understand the extent /context and analyse

Field staff has to consider the following facts of rural life

- Farmer's livelihood complexity
- Traditional, indigenous knowledge prevailing
- Farmers own criteria / indicators in judging and assessing the situation
- Conflicting interest of different stakeholders / resource users
- Cultural issues, factors and values

Different types /levels of farmer participatory research

The technology development could be at different scales

- Contractual – renting land for conducting trial
- Consultative – identify the problem with discussion with the farmer and then design and implement the trial by the researcher on the station.
- Collegiate – identify, design, implement monitor and evaluate jointly
- Associates – After phasing out when a group of farmers carrying out PTD process, capable enough to conduct trials systematically and exchange findings with researchers

Preparation for intervention in the field

Before making the intervention, it is important that proper steps are taken in choosing the area and building necessary rapport with people. Following steps would help in making effective intervention.

- Area selection
- Secondary data collection
- Inventory of other organizations / projects working in the area
- Orient the community about the project

- Rapport building
- Working strategy procedure through discussion and common understanding and consensus of the target people.

Understanding the local agricultural problems opportunities

- Using PRA tools like through focus group discussion reflect on local agricultural patterns and constraints experienced.
- Assist farmers to analyse their problems and causes by using PRA tools
- Analyse the extent of problems in terms of agro-ecological and socio-economic context
- Generate list of potential resources, opportunities, and ideas

Identify research and development issues

Prioritize the identified problems – collect information on the identified problems.

- Identify the possible solutions / options against the prioritized problems
- Possible solution options may generate from – local knowledge; expert farmer; outside the locality
- Analyse the possible solutions /options in the local context
- Develop understanding on testing the potential solution /option
- Hypothesize the development with farmers

Experimentation

Following the steps indicated below in setting up the experiment would avoid potential problems.

- Review the farmers existing experimentation practices
- Based on that design the experiment
- Define the experiment evaluation indicators and develop monitoring and evaluation tools
- Train farmer researcher
- Establish and manage experiment with farmers
- Assist farmers to monitor the experiment
- Assist farmers in evaluating the experimental results
- Review the experiment results, experience and develop the next action plan based on the experience

Limitations of farmer's experimentation

There are several limitations in farmer participatory research. These limitations should be kept in mind while designing and implementing farmer participatory research

- Undirected experimentation

- Lack of analytical approach
- Poor experimental design (e.g. replicates, controls, etc)

Result sharing: Farmer to farmer extension

Study the existing farmer-to-farmer information sharing practices and strengthen the exiting systems

- Through arranging cross visits
- Through arranging learning by doing on farmers farm
- Through development of audio-visual training aids for farmers by the farmers
- Development of farmer extensions /promoter at grass root level through training / guidance

Sustaining the process

- Inspire farmers to form formal groups and link them to central farmer organizations
- Train in-group management and group development
- Link the framer groups to extension services
- Advocate at national level for policy support to PTD process. Provide institutional support
- Document the process, experimentation methods, and extension systems
- Assess the impact of technology and the process on the livelihood of people

Farmer innovations

To enable us to understand the innovative potential of farmers, let us examine some of the inventions made by the farmers with the commodities that are covered under the ASEAN project.

Problems of farmer participatory research

There are several constraints in implementing farmer participatory research

- It takes a longer time to establish contacts, build relationship and win the confidence of farmers.
- Farmers may be motivated to undertake research in anticipation of benefits
- Farmers always anticipate quick results and prefer short cuts
- Literacy level being low in many instances, record keeping is a major challenge

It is important to note that farmer participatory is not the solution for all problems and essential precaution must be taken to advocate farmer participatory research as a solution to various problems (Bentley, 1994)

Innovations in tiger shrimp:

The farmers in Kerala, India, developed shrimp farming along with other finfishes in the brackish water areas of this state. During the monsoon, a salt tolerant paddy, known as Pokkali is grown. After the harvest of paddy, shrimp farming is undertaken in the fallow paddy fields. The method of paddy cultivation and shrimp farming are considered to be almost organic in nature and this traditional method has been in practice for the past several decades. This method of cultivation has also spread to other neighbouring states like Goa and Karnataka. While the intensive farming of shrimps in India faced several catastrophes, the cultivation of shrimp in Pokkali paddy field, following the traditional methods remained unaffected.

Zero tiger:

The farmers in Thailand invented the culture of shrimp in fresh water. In the technique evolved in Thailand using the brine solution in the fresh water was adapted with a view to increase the salinity level to get the good growth. However, farmers in India explored the possibility of cultivating the tiger shrimp in completely fresh water by gradually acclimatizing the tiger shrimp seed to fresh water condition. This culture of shrimp in almost freshwater environment spread to wide area. Even now there are farmers who are successfully culturing tiger shrimps with Indian major carps and obtaining good amount of profits. It is important to state here that the efforts of farmers in Andhra pradesh to culture tiger shrimp in fresh water with carps was started as early as in 1980's. However, the scientific community ridiculed the efforts until such time when the culture of shrimp in low saline waters became a major development in the developed world. As all the brackish water species have the ability to tolerate salinity from near freshwater condition to highly saline environment, efforts are now made to culture several of the finfish species in freshwater conditions.

Enhancing the production of natural fish food:

Farmers in Andhra Pradesh use mollusks with other carbon sources to increase the natural zooplankton production in the pond. This enhanced production of natural food, particularly in the early phase helped to increase the survival and the growth of shrimp. It is also believed that this mixture reduces pH of water, favouring good growth of plankton with apt carbon – nitrogen ratio.

Use of substrates to enhance periphyton production

Shrimp are known to be active periphyton feeders. Enhancement of periphyton availability in the ecosystem would enhance the growth of fish. Substrate presence coupled with appropriate carbon-nitrogen balance in the water has always resulted in the increased food production and thereby growth of shrimp.

Snakeheads

The culture of snakeheads is wide spread in the Southeast Asian countries. However, breeding of these fish under captive conditions has not become successful in many countries. Hence pressure on the natural larvae produced continues. Some of the innovative farmers in Cambodia have accomplished good success in breeding of this air breathing fish by simulating natural breeding environment.

The farmers in Cambodia also prevent the occurrence of disease in snakehead by adopting some of the microbial preparations that help to keep the pond environment clean. While several farmers are suffering from disease problems, those who follow the use of microbial preparations are free from the disease.

Tilapia

In tilapia, several innovations have been made by farmers in breeding, hatchery technology, feeding, culture environment, post harvest management of the fish to retain the freshness, etc. Each of these farmer innovations have led to the improvement in the tilapia culture technology and production levels.

In Vietnam, farmers are known to collect only swim up fry from the brooding fish and allow them to develop further. Some of the hatchery operators believe that quality of the seed produced from the swim up fry rather than the collection of egg is better. In Bangladesh, farmers have learnt the technique of producing the quality seed of tilapia in paddy fields.

Farmers have also invented cages that are useful for the culture of tilapia. These cages fitted with floats have been used to produce tilapia fingerlings and in some cases using them to grow to market size.

Groupers

Farmers have developed the method of growing groupers in cages using trash fishes. The culture of fishes in cages has now become possible with the use artificial pellet feeds. There are several other local techniques that have been developed to improve the larval survival by the farmers.

Conclusion

Adoption of participatory approaches to identify the problem(s) and their causes with recognition and respect to the knowledge level of the each stakeholder should help in developing effective strategy to address the issues confronting the production systems. Once the problems are identified, there is a need to undertake good review of the current status of knowledge on the issues identified. Based on such a review, problems that would need higher level scientific input and investigation can be best handled by the scientific institutions, while the farmer based organizations can help in finding solutions to the problems through field based research. Education to farmers should focus on giving principles behind each of the technology and not the package of practices. Once the farmers are able to gain better understanding on the principles, they always explore various options with the knowledge they have gained.

Honeybee network (http://www.sristi.org/honeybee.html) established by Prof. Anil Gupta of the Indian Institute of Technology is filled with several stories on how the people at grass root level innovate to solve their problems when they have good knowledge on the subject. The central message from all the developments is very clear: good partnerships between farmers and scientists can help in solving all the problems.

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Communication and networking mechanisms for improving services to small farmers (Aceh Model)

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Abstract

The Aceh Aquaculture Communication Center (AACC) has been newly established by the Regional Centre for Brackishwater Aquaculture Development (BBAP) at Ujung Batee, Aceh, Indonesia, with assistance from the ADB funded ETESP-fisheries project. The communication centre is a new resource to support the future development of aquaculture in Aceh, and is one of the supporting structures for a network of Aquaculture Livelihood Service Centres (ALSC) providing a better interactive technical advisory service, such as disease diagnosis, information, and training services, for farmers.

Innovative approaches are essential for effective communication and networking involving farmers. This paper address how the communication center was set up and operating to provide services that farmer in Aceh need towards maintaining and expanding their livelihoods.

Introduction

The world community responded rapidly to the devastating effects of the Tsunami in December 2004 in Aceh and elsewhere. Asian Development Bank (ADB) was quick to initiate a project, “Earthquake and Tsunami Emergency Support Project (ETESP)”, with a major component on fisheries and aquaculture (ETESP-Fisheries) in Aceh, to rebuild the livelihoods of the coastal communities that were most affected.

Many technical, social and economic difficulties confront rural producers trying to rebuild their livelihoods devastated by natural calamities, despite the generosity of donors and concerns of the government. Governments, more often than not, express rehabilitation in terms of the repair or building of state infrastructure but this has limited impact unless the effected populations are assisted through their difficulties to become productive and socially organised.

The potential to improve livelihoods and reduce rural poverty through rebuilding the coastal fisheries and aquaculture in Aceh is a gigantic task. The potential lies in the formation of producer associations which could be trained with business organizational skills and would assist mitigate low productivity, to form a network for dissemination of better management practices, to negotiate better deals on inputs, to arrange credit from banks, to assist coordinated cropping and marketing of larger quantities, provide a legalised status required for investment, and to provide traceable sources for consignments of shrimp.

However, there are challenges to overcome in attaining the above. These challenges are principally are as follows:

- A need to develop a vision and a guiding policy from government which has difficulty to move from “controls” to “service” functions.
- The development of functional services available through government and private sector.
- The legal framework which promotes the formation of “producer associations” as legal entities.

- An increase in reliable productivity from traditional ponds.
- Facilitation, acceptance of awareness of concepts and modes of practices such as "Better Management Practices (BMPs)' and adoption thereof to improve yields and product quality, food safety, and reduce disease risks.
- Awareness of the increasingly stringent consumer demands of international markets in relation to food quality, traceability and sustainability
- Ability to produce the quantities and qualities demanded by buyers thereby gaining valuable income potential.
- Wider access to, and capacity of, technical, market and financial services.

In this paper the form and function of Aquaculture Livelihood Service Center (ALSC) and Aceh Aquaculture Communication Center (AACC) are presented, as it is thought that this is a novel concept that has been introduced and or experimented to ensure sustainable growth of small scale aquaculture, and would have applicability for comparable situations elsewhere.

Aquaculture Livelihood Service Centres (ALSCs)

ALSC based farmer group at sub district and district level implement and manage the aquaculture activities through participatory approach in order to accomplish their common goal of reducing risk and the maximizing profit while meeting the expected market demand through sustainable aquaculture operations. The ALSC are expected to become fully self sustaining business and technical centres for the fish/shrimp farmer through payment of services fees by the members. The member are free to obtain services from the private sector e.g. feed and fertilizer suppliers, hatcheries, shrimp exporters, private laboratories and banking services. The members of the associations would achieve benefits in purchasing inputs and marketing produce and thereby maximizing their profits and minimizing cost of production.

The activities of ALSCs are also technically supported and advised by various government agencies' staff such as the DKP- Dinas Perikanan dan Kelautan (=Marine and Fisheries Affairs Agency). The activities are coordinated by ETESP Fisheries, FAO and OISCA field facilitators and lead farmers. The engagement of the different agencies through the ALSC is mediated to collate the perceptible differences in approach. Most aqua-farmers in the respective sub-districts are active members of ALSCs. The registered members abide by the rules and regulations of ALSCs decided by the community (e.g. prohibition of the use of pesticides and antibiotics, crop planning, and a group approach to finding solutions for the various aquaculture related issues). The committee members/lead farmers and children of the farmer communities are well trained in the basics of computer operations and who in turn continue to train the farmer community/ groups at the village level. Leaders of villages in the sub-districts are also executive members of ALSC committee and it enables the ALSC to operate within the established social structure of the villages and contributes to the effective decision making. The matter of "elite capture" is ever present but countered through frequent meetings at which the farmers of all levels have democratic voice.

Group approach and linkage to stakeholders:

ALSC operations bring together aquaculture farmers and organizations from different backgrounds to work in partnership, a process that requires partners to pool their commitment of human, financial and natural resources to achieve sustainable growth of the aquaculture sector and also thereby increase aquaculture farmer wealth in Aceh Province, Indonesia.

Promoting sustainable aquaculture:

ALSC based farmer groups at the sub district and districts levels implement and manage the aquaculture activities through a participatory approach in order to accomplish their common goal of reducing risks and maximizing profits while meeting the expected market demands through sustainable aquaculture operations.

Planning activities:

ALSC centres will support farmer communities for decision making in crop planning including harmonized stocking and harvesting in collaboration with various stake holders to minimize the risk of disease outbreaks during farming and improve the overall quantities simultaneously harvested from many small scale producers, both of which are the major challenge for the farmers in Aceh.

Providing Services:

The ALSCs will also provide services such as; technical services such as for example, application and adoption of BMPs, disease diagnosis, information, training, financial services (planned), for the well being of individual farmers as well as farming communities.

Legal entities:

There are ongoing efforts by the ALSC committees to register producer associations as legally recognized entities for furthering business developments and mutual benefits to the stakeholders thereby improving the livelihoods of the aqua-farmer communities. The legal status would facilitate aqua-farmer communities' access to banking and micro finance services for improving the aquaculture production and maximizing their profits.

Taceability and Marketing:

At present, most Aceh shrimp are grown extensively and at most semi-intensively using low densities but capable of producing superior quality shrimp. Therefore there exists a strong potential for branding Aceh shrimp. However, certain practices have to be put in place through the ALSCs system in achieving this goal; these include implementing of BMPs, maintain consistent quality and quantity, establish partnership with processing plants/exporters, assuring food safety standards through record keeping and traceability system.

The challenges for the exporters are to organize group harvests at sub-district and district levels. This can be easily facilitated through farmer owned and managed ALSCs:

- Post larvae and the feed are sourced from selected suppliers through ALSCs.
- Traceability back to shrimp farms and the hatcheries through record keeping at all levels.
- Selling produce as one unit coordinated by ALSCs to one processor/exporter.
- Better Management Practices monitored by ALSC committee members to control the hygiene and safety of shrimp produced associated farmers
- All inputs are screened for banned antibiotics.

Aceh Aquaculture Communications Centre (AACC)

Aceh Aquaculture Communication Centre (AACC) is located at Brackishwater Aquaculture Centre (BBAP/Balai Budidaya Air Payau) at Ujung Bate, Aceh Besar district, NAD, North Sumatra, Indonesia. AACC was established in January 2009 with the approval of the Indonesian government, funded through ADB ETESP and technically advised by ETESP NACA. It provides information and communication services related to aquaculture direct to farmers and their associations through the ALSCs.

Formal agreement between ADB-ETESP and BBAP to delegate 8 part-time staff for efficient operation of AACC was reached on 29 April 2009. The job responsibilities for AACC staff are well described and necessary training is being provided. For further strengthening and consultation of the AACC-ALSCs operational system, there are current plans to conduct regular visits to each ALSC to establish full time permanent position for AACC operations.

Principles of AACC are to: 1) Facilitate communication between farmers and other stakeholders/partners; 2) Provide free source of information to ALSC and farmers through website, printed materials, and other communication tools; and 3) Facilitate ALSC and farmers in Aceh to access services provided by BBAP (Information, technical, disease diagnosis, and training). At this stage, AACC provides four major services and will gradually develop and improve the services including;

Information Services:

Providing information on market access; product prices, suppliers (hatchery, feed, agro input supplies). Latest articles/ information related to sea food business internally and externally. Regular dissemination of updated news and practical information about aquaculture has been initiated.

This information can be accessed through the AACC website, brochures, poster and newsletters. The interactive website, "Jaringan Petambak Aceh" (Network of Aquaculture Farmers in Aceh; www.tambak.org) will provide practical information and materials for aquaculture farmers, covering market information, extension materials, business directories and others developed based on the needs identified by participation of the farmers themselves. AACC provide online consultation and communication with ALSCs calling system online (Voice over Internet - Skype) for immediate feedback and technical advices.

Technical information service:

This service provides all technical aspect on aquaculture; information and technical consultation. Normally ALSC committee members provide the required services if within their capacity and experience. However, requests beyond their capacity are forwarded to AACC or another appropriate institution for technical assistance. As well, regular information on new technologies is disseminated to ALSCs to keep the farmers updated on the recent development in sustainable aquaculture practices. The information service is underutilized at present being newly established but records are kept of enquiries and these show a growing trend in the number of enquiries. The AACC must prove its capability to the farmers in order that the demand for the services grows.

Disease Diagnose Service:

AACC facilitates the farmers through ALSC to access laboratory facilities at BBAP centre for disease diagnosis. The diagnoses results and recommendations are sent back to ALSC rapidly to be effective and applicable. Established protocols and standard operation procedures for sample collection for water quality and disease diagnosis are provided to farmers. Fine tuning of protocols and SOP for aquaculture practices in Aceh will be further improved as development progresses. In case of serious disease outbreak, AACC staff will visit and provide practical field level solutions to farmers through meetings and this information will be disseminated to other areas for prevention of further spread of such diseases.

Training Services:

AACC conducts training based on identified needs of Aceh farmer communities through ALSCs or when new technologies become available and are ready for dissemination. The training may focus on technical aspects, business management, and other capacity building topics through lectures and/or hands-on training. For deliberation of services, AACC cooperate with training providers, such as extension unit of BBAP or other government institutes, as well as the other parts of the private sector.

Effectiveness of the ALSC-AACC model

- There is growing close coordination and collaboration between farmers at the sub-district and district levels. Considering the history of the area this itself is a breakthrough. After establishment of ALSC, farmers have improved crop planning, sharing experiences and resources through regular farmer meetings organized by ALSCs with the objective of overcoming the various issues and challenges in their practices.

- Information on disease outbreaks at village, sub-district and district level are quickly transmitted across boundaries, are well discussed and shared with other ALSCs for control of disease through a group approach.
- The farmer owned website facilitates effective communication between farmer communities and stakeholders. The website provides a platform for improving business and collaboration among stakeholders.
- Effective communication between farmer communities and government agencies, research organizations and laboratory services established. Communication gap between farmer communities and stakeholders have been reduced through ALSC-AACC operational system.
- ALSC-AACC operational systems are well explained to stakeholders through meetings/discussion groups and it helps to plan their activities based on the community needs e.g. banks, micro finance units).
- ADB/ETESP facilitated service provider meetings with input suppliers of quality materials and at discounted prices. Service providers welcome such arrangements through the ALSC system (e.g. Goldcoin feeds, Medan). To date a few exporters and processors have visited ALSC sites and started preliminarily discussions for group harvests and on processes leading to the introduction of a traceability information system (need further supports during harvest periods July-September 2009).
- Effective dissemination of BMPs was achieved through ALSC-AACC system in four sub-districts. As a result harmonized stocking and crop planning are in place, communities are enthused in harmonized harvesting and traceability for minimizing risks and maximizing profits through high level coordination with stakeholders.
- The Table below indicates the types of services sought and provided to farmers in the current system. It is evident, although the data are available only for two months, that the use of the system of communications to address farmer problems and concerns are on the rise, indicating that the system is operating to expectations.

The AACC concept is new, but together with the ALSC is expected to continue to provide necessary information and technical services to aquaculture farmers in Aceh to maintain and expand their livelihoods in this economically important rural sector in Aceh.

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Maintaining genetic quality of fish shellfish under small holder farmers in the ASEAN countries

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Abstract

This document aims to provide simple concepts and practical methods in genetic management in hatcheries. These include concepts on inbreeding, effective breeding number, genetic drift and bottlenecks and the relationship between them. The ultimate goal of genetic management of broodstock is to reduce inbreeding as much as possible and simple and practical methods to address inbreeding issue are discussed.

Aquaculture is a critical sector for food production in the ASEAN. As with other farming sectors, aquaculture production in the ASEAN is dominated by small scale farms, which are essentially family owned, operated and managed.

In some of the ASEAN countries, the seed production sector is managed by the government hatcheries (i.e. nucleus) where genetic improvement programs are undertaken, and the seed are broodstock are disseminated to a number of hatcheries (i.e. multipliers) where seed are produced and supplied to farmers. In such a system, genetic quality of the seed are managed at the nucleus level and farmers do not have to worry about genetic management aspects, provided that the genetic management scheme at the nucleus and multipliers levels are satisfactory.

However, it is also true that in many countries small scale hatcheries exist in order to support the aquaculture sector in rural areas. Examples include hatcheries for the Chinese and Indian major carps and tilapia. There is evidence to suggest that genetic quality produced by many hatcheries in the region had deteriorated. Aquatic species in general are highly fecund, coupled with the tendency of keeping a small number of brood stocks to reduce production costs would result in a rapid loss of genetic diversity.

Genetic changes in hatcheries will not only affect the performance of seed, and hence productivity, but also indirectly pose potential impacts on the wild counterparts. Special attention should be paid in the case of indigenous species where the wild gene pool needs to be conserved.

This documents aims to provide some fundamental concepts on genetic management aspects of brood stocks in hatcheries. Genetic management of brood stock involves the control of inbreeding, genetic drift and bottleneck.

Inbreeding

Inbreeding is the mating of relatives, for examples between brother and sister, between cousins, or between parents and their offspring. Although well planned and directed inbreeding can be beneficial, unintentional and unplanned inbreeding will cause problems.

Genetically, inbreeding increases homozygosity in the offspring (i.e. genetic similarity) which means it also decreases heterozygosity (i.e. genetic diversity). Homozygosity is also produced when non-relatives mate and genetically, the two forms of homozygotes are identical. Even though the two forms of homozygosity are identical, a distinction is made because of the way homozygosity is produced and its consequence.

Why inbreeding is a concern? As inbreeding increases, it often causes a decrease in productivity which is termed "inbreeding depression". Inbreeding depression is a decrease in growth rate, fecundity, appearance of deformities, etc. that is observed in the inbred group when it is compared to a control population where there is no inbreeding.

The negative effects of inbreeding usually do not manifest immediately. Inbreeding depression is often delayed (i.e. they may not occur until several generations after inbreeding has begun). How quickly inbreeding depression occurs and manifest depends on the amount of inbreeding that has been produced and the trait.

However, note that it could be erroneous to think that inbreeding is a major reason behind many of the production problems. Deformities and decrease in yield are also due to non-genetic factors such as developmental errors, toxins, nutritional deficiencies and poor water quality.

Inbreeding can be avoided by tagging animals so that parent-offspring, brother-sister and half-siblings matings can be avoided. However, tagging for large number of fish can be expensive for small scale hatcheries, as such hatcheries must manage the population as a whole to minimise accumulation of inbreeding by managing the effective breeding number (N_e).

N_e is determined by:

$$N_e = \frac{4N_f N_m}{N_f + N_m}$$

Where: N_f and N_m are number of females and males that leaves viable offspring which in turn contribute genetic material to the next generation.

Based on the above equation, N_e can be increased by two ways:

- Increasing number of number of females and males that leaves viable offspring which in turn contribute genetic material to the next generation; and
- Bringing sex ratio to 1:1.

Example 1:

A fish hatchery has 1000 brood stock, of which the managers used 900 brood stock for spawning this year. However, only 800 brood stock produced viable offspring. He uses hand-striping and artificial fertilisation technique and keeps viable offspring from all families for potential brood stock.

1. Calculate N_e in case sex ratio he used was 1:1; (Assuming his brood stock population has 400 males and 400 females)
2. What N_e would be if he used sperm from 1 male to fertilise eggs of 3 females?
3. What would happen to N_e if assuming case 1, but he sells offspring from 200 families for grow-out farmers, and only keeps some offspring of the remaining families for potential brood stock?

So what is the relationship between N_e and inbreeding? The reason we need to manage N_e is that it is reversely related to inbreeding:

$$F = \frac{1}{2N_e}$$

Where F is the percent increase in homozygosity or the amount of inbreeding produced (0-100%) in a single generation. This formula shows that when N_e decreases F increases and vice-versa. N_e that are less than 50 produce large amount of inbreeding per generation (Figure 1).

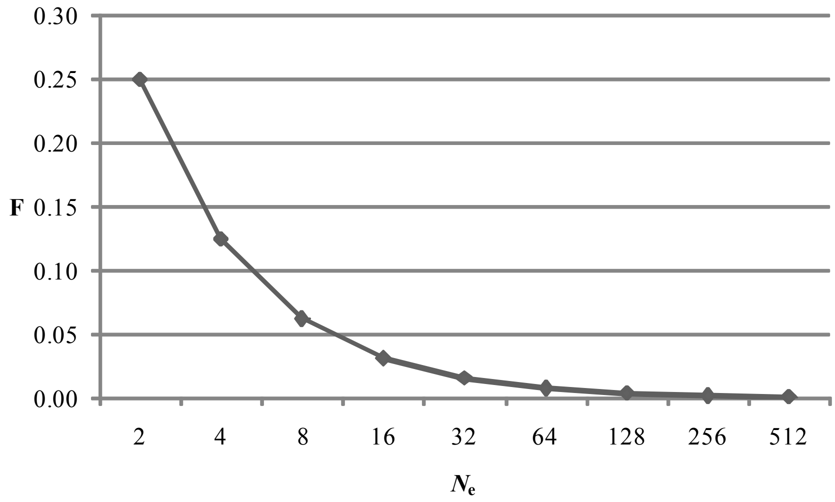

Figure 1. Relationship between N_e and F. F is the inbreeding (percent increase in homozygosity) produced in once generation in a population with no previous inbreeding.

In a closed population once inbreeding has occurred, it lowers the N_e of the next generation:

$$N_{eF} = \frac{N_e}{1+F}$$

Where N_{eF} is the effective breeding number in a closed population with F>0%. For practical purposes, the total F is produced over a series of generations can be calculated by summing the F that is produced in each generation without considering previous inbreeding.

So how large N_e should be to minimise inbreeding? There is no rule of thumb of how large N_e should be unfortunately. This depends on the purpose/goal of the hatchery (Figure 2).

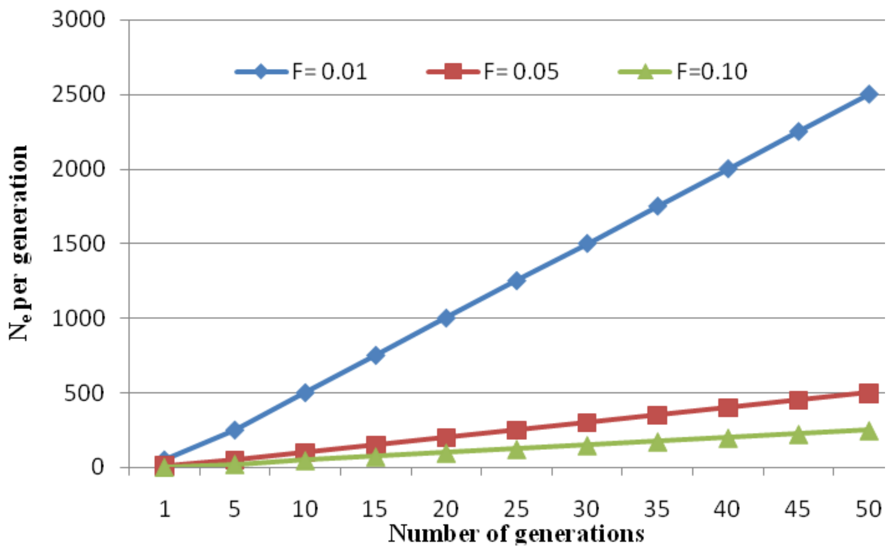

Figure 2. N_e needed per generation to produce F of 1%, 5% and 10% after 1-50 generations.

For small hatcheries, it may be difficult to manage inbreeding but they should be encouraged to do so. If hatcheries maintain a constant N_e = 50 for 5 generations, they will keep $F \leq 5\%$. This recommendation produces good short term (5 generations) management and is not excessive.
Techniques to improve N_e include:

- Increase number of brood stock that can spawn and provide viable offspring
- Keep male: female ration as close to 1:1 as much as possible.
- Apply pedigree mating: each male leaves a son and each females leave a daughter as brood stock for following generation (can be more than one but as long as all leave the same number).
- Number of offspring used for potential brood stock should be equal among families.
- Milt should not be pooled or added in a sequential manner. These practices cause gametic competition and one male can fertilise most of the eggs, producing N_e much less than expected.
- Stretch the time of replacing brood stock: The desired N_e shown in Figure 2 is given in number of generations, not number of years. If the goal is to keep inbreeding below a given value for 20 years and the normal procedure is to use a 2-year generation interval, 10 generations will be produced during the 20-year plan. But if generation interval could be stretched to 3 years, could be 7 generations would be produced during the 20 years, which means a smaller N_e could be used to achieve the desired goal.
- Procure new brood stock from a different source. If 10-15% new brood stock are introduced each generation, the amount of inbreeding can be drastically reduced.
- Maintain two unrelated populations and produce hybrids (or swapping brood stock with other hatcheries).

Genetic drift

Genetic drift is the random changes in gene frequency – changes that are not due to selection, migration or mutation. The causes can be natural e.g. a sudden raise of temperature due to fire at one stretch of the river that kills a large number of fish, or could be anthropogenic causes such as the way fish are collected as foundation population.

Genetic drift will ultimately lead to the loss of genetic diversity. When procuring fish for broodstock for example, often only a small portion of a population is collected that causes a condition called founder effect – where genetic drift creates a population in which the gene frequencies are markedly different from those of the original population.

Similar to inbreeding, genetic drift is inversely related to N_e – the smaller N_e the more chance that genetic drift changes the allele frequencies (i.e. one genetic form will be gradually lost). The probability of losing an allele via genetic drift in a single population is illustrated in Figure 3.

Recommended N_e to minimise genetic drift range from 500-5,000 with 500 being the most common. Methods to determine based on percent guarantee and allele frequencies can be illustrated in Example 2.

Example 2: You want to save alleles (frequency q = 0.01) and 95% guarantee of saving the allele (P=0.05) after 10 generations. What constant N_e is needed to achieve this goal?

- Step 1: Calculate guarantee per generation (G) that is needed to produce a guarantee after 10 generations
    - $0.95 = G^{10}$

- $G=(0.95)^{1/10}$
  $G = 0.994883803$

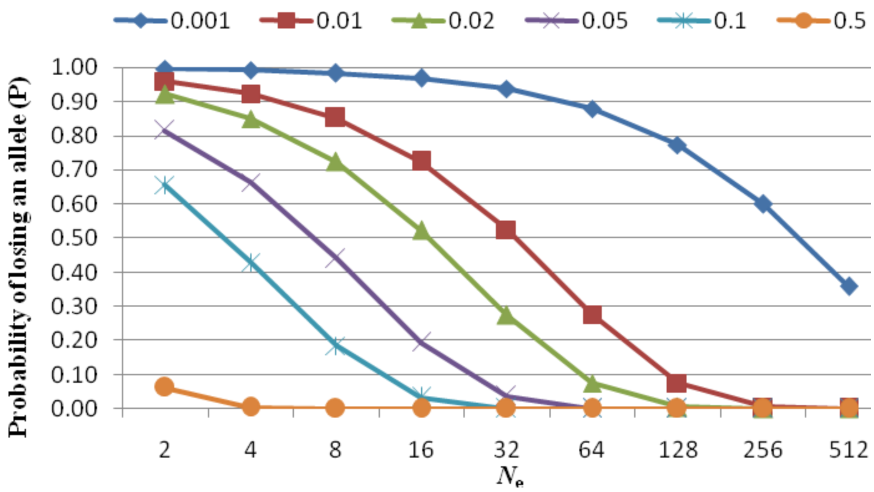

Figure 3. Probabilities of losing an allele (frequencies f = 0.001 – 0.5) for various N_e. These probabilities are for a single event (spawning season or acquisition of brood stock).

- Step 2: Calculate the probability (P) of losing allele per generation
  - Probability of losing = 1 – probability of saving
  - Probability of losing = 1 – 0.994883803
  - Probability of losing = 0.005116196882
- Step 3: Calculate the N_e that is needed to produce a P = 0.005116196882 when q = 0.01 (the frequency of the allele you are trying to save):
  - $P = (1-q)^{2N_e}$
  - $0.005116196882 = (1-0.01)^{2N_e}$
  - $N_e = 262.5$
- N_e is rounded to the next whole number, so a N_e = 263 is needed every generation on order to produce a 95% guarantee of saving an allele with frequency of 0.01 when the 10th generation is produced.

Although we do not expect the farmers to calculate the N_e in this case it is advisable that extension officers or technical workers be aware of this and help farmers in achieving the goal of the hatcheries.

Bottleneck

In practice it is difficult to maintain minimum constant N_e. Many factors conspire to occasionally reduce population size. These sudden drastic decreases in population size are called “bottleneck”. The genetic effects of bottleneck can be devastating, i.e. leading to changes in allele frequencies and inbreeding and genetic drift.

Causes of bottleneck can be any sudden changes in environment such as disease outbreaks, or flooding, or sudden decrease in temperature that take away large number of brood stock. As such in order to avoid bottleneck, care must be taken into account to avoid sudden changes in the environment that may cause severe fish kills.

Effect of bottleneck can be illustrated in the example below.

Example 3: If a farmer is trying to maintain a constant N_e of 344 for 10 generations in order to produce a guarantee of 99% for keeping an allele at frequency of 0.01 and there is a bottleneck of 25 in the 8th generation, estimate the probability of losing the allele when the 10th generation is produced.

- Step 1 and 2:

N_e	**Probability of losing allele (P)**	**Guarantee of keeping allele (1-P)**
344	$(1-0.01)^{2*344}$	0.999006852
344	$(1-0.01)^{2*344}$	
344	$(1-0.01)^{2*344}$	0.999006852
344	$(1-0.01)^{2*344}$	0.999006852
344	$(1-0.01)^{2*344}$	0.999006852
344	$(1-0.01)^{2*344}$	0.999006852
344	$(1-0.01)^{2*344}$	0.999006852
25	$\mathbf{(1-0.01)^{2*25}}$	**0.394993932**
344	$(1-0.01)^{2*344}$	0.999006852
344	$(1-0.01)^{2*344}$	0.999006852

- Step 3:

Guarantee of keeping allele after 10 generations = $(0.999006852)^{9}*0.394993932$
= 0.3915

- Step 4:

Guarantee of losing allele after 10 generations = 1 – 0.3935 = 0.6085
As such, the bottleneck of 25 at generation 8 increased the probability of losing the allele in the 10th generation from 0.01 (which was the goal) to 0.6085.

Conclusion

Genetic management in hatchery is although simple but has not been implemented adequately and scientifically in a majority the ASEAN member countries. This is because most hatchery managers are poorly trained in genetics and as such it is neglected in the hatchery development plan. Also because not many hatcheries keep record of performance of the seed they produce, the effect of inbreeding if occurred would not be able to monitor or visualised. It is essential that the importance of genetic management be recognised and action is taken at the hatchery level to ensure the long-term supply of good quality seed. Needless to say this needs to go hand in hand with good aquaculture husbandry and developments in nutrition or fish health.

Aquaculture extension and training of small scale farm - challenge and opportunities

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Abstract

Small-scale farming in developing countries is characterized by its complex and often harsh farming environment, limited farming resources, and highly personalized and diverse farming systems. Small-scale farmers are often socio-economically marginalized with little financial capacity and self motivation to accept and adopt new technology. These factors together impose a serious challenge to success of aquaculture extension and small-scale farmers' training. The problem is further aggravated with imperfect extension systems and lack of skillful extension agents. To make extension and farmers' training effective, extension approaches with better participation from farmers should be promoted and training capacity strengthened at both institutional and individual level. Extension agents should be well trained in both aquaculture technology and extension/training methods.

Extension System

The term "Extension Education" was first introduced in Britain in 1873 by Cambridge University then spread to United States of America attached as part of educational institutes in 1914 (Jones and Garforth, 1997). Extension education is different from the conventional educational institution; it is non-formal without regular classes, grades, degrees, or diplomas. The name "extension education", "extension work", or "extension" has come to be accepted generally to mean non-formal education of the rural population no matter what agency or institution administers it. Extension in aquaculture may be defined as an *organized service* and *a system* which assists people in aquaculture, *through educational procedures*, to improve aquaculture techniques, increase production efficiency and farmers' income, and improve their socio-economic conditions. Training is the most important measure used in extension for information dissemination.

Traditionally, the extension service has been given the task of acting as an intermediary between researchers and the farming community (Figure 1). The extension agent is supposed to go out to the farm, collect information about both perceived and unperceived needs of farmers, and transmit it to scientists. The scientists are then supposed to design appropriate solutions and give them to extension agents who are supposed to pass them along to the farmers (Elwell 1992; MacKay 1992).

In the traditional view depicted in Figure 1, extension is clearly the key to information flow both to and from researchers and farmers. Extension agents are expected to be half scientist and half farmer, able to pick up and understand a technical journal article, put it into the specific context of his or her target community, and then communicate the information effectively to practical-minded farmers who have limited formal education. There is no direct linkage between scientists and farmers and the success of such an extension model is largely dependent on cooperation between research and extension, and communication ability of extension agents.

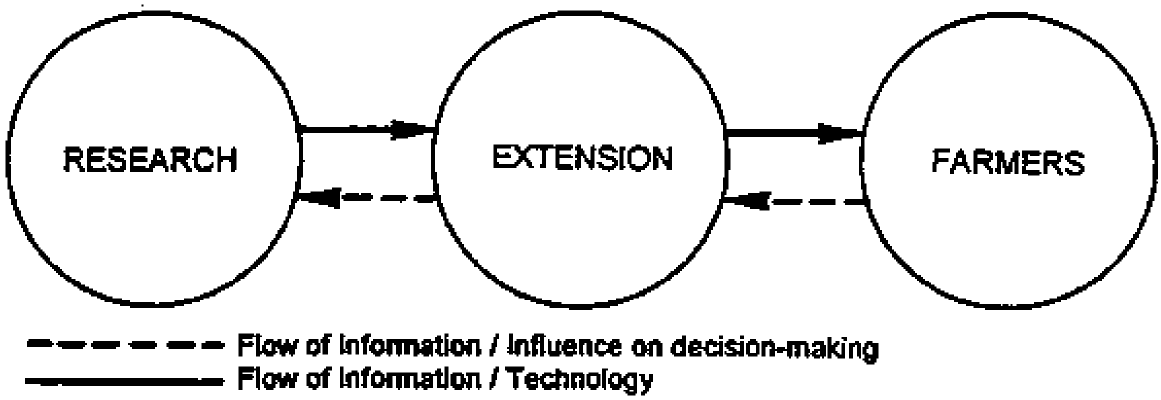

Figure 1: The Research-Extension-Farmer continuum as it currently exists in many developing countries

Failure often occurs due to lack of proper training for extension agents, and miscommunication or none at all between researchers and farmers resulting in research focus drifting away from farmers' needs. In an improved extension approach (Fig 2), scientists put much more efforts on understanding farming environment and assessing farmers' needs. Technological innovation and extension process start with identification and assessment by scientists of problems and constraints faced by farmers in farming systems. Research projects usually including a few on-station experiments are formulated based on results of the assessment. Implementation of the research projects generate knowledge and propose technical solutions for perceived problems. Extension agents disseminate the new knowledge to farmers.

The extension scheme earned applause in some cases especially in solving technical problems in culture systems and improving aquaculture productivities. However farmers' knowledge is often neglected and they are treated as passive receivers of technology from outside.

Modern extension services take more holistic and system approaches where indigenous knowledge, participation of farmers in research and extension process, collaboration of different agencies and extension methods based on adult learning theories are emphasized.

Several general principles are:

- Rural people are intelligent, capable and desirous of receiving information and making use of it for their individual and community welfare.
- The spirit of self-help is essential for democratic living.
- Extension starts where the people are and with what they have. Improvement can begin from there.
- Extension programs are based on the needs of people and are decided upon by the people.
- The classroom is where the people are: on the farms, in their homes, and villages.
- Education is carried on either with groups of people or with individuals.

Extension thus involves working with people where they are, building on what they have and adding to what they know. It is an educational program for the people, based on their needs and problems on a self-help basis.

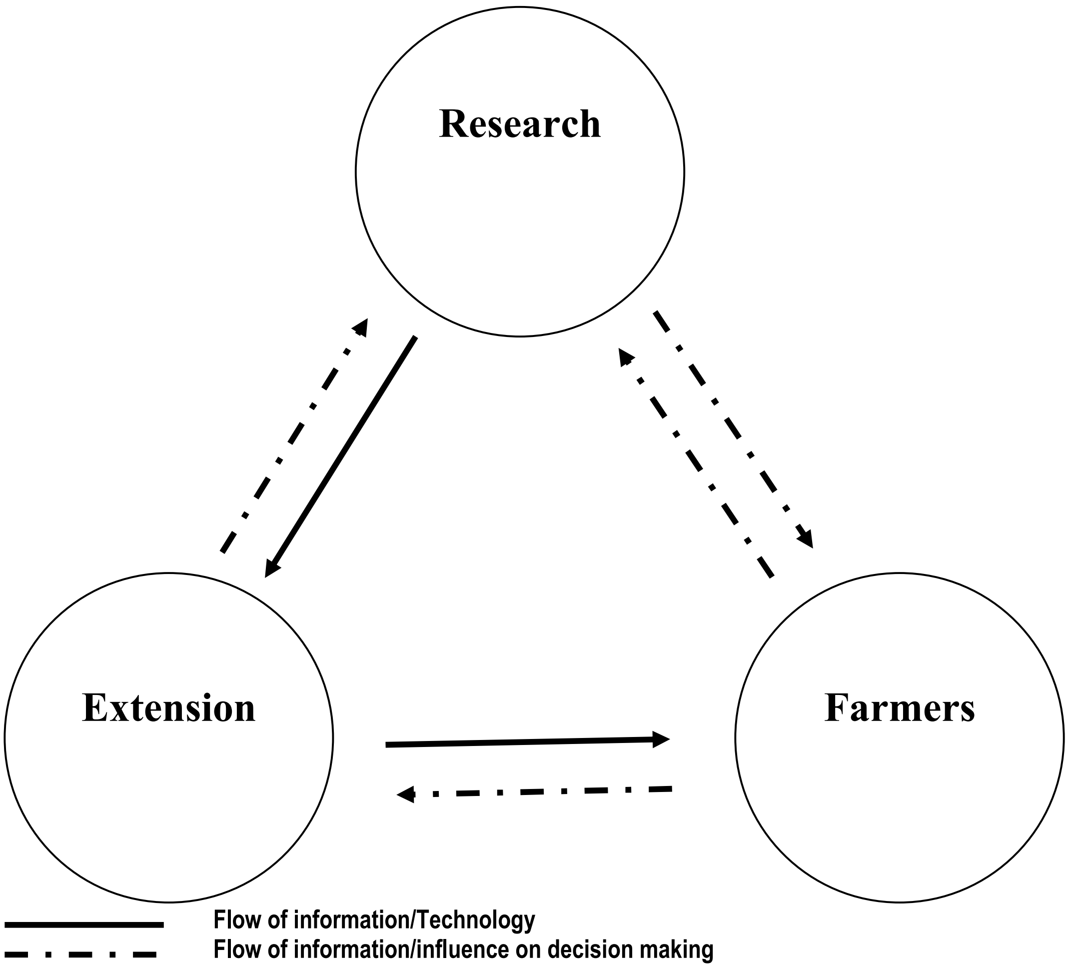

Fig 2. An improved extension scheme.

Challenge in Aquaculture Extension and Training of Small Scale Farmers

Challenge in technology extension to and training of small scale farmers is closely and characteristically associated with physical and socio-economic environment in which small-scale farming is carried out. Rural small-scale farmers carry out their farming activities in complex both internal and external physical and socio-economic environments. The physical environment, especially for farmers in developing countries is often dominated by low availability of or limited access to farming resources, uncertain natural conditions, and little capacity to cope with any natural disasters. Small scale farmers often find it difficult to adopt any change in their farming systems due to resource limitation and farming risk related to harsh environmental conditions. They are often the socio-economically marginalized and have very little social influence and financial power which virtually prevent them from investment in adopting new technology.

Lack of efficient information exchange and interaction between scientists, extension agents and farmers impose another major challenge to aquaculture extension. Extension and research are often housed separately, often in entirely different government departments and hence seldom interact with each other. Extension agents are not invited to research meetings and vice versa. Researchers tend to scorn the more poorly educated extension agents, just as the extension agents scorn the farmers. None of these conditions creates an atmosphere conducive to the flow in information.
Training for aquaculture extension agents is often inadequate for what is arguably the most difficult aspect of technology development and transfer (Haight 1995). Aquaculture extension agents are typically trained in only the most basic aspects of the technology they are expected to disseminate. They seldom understand the underlying

principles of aquaculture and consequently lack the flexibility they need to fit fish farming into the highly personalized farming systems. Consequently, although information does flow to farmers, the quality of this information is not always very high. The farmers perceive this and, more often than not, wisely refuse to adopt it.

Extension agents only rarely receive training in the interpersonal and communication skills which are essential for the efficient transmission of information between persons of different education levels. Most of them have little knowledge on adult learning process and lack of skills to do farmers' training. Being government officers, extension agents often tend to show their superiority to rural people and lack of mutual respects which mentally hindered farmers' acceptance of technical advice and useful information.

Extension in most developing countries is the entry-level function in government departments dealing with small-scale farming development, including aquaculture. Since high quality human resources are usually in short supply, there is a high degree of upward mobility in government services. Hence, extension personnel who perform well and have superior capabilities are quickly removed from the field, given additional training, and end up working in laboratories or behind desks. Left in the extension services are inexperienced young people and older people who were judged by their superiors as unsuitable for promotion.

Government services in developing countries often suffer from inadequate funding. It is not surprising that extension, which is often viewed as a low-level job, also receives minimal financial support. Furthermore, the payback from such dispersed activities as small-scale aquaculture is difficult to document. Transportation, facilities and essential equipment for data collection and analysis are expensive and thus often in short supply, and salaries are often not sufficient to cover the cost of living for staff. Couple this with inadequate training, and it should be no surprise that the information collection and transmission capability of the majority of extension agents is less than what it should be.

Opportunities for Improvement

Despite the major challenges, rural economic and social development in general has been nurturing favourable environment for improvement of aquaculture extension and farmers training.

Apart from increasing fund from government, financial support from private sector, development agencies and NGOs to aquaculture extension is also growing. The increasing financial input makes it possible for many exploratory and innovative extension projects to be implemented and for much qualified professionals to work in aquaculture extension.

Institutionally, systems are changing and functioning towards establishment of a closer linkage between scientists, extension agents and farmers. Researchers have the tendency to consult with extension agents more frequently. Joint staff meetings or representation by research at extension meetings and vice versa are becoming possibilities. Conducting joint demonstrations to farmers has been used as a means of getting research and extension together by many development projects. Another mechanism is to have researchers and extension personnel conduct joint experiments and in fact some research projects hire qualified extension specialist to make sure their research is relevant and research findings are disseminated and extended to targeted farming communities. Such research projects would not only bring scientists and extension staff into contact with each other, it would also have the added benefit of encouraging extension agents to study the underlying principles of aquaculture in a controlled fashion.

Basic aquaculture technologies are not in short for choice, which form a rich knowledge base for aquaculture extension and development. Various innovative extension approaches are field tested and readily available
At the other end of the continuum, farmers are receiving better formal education than before. They also have much better access to information with fast development of modern information technology. They have broader

view of outside world than before and tend to accept new things with open minds. This mental altitude change, though still at slow pace, has great impact on rural development in near future.

To make the extension system function as designed, the human and physical resources allocated to the extension services must be substantially improved over what they are today. Extension agents must be adequately trained and supported in their work. The training should not only focus on aquaculture principles and technology, but on knowledge and skills in communization and training farmers. Training of trainers should be carried out in which extension agents gain knowledge on theoretical aspects of adult learning and enhance their skills in training design, planning, and implementation for small scale farmers.

Training and institutional reform of the extension services are, of course, absolutely essential for the long term growth and viability of agriculture in developing countries, but short term solutions are also needed. Since the bulk of quality education has been provided to the research side of the research-extension equation, it seems reasonable to shift some responsibility in that direction in order to meet short-term objectives. If our short-term solutions work, it may well preclude the need for the old structure entirely and pave the way for a completely new approach to technology development and transfer.

More participatory tools such as PRA, RRA etc may be promoted for identification of famers' problems, their interests and researchable topics. Other research models and extension methods, for example participatory action research and participatory action learning, may be carefully chosen, designed and adopted in technology development and dissemination. Application and incremental modification of the available technology in a participatory approach would generate new knowledge of interest to a wide variety of scientists and provide highly relevant information to farmers. Expensive equipment is seldom needed to do such work. Thus, in the short-term, directing research at the problems faced by small-scale farmers might actually help reduce the conflict between the desire to produce quality results and the imperatives imposed by shrinking budgets. It might also, in the longer term lead aquaculture research away from a focus on high-production/high pollution farming systems to those which might be more socially and environmentally.

Conclusion

Aquaculture extension and farmers' training are facing great challenge from imperfect and often inefficient extension systems, inappropriate extension approaches, the natural of small-scale farming, and lack of skilled extension agents. With increasing attention and resource inputs from government, private sector, development agencies and NGOs, traditional aquaculture extension will shift into a service system in which information exchange between scientists, extension agents, and farmers is improved, farmers' active participation enhanced and appropriate aquaculture technology developed and adopted.

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Disease diagnosis and prevention strategies in aquaculture including vaccination

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Abstract

This lecture note is aimed to produce general information of the disease diagnosis and its role in the aquaculture practice. It is noted that it is not aimed to provide a complete procedure of diagnostic methods for aquaculture operators, since some of those techniques involve with comprehensive procedures. However, it provides sufficient information to handle with the disease when it occurs within a farm. The prevention strategies and vaccination are also described here to give a better view of disease prevention.

Introduction

Disease diagnosis is a major mean to access the health status of aquatic animals in their environment. It is not confined only to investigate the aetiology of the disease, but also to envisage the hidden threat under the water. This provides valuable information to farmers to understand their pond situation and can plan ahead to cope with the disease when it becomes an outbreak within either their farms or regional level.

It has been well understood that prevention is far better than cure. Since fish gets infection with different degrees and the sub-clinical level is often overlooked, an early detection of pathogen is one of the successful key to control the disease. Thus, diagnosis and routine health monitoring well serve the surveillance scheme in aquaculture.

This lecture note is aimed to provide a general view of the diagnosis procedure and guideline how to prepare samples for diagnostic laboratory when it is required. The prevention strategies including vaccination are also described here as this will be an option for the farm management to reduce any loss due to the disease outbreak that may occur.

Disease diagnosis
Sample collection

Collection and handling of fish samples is the most critical step in order to obtain an accurate diagnosis addressing the fish health status in a pond. Sample size is also important since it is a major factor determining the accuracy of the method. Sample can be collected for two main purposes of diagnosis: one is for health monitoring and another is for disease diagnosis. These two purposes may cause a different size of sample collection. In general, the sample numbers should be high enough to be a representative of the population where the percentage of prevalence is approximately estimated (see the table 1).

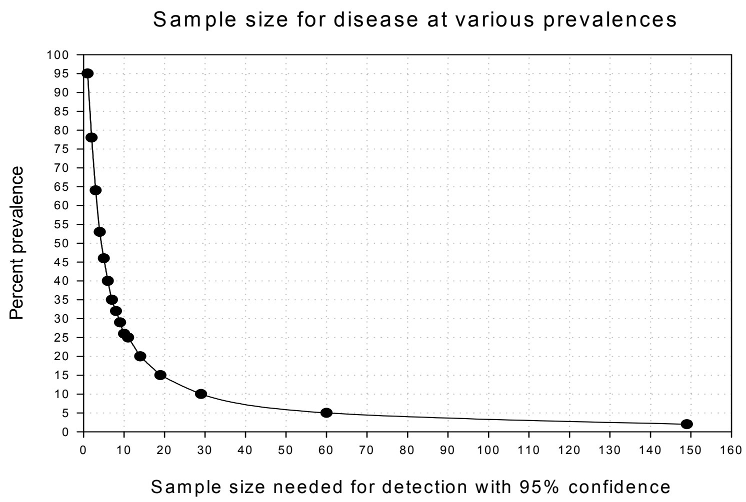
All samples collected must be as alive or freshly dead. However, freshly dead fish are less preferable than the live fish since the changes occurring upon the death may make accurate diagnosis difficult. When fish dies, small external parasite may be lost almost immediately, surrounding bacteria invade the fish and make it difficult to determine the disease, and virus may die within a few hours. Moreover, most organs rapidly deteriorate which makes the fish is nearly impossible to be diagnosed by histology.

Along with fish sample, the supporting information should be submitted to the diagnostic laboratory. This information will help to clarify if handling stress, change of environment or infectious agents are of concern. The supporting information is including:

- gross observation
- mortality rate
- feed records
- stocking records
- environmental parameter
- history and origin of fish population
- reasons of submitting the samples
- owner or contact name, address and phone number
- date of sample collection

Table 1 Sample size collection at different prevalent of disease infection

Sample size needed for 95% confidence detection																
	Target prevalence (%)															
Population Size	2	5	10	15	20	25	26	29	32	35	40	46	53	64	78	95
50	48	39	22	15	12	10	10	9	8	7	6	5	4	3	2	1
100	78	45	25	17	13	10	10	9	8	7	6	5	4	3	2	1
250	112	55	27	18	14	11	10	9	8	7	6	5	4	3	2	1
500	129	56	28	19	14	11	10	9	8	7	6	5	4	3	2	1
1,000	138	57	29	19	14	11	10	9	8	7	6	5	4	3	2	1
1,500	142	58	29	19	14	11	10	9	8	7	6	5	4	3	2	1
2,000	143	58	29	19	14	11	10	9	8	7	6	5	4	3	2	1
4,000	146	58	29	19	14	11	10	9	8	7	6	5	4	3	2	1
10,000	149	59	29	19	14	11	10	9	8	7	6	5	4	3	2	1
≥100,000	149	60	29	19	14	11	10	9	8	7	6	5	4	3	2	1



This curve was calculated using the survey toolbox software described by Cameron (2002).

Live sample collection for transportation

Fish should be packed in secured containers such as double plastic bags or polystyrene box. Polystyrene box is suitable to pack the spiny fish species which requires a durable container and when the destination is not far. Double plastic bags are more popular for long distance transportation including by airways. Water can be filled to one third of the container capacity with the remaining 2/3 volume inflated with oxygen. The bags should be tightly sealed with rubber bands and packed inside a polystyrene box or cardboard box lined with styrofoam. Ice packs may be required for a long transportation. The volume of water to fish volume is particularly important for live fish being shipped for ectoparasite examination, so advance checking with the diagnostic laboratory is recommended. To shorten the time between removal of fish from water and transportation, samples should be collected as close as to the shipping time and early inform the diagnostic laboratory.

Tissue sample collection

Prior to fixation, fish should be humanly killed. Small fish can be done by decapitation, while the larger fish is done with a overdose of anaesthetics. Very small fish can be wholly immersed into the fixative agent in a minimum of 10:1 (fixative: fish) volume ratio. For large fish, the body cavity should be split open and displaced the viscera organs to allow maximum penetration of the fixative. The organs can be possibly removed and fixed separately with the 10:1 (fixative: sample) volume ratio. Most tissues require a minimum of 24-48 h fixation time. However for some specific diagnostic techniques, the length of fixation may be varied. For instance, the samples collected for DNA-based technique analysis, the fixation time should not exceed 24 h as it may cause difficulty to recover the DNA from sample. So, it is highly recommended to get some advice for the diagnostic laboratory before the procedure.

The most suitable fixative for preservation of finfish for histopathological study is phosphate buffered formalin which can be prepared as following:

37-40% Formaldehyde 100ml
Tap water 900 ml
$NaH_2PO_4.H_2O$ 4.0 g
Na_2HPO_4 6.5 g

General diagnosis
External examination

Place the specimens on the clean flat board and keep them moist during examination. Examine external body surface, body form, abdominal form, skin coloration, eye appearance, and record any abnormality. The entire surface should be examined including opercular and oral cavities, gills and fins.

Scrape along the body trunk of specimen with coverslip and place on a slide with a drop of water. Examine the sample under a light microscope. Gill samples are also taken and examine in the same method.

Internal examination

Withdraw blood samples from a caudal peduncle, where the fish is too small to do so, the caudal peduncle can be chopped off to collect the blood sample. Place a small drop of blood and smear on the slide and observe under the light microscope for any parasite infection.

Open up the abdominal cavity. Observe any lesion and abnormality of the visceral organs such as discoloration, enlargement, ascites, oedema, lesion and nodules. The organ can be aseptically collected for bacteriogical and virological examination.

Fungal examination

Fungal infection is commonly found when the water temperature drops down and fish encounter with some health problem such as injury, parasite manifestation and bacterial infection. The clinical sign can be easily seen as cotton-like growing on the skin, which can cover large area. This external fungus mostly belongs to *Saprolegnia* sp.

Epizootic ulcerative syndrome (EUS) is an internal fungal disease caused by *Aphanomyces invadans*. Infected fish typically show necrotic dermal ulcers and mortality is reasonably high. Confirmatory is usually done by histopathology to demonstrate mycotic granulomas and invasive hyphae. Fungal isolation can be done for identification purpose.

Bacteriological examination

Gross clinical signs can be observed as a presumptive diagnosis, however some infected fish may not reveal any clinical signs until the infection become well-advanced stage. These clinical signs are including:

- abdominal distension (dropsy)
- exophthalmia (pop-eye)
- scale protrusion
- haemorrhagic lesion on skin, fin, eye, and internal organs
- enlargement of internal organs
- discolouration of skin and internal organs
- abscess or granuloma on skin or internal organs

Confirmatory should be done by the diagnostic laboratory. This includes bacterial culture, biochemistry test, and some advanced techniques may also be applied to speciate the bacterial species.

Virological examination

Viral diseases caused by a wide range of virus and each disease shows different clinical signs. Some are unique to the disease, while some are commonly found in other pathogen infection. However, viral disease is commonly reported as host specific infection. This may narrow the host range for presumptive diagnosis.

Confirmatory is mainly done by viral isolation which requires a specific cell line. This poses a difficulty to some viral diseases when the cell line is not available, particular to shrimp viral diseases. By this means, DNA-based techniques are commonly adopted. Along with viral isolation, histopathology is also applied to investigate the evidence of viral infection. Further confirmation can be done by transmission electron microscopy (TEM) of ultra-thin section of infected tissue to reveal viral particles.

Advance diagnostic techniques
Enzyme-linked immunosorbent assay (ELISA)

ELISA is one of antibody-based techniques originally developed for the analysis of murine antibodies and some years later it was adapted for trout antibody affinity analysis. ELISA has extensively been studied for both immune response of fish and diagnosis of their diseases as it has been known for a rapid and sensitive method.

ELISA can be performed with four variations; the assay can be done in antibody excess, in antigen excess, as antibody competition, or as antigen competition. Assay done in antibody excess or as antigen competitions are used to detect and quantitate antigens, while antigen excess or antibody competition assays are used to detect and quantitate antibodies.

In principle, the only factors that need to be considered in choosing the correct design of an immunoassay are the types of antibodies that are available (polyclonal antibodies, monoclonal antibodies, a single or two or more monoclonal antibodies) and whether pure or impure antigen is available.

Polymerase chain reaction

PCR is a technique for the *in vitro* amplification of specific DNA sequences by the simultaneous primer extension of complementary strands of DNA. The reaction composes with three steps including: denaturation, annealing and extension. The final products or PCR products are subsequently analysed by agarose gel electrophoresis or with some more advance techniques for further required information.

***In situ* hybridization**

In situ hybridization is a technique for identifying specific nucleic acid sequences (genes) in their cellular environment. The probe is oligonucleotide specific to the target DNA of the pathogen/organs. The probes are normally linked with the signal system, which can be enzymatic system or isotopic system. In final step the linked signal is visualized with relevant enzyme/substrate to determine the reaction.

Disease prevention strategies
Good farm management

Good farm management is a major part of the disease prevention strategies. Since the infectious agents are all around in the environment and surrounding wild aquatic animals, farmers should take a number of measures to minimize the disease in their stocks. These measures are including:

- screen seed/broodstock for any infectious agents before introducing into the farms
- control water source and quality to ensure optimum growing of their animals and reduce exposure to pathogens
- maintain stocking densities at optimum level
- allow time to fallow sites between crops and apply disinfectant to pond/tank and equipment
- apply strict hygiene practices including disinfection procedures
- avoid equipment movement between different areas of the farms
- improve nutrition and diet, and store them in cool, dry, and well-ventilated place to prevent rancid and moulding
- closely monitor the stocks to ensure early detection of disease problems

Health surveillance

Regular monitoring of fish health is highly recommended to be part of good aquaculture practice. This will assure the farmer to be aware of the fish health status and any early infection that may occur within their farm. The sampling size must be well represent the whole population and minimize the overlooking of the early infection. Number of fish samples for the health surveillance purpose is described in Table 1.

However, the process of capturing fish can introduce some certain degree of stress to both sampled fish and the entire population. Netting and handling should greatly be taken care and time out of water should be minimized. Anesthetics are also commonly practiced to improve fish survivability and growth post handling.

Vaccination

Various types of vaccine are commercially available mainly to the major diseases of economic fish species. Monovalent vaccine is a product to cover only one pathogen strain, whereas the multivalent is aimed to cover a few different pathogen strains. The application methods are also various among company, however the general practice are including injection, bathing, and feeding. Age and size of fish also play a role in the response to the vaccination. Vaccination at the early stage of fish normally confers a better response to the vaccine.

Principle of vaccination

Vaccination should be conducted in the healthy fish and where the environment is free from the diseases. Fish should not be subjected to any kind of stress including diseases before vaccination. Things to be considered when apply a vaccination scheme into the farm include fish age, vaccination method, time to vaccinate, interval period between doses (if applicable) and withdrawal period before production harvest.

Practical constraints

The ideal of vaccination is to provide effective protection to fish from the target disease throughout the production cycle. However, most vaccines have their limitation and vaccination procedure cannot avoid introducing some certain degree of stress due to over crowding, handling, insufficient oxygen supply and anesthetic effect. Sometime, protection period cannot be planed especially to non-seasonal diseases. Vaccine cost and its availability are also major constraint for the vaccination scheme of aquaculture.

Evaluation of vaccine

Evaluation of the vaccine efficacy is mainly done by the relative percent survival (RPS). The calculation is made using the following formula;

RPS = 1- (vaccinated fish mortality% / non-vaccinated mortality%) x 100 %

This method has a baseline criteria that at least 25 fish should be used in duplicate for each test population, while the challenge should cause at least 60% mortality in control group on the same time scale of the natural disease. The cause of mortality should be determined and non-specific infection must not exceed 10% in any group and mortality rate of vaccinated fish must be below 24% if the test is concerned to be positive (Ellis, 1988).

Availability of fish vaccine

Vaccination has been integrated into the disease prevention strategies of the salmon and trout industries over a decade. Since these two fish species have a high marketable value, which a healthy fish stock justifies the price paid per vaccine dose. Some other commercial vaccines are also available such as for channel catfish, European seabass and seabream, Japanese amberjack and yellowtail, Atlantic cod, and tilapia. Vaccine against *Streptococcus iniae* in Asian seabass is now available, whereas other bacterial and viral vaccines are still developed.

Conclusion

Disease prevention strategies involve with various factors including, species economy importance, financial circumstance and national regulation. Vaccine is one of an ideal method as its benefit is long term last. However, availability of vaccine particular to the Asian economic important fish species is rather limited. Cost of vaccination is also the main constraint both the user and developer company. The health surveillance and good farm practice seem to be better practical low cost measure to prevent and control the disease. However this may require a training, which includes from know-how level to professional level. The scheme should be implemented into the national strategies and sufficient training should be regularly provided to farmers.

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Major finfish diseases in Asia and practical measures adopted in controlling diseases

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Abstract

The health of cultured fish normally related to aquaculture management practice. The major diseases of finfish in Asian aquaculture are grouping into parasitic diseases, bacterial diseases, viral diseases, fungal diseases and nutritional diseases. Parasitic protozoa such as *Oodinium* sp. *Trichodina* sp., *Ichthyobodo* sp., *Ichthyopthirias multifiliis*, and *Tetrahymena* sp. are the most serious diseases to fish fry and fingering. There are many bacterial diseases that cause severe problem in fish culture, such as motile *Aeromonas septicaemia,* streptococcosis, vibriosis, mycobacteriosis. There are many viral pathogens that cause diseases in fish, such as lymphocystis, viral nervous necrosis (VNN), spring viraemia virus and koi herpes virus. Epizootic ulcerative syndrome (EUS) is the pandemic fungal disease of many freshwater and brackish water fish.

Introduction

The knowledge on finfish diseases will help to increase or improve the productivity or production in aquaculture. Anyone who interested in fish health or biological sciences can practice and work as diagnostician on fish health. Study on fish diseases can be done by self learning and practice or attend fish disease courses.

The understanding on the meaning of the word “disease” is important to go further to know more about finfish diseases. Diseases mean any abnormality of structure or function of the organisms, inability to perform physiological function at normal levels. Diseased animals are not just sick or die but they are those performing below expectations. The unit of interest for diseased fish is the population, which can be ponds, cages or tanks, farms, areas of the country or the whole region. The study of disease patterns in the populations is “epidemiology”.

Fish are poikilothermal animals, which mean their body temperature change according to the water temperature. Their biological systems are tremendously altered by water temperature and other environmental factors. Therefore, good management is very important practice for the successful of fish farms. Environmental factors that may affect the health of cultured fish are as follow:

Temperature:

Is the most important factor to fish health. Rapid changes of water temperature can cause stressful condition to fish. Fish can tolerate to temperature drop better than a rising temperature. Fish will be more susceptible to pathogens in rising temperature condition.

Dissolved Oxygen:

Small fish require more O_2 than larger fish. Fish living in low dissolved oxygen water will gather at water inlet or gasping at water surface. Gill damage or pale can be the sign of O_2 deficiency.

Ammonia:

Ionized ammonia will cause damage to gills and other organs. Toxicity of ammonia is varied with pH and temperature.

Nitrite and nitrate:

Nitrate is non toxic to fish but nitrite is the toxic form to fish. High level of nitrite in the water can increase methaemoglobin in fish blood, which cause the disease called "brown blood disease".

Carbon dioxide:

High level of CO_2 in fish blood will inhibit the O_2 uptake. Level of less than 6 mg/l of free CO_2 in water is accepted for aquaculture. High level of CO_2 in water can cause nephrocalcinosis in fish, which can damage kidney.

Chlorine:

Is extremely toxic to fish, causing acute gill damage or gill hyperplasia if fish expose to low level of chlorine for a long time. Use of sodium thiosulphate at the concentrations of 3-5 mg/l cans neutralize the toxic of chlorine.

Supper saturation:

Supersaturated water with O_2 or N_2 can cause gas-bubble disease in fish. In aquarium or hatcheries, supersaturated water may cause by leaking of pump or valve system. Aerating or agitating the water can solve the problem. Young fish are more susceptible to supersaturated water condition than bigger fish. Low level of super saturation may cause cataract, fin rot or gill disease in fish.

Suspended solid:

The solid particle that suspend in the water will irritate skin and gill epithelium. Over feeding practice is the most important sort of suspended solids in the water.

Toxic organic compounds:

Many organic compounds are toxic to fish. Clinical signs and toxic effects in fish cause by organic compounds are variable due to fish species and types of compounds. High concentrations of organic compounds cause respiratory failure and death to fish. Sub-lethal concentrations may cause blindness, anemia, skin lesions, poor growth, tumors etc.

Diagnosis

The proper results on fish health diagnosis should come from a set of information on aquaculture practice of the farmers, water quality parameters and pathogen examination.

Infectious disease is a disease cause by pathogenic organisms including parasites, bacteria, fungus and virus.

Parasitic diseases

A great number and diversity of animal species are capable of parasitizing fish, ranging from microscopic protozoan to grossly visible crustaceans and annelids. In the wild, there is a big range of parasites but small in number, which opposite to cultured system that ranges of parasites is limited but larger in numbers.

There are many factors favor parasitic diseases. High stocking density provides more hosts that will direct contact to parasites. Physical trauma, such as handling, grading can cause injury which become the port of entry of parasites and other pathogens. Sub optimal quality and quantity of pond water may cause stress to fish. Selective breeding fish for proper color or shape may cause the weakness. The introduction of exotic species may introduce new parasites or other new diseases. Some predators may act as intermediate host to some parasites. The change in temperature flavors parasites. Earth pond flavors the completion of life cycle of some parasites. Fish in cage culture expose to parasites directly and cannot escape.

Parasitic organisms that cause severe damage to fish normally are protozoan parasites. There are many parasitic diseases in finfish, such as:

Oodiniasis, velvet/rust/gold rust disease

Dinoflagellate protozoa, *Piscinoodinium* sp and *Amyloodinium* sp are the causative agents of this disease. The shape of this parasite is spherical or pyriform, size 30X100 micrometers. There are tremendous numbers of vacuole in the cytoplasm with one nucleus. These parasites are found on skin and gills of fish. Infested fish demonstrate rusted color on body and gills.

Treatment

Formalin and salt (NaCl) at the concentrations of 40-50 ppm and 0.3-0.5 percent respectively for 24 hours.

Ichthyobodiasis (Costiasis)

This disease is the disease of both freshwater and marine fish and the causative agent is I*chthyobodo* sp (*Costia* sp). There are two species found in South East Asia, *I. necatrix* and *I. pyriformis*. This parasite is oval or kidney bean shape with a pointed end and two flagella, size 10X20 micrometers. They cause more problems for fry and fingerling and weaken the adult fish. Infested fish produce excess mucus that forms a blue grey film over the host body surface and gills. Fish will not feed in case of heavy infestation and may swim rapid, erratic movements or flashing. Fresh skin scrapping and gill squash can demonstrate parasites under the microscope.

Treatment

Formalin at the concentrations of 25-40 ppm for 24 hours.

Ichthyopthiriosis, Ich, white spot

Ichthyopthirias multifiliis is the causative agent of this disease. This parasite is the large ciliated protozoa with the diameter around 1 millimeter. They feed and grow under epidermal layer of the skin and gills of host. Mature trophonts leave their host and transform into reproductive cysts call tomont. The immature stage call theronts are produced within tomonts by self division. Theronts are released into water and infest fish. Theronts can not survive without host within 24 hours. Infested fish showed white spot on body and gills. Haemorrhagic lesions can be seen on the skin of diseased fish.

Prevention and treatment

Leave the infected ponds or tanks empty for one day or more. Prevent wild fish or amphibians come into the ponds or quarantine newly arrive fish before stock. Raise water temperature 1-2 ^{o}C may kill trophozoints.

Trichodinosis

The causative agents of this disease are Trichodinids which is ciliate protozoa found on skin and gills. These parasites look like saucer or bell shape disk from lateral view with sucking on ventral size. Dorsal view shows round shape. Multiply by binary fission. They feed on bacteria. Infested fish show abnormal coloration, sluggish and lost weight.

Treatment

Formalin at the concentrations of 25-50 ppm for 24 hours.

Tetrahymeniasis

This is the disease of freshwater fish especially guppy. The causative agent of this disease is *Tetrahymena* sp., which is oval shape ciliate protozoa, size 30-50 micrometers with 30-40 rows of cilia through the whole cell. Cytostome found at anterior part of the cell with row of cilia around it. There are one macro and one micro nucleus. Reproduce by binary fission, Infested fish show white patch on the body with some focal necrosis and hemorrhagic lesions. Some infested fish may develop scales protruded.

Good management is the best prevention methods as there is no chemical treatment available.

Bacterial Diseases

There are many bacterial diseases that cause severe problem in fish culture, such as motile aeromonas septicaemia, streptococcosis, vibriosis, mycobacteriosis etc.

Motile Aeromonad Septicaemia

The causative agents of this disease are *Aeromonas hydrophila*, *A. sobria* and *A. caviae*
These bacteria had been found in healthy or diseased fish and aquatic environment. The isolation of these bacteria might serve as a water pollution indicator.

Clinical signs of this disease are petechiae hemorrhagic lesions, congestion, ulceration, ascitic fluid in clinical dropsy, abdominal swelling, tissue necrosis, and fin/ tail rot.

Motile *Aeromonas septicaemia* disease may occur under stressful conditions such as crowding and low water quality. The confirmation of this disease is the isolation of Aeromonas bacteria from infected fish. Aeromonas can grow on most general purpose medium. However, R.S. medium is a selective media for this genus.

The characteristic of Aeromonas are as follow:

- -active motility with a single polar flagellum
- -produce gas and acid from carbohydrates
- -gram negative, short rod 0.5 x 1.0-1.5 micrometers
- -aerobic and facultative anaerobic

- -oxidase test positive
- -resistance to vibriostat 0/129

Health management is the best method for controlling this disease. There are varieties of antibiotic that can be use as a chemotherapeutic treatment.

Streptococcosis

The causative agent of this disease is *Streptococcus* sp, which is gram positive bacteria, coccus shape and non-motile. There are several other closely related groups of bacteria that can cause similar disease, including Lactococcus, Enterococcus and Vagococcus. Many species of fish have been found susceptible to infection such as eel, trout, tilapia, sturgeon and many species of ornamental fish.

High water temperature, high stocking density, harvesting or handling, poor water qualities are some stressors that have been associated with this disease out break. Infected fish show abnormal swimming behavior (spinning), loss of buoyancy control, lethargy, darkening, one or bilateral exophthalmia, corneal opacity, hemorrhage in or around eyes, opercula plate, base of fins vent etc., ascites. In some cases, fish may show no obvious sign before death.

Confirmation of the disease by isolation of bacteria from kidney and brain follow by identification. There are varieties of antibiotic that can be use as a chemotherapeutic treatment.

Vibriosis

The most common bacterial disease in marine fishes, that frequently act as opportunistic pathogens causing disease in fish which are under stress problem in seabass and grouper. The causative agents of this disease are *Vibrio* spp., *V. parahaemolyticus*, *V. Alginolyticus*, and *V. Cholerae*.

Some infected fish get acute infection and death without clinical sign. The typical clinical signs are darkening of body coloration, loss of appetite, hemorrhagic septicaemia, ulcerative lesion on the skin and exophthalmia.

Vibrios are Gram negative, straight or slightly curved rods, motile, facultative anaerobic, oxidase and catalase positive, sensitive to vibriostat 0/129. They can grow on general purpose media with 2 percent NaCl, and Thio-sulfate Citrate Bile Salts Sugar Agar (TCBS) is a selective media.

Possible control methods are maintenance of high water quality and good husbandry. There are varieties of antibiotic that can be use as a chemotherapeutic treatment.

Viral Diseases

There are many viral pathogens that cause severe diseases in fish, such as lymphocystis, viral nervous necrosis (VNN), spring viraemia virus and koi herpes virus

Viral nervous necrosis (VNN) or **viral encephalopathy and retinopathy (VER) disease**

Viral nervous necrosis disease affecting larvae and juveniles of many farmed marine fish in Asia and Australia. There were reported in Australia, China, Japan, Indonesia, Philippines, Singapore, Taiwan and Thailand. VNN virus infected more than 30 marine fish species, especially at the larval and juvenile stages, and the infection usually results in high mortality. Mass mortality were reported in larval sea bass *Lates calcarifer* in a hatchery associated with clinical signs such as abnormal swimming behavior, pale-gray discoloration of the body

Histological investigations in moribund fish revealed marked vacuolation in the retina and brain. Cytopathic effects (CPE) were observed in SSN-1 cells inoculated with the tissue filtrate of affected sea bass

Control methods are disinfection of fertilized eggs by ozonized water. Disinfection of water, feeds, ponds, facilities and tools. Take off feces and dead fish from the ponds frequent.

Koi herpesvirus disease (KHVD)

Causative agent of this disease is pathogen type: DNA herpes-like virus in the family Herpesviridae name: Koi herpesvirus (KHV) (170 – 230 nm). Common carp, Koi carp (*Cyprinus carpio*) is the specific host for this virus. KHV first reported in Israel and USA in 1998 and after that it was pandemic to many countries world wild.

Clinical signs of this disease are hemorrhagic lesion on skin and focal rotten gills with excess mucus excretion. Infected fish will gather at the water inlet.

Diagnosis techniques are virus isolation and confirmed by PCR of the viral isolates. Even without isolation of the virus PCR can be used to detect the DNA of virus in fresh, infected tissues.

Fungal disease
Epizootic Ulcerative Syndrome (EUS)

The case definition of EUS is "a seasonal epizootic condition of freshwater and estuarine warm water fish of complex infectious etiology characterized by the presence of invasive *Aphanomyces* infection and necrotizing ulcerative lesions typically leading to a granulomatous response" (ODA, 1994). The synonyms of this disease are EUS-related *Aphanomyces* (ERA) Philippines, Red Spot Disease (RSD): Australia, Mycotic Granulomatosis (MG): Japan, Ulcerative Mycosis (UM): East Coast USA.

The causative agent of this disease is a fungus name *Aphanomyces invadans*. The clinical signs of disease are normally start with mass mortality of wild and cultured fish in a new location. Infected fish show small red areas or ulcers on the body, deep hemorrhagic ulcers with fungal mycelium on surface, skull erosion, loss of eyes and part of the brain.

This disease can be confirmed by the isolation of *Aphanomyces invadans* fungus and the specific mycotic granulomas found in the histological sections of various tissues of infected fish with some special stains; Grocott's, Periodic Acid Schiff's (PAS) or UV Tech.

Prevention and control

Keep eyes on the health of the wild fish during the cool season. If the EUS spread to the fish pond, stop water exchange, remove the moribund and death fish. Improve water quality using agriculture lime or hydrate lime. Salt can be applied to minimize the toxic of H_2S

Recommendation

An accurate disease diagnosis is necessary for diseases in finfish management, prevention and treatment. www.oie.int and www.enaca.org are good sources of aquatic animal disease diagnosis techniques.

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Accessing better markets–improving competitiveness of small-scale shrimp farmers: A Case study of Thailand

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Abstract

The technological advances of shrimp farming systems have not only contributed to a rapid expansion of Asian shrimp culture, but have also created greater opportunities for foreign exchange earnings. Nevertheless, marine Shrimp farming is the most debated aquaculture business in Asia primarily due to the economic reasons and associated environmental risks. In principle, shrimp farming industry in Asia has often been promoted for the possibility of increasing rural employment and generating foreign exchange. However, there are indications of shrift from shrimp farming being a small-family business to corporate dominated business.

Thailand is the leading shrimp exporter with annual foreign exchange earning of over two billion US dollar. Though shrimp farming development in Thailand has generated substantial economic benefits it has been accompanied by rising concerns over environmental and social impacts of development. Recent development in the world shrimp trade to go for certified product under the chain of custody concept added further to the social concerns, as it has negative consequences for the resources poor small-scale shrimp farmers, who do not have capacity to adapt to the new standards. Apparently, the phenomenal growth exhibited by small-scale shrimp farms in the past decade was achieved with minimal policy and institutional support. In the present time small-scale farmers cannot earn a good price because they have a limited market for their products and they do not have enough knowledge and capacity to adapt to the new standards to get access to the niche market.

This paper presents an overview of shrimp farming development in Thailand and discusses the issues and challenges being faced by the small-scale shrimp farmers. The paper tries to give insight on growth potential of Thai shrimp sector and capacity building needs to improve competitiveness of small-scale shrimp farmers to sustain their business. First, it provides brief details of the shrimp industry in Thailand; then examines the drivers of the development, associated issues and policy implications. With the purpose to assist small-scale shrimp farmers to improve product compliance with the EU standards the Asian Institute of Technology (AIT) and the Network of Aquaculture Centres in Asia-Pacific (NACA) conducted a project titled “Capacity building of small-scale shrimp farmers on adaptation of best management practices (BMPs) to promote Thai shrimp export to the EU”. This paper summarizes the lesson learned from the project and put forward vision for improving competitiveness of small-scale shrimp farmers. It is suggested that if shrimp aquaculture has to be seen as a sector to enhance the socioeconomic condition of the rural communities it would be required for the government to regulate growth of the industry keeping pro-poor policy in mind.

Introduction

The current worldwide growth rate of the aquaculture business (8.9–9.1% per year since the 1970s) is driven by the developing countries (Gutierrez-Wing and Malone, 2006; Subasinghe, 2005). Asia has consistently contributed about 90% to the total world shrimp supply. Shrimps are the highest value seafood in Thailand and have become important both in terms of generating foreign exchange earnings from exports and creating employment opportunities in the domestic economy. Since 1991, Thailand has been the world's leading producer and exporter of marine shrimp, exporting up to 90% of its production (Huitric et al. 2002). However, although the production and financial performance of the shrimp aquaculture industry has been impressive, its rapid growth has led to a number of technical, environmental, economic and social problems, which have been widely reported. In recent times environmental and economical limitations associated with the development of the shrimp aquaculture have become more pressing, and would hamper its growth if not addressed adequately.

In general, because of their relatively high price, sales of shrimp products suffer during an economic crisis because consumers have lower purchasing power and they tend to be more careful regarding the quality of the product. Further to this current market trend indicates that competition has significantly increased in world shrimp markets, as many Asian countries expand shrimp culture. Oversupply of cultured shrimp products in the global market has already occurred and consequently, market prices of shrimp have dropped and profit margins have been squeezed. Relatively high production costs as well as receiving the lowest average shrimp price per kilogram, the intensive shrimp farming in Thailand has comparatively become less lucrative and in many cases neutral, and the most affected group are the small-scale shrimp farmers. Given significant differences in the cost structures and access to market industrial shrimp farms always have competitive advantage over the small-scale shrimp farms and thus, they can position themselves better to cope up with the market eventuality.

On the other hand, increased international interest in environment and seafood safety has resulted in development of variety of standards and guidelines for shrimp farming, and thus, making it difficult for the small-scale shrimp farmers to understand and adopt the new standards being laid mostly by the importing nations. This is particularly critical for Thailand, where about 80% of the total shrimp farms belong to small-scale farmers and about 85% of the farmed raised shrimp is meant for export. Small-scale shrimp farmer lacks capital education and the motivation to accept the changes under the current conditions of the market. While most small-scale shrimp farmers are aware of the risks in business, majority are not able to adopt the standards. It is a challenge for the government as well as the society to full fill aspirations of thousands of small-scale shrimp farmers and therefore, intervention to support their capacity development on various environmental, food safety and market access related issue are highly desired.

Research and development accomplishments

Farming of marine shrimp has been successful in Thailand because climatic conditions mean that two or more crops per year are possible and also because of government support for the industry. Historically, a steady price and a large demand for shrimp from Japan, US and Europe prompted the Department of Fisheries, Thailand to promote semi-intensive marine shrimp farming as early as 1973 through the establishment of hatcheries to help relieve the fishing industry (Flaherty and Karnjanakesorn, 1995). But intensive shrimp farming arrived in Thailand during the 1980s and it quickly became an important export industry. During the period of 1987–1991, there was widespread intensification of shrimp farming and by 1994, 80% of the shrimp farms in Thailand were intensive (Dierberg and Kiattisimkul, 1996). Almost all the exported shrimp from Thailand are raised on earthen shrimp ponds as the number of farms has increased from 3,045 farms in 1978 to 33, 444 in 2005, covering 71, 825 ha (DOF, 2007).

Progression of shrimp farming development in Thailand reflects continuous improvement in methods of hatching, producing, harvesting, transporting, processing, marketing and exporting cultured shrimp. Despite the technological improvements evident suggests that shrimp farming development coincides with the pollution of the culture water which poses long term environmental risks (Piedrahita, 2003). Naylor et al. (2000) observed that while technology exists to reduce outputs from shrimp ponds, such as water treatment and pond lining, or even through culturing different organisms such as herbivores, these are seldom employed. Certainly, intensive shrimp farming is heavily dependent on the environment, particularly when it does not invest in water and pond management treatment facilities. The other important issue is quality and safety of the product, which has led to the development of several strict measures and standards by the importing countries to be implemented by the shrimp producers. To adapt the standards in addition to knowledge shrimp producers need capital investment to improve the infrastructure, which the small-scale farmers largely lack.

Owing to its importance in generating foreign exchange and in creating domestic employment, the shrimp industry in Thailand has been actively promoted by both the government and the private sector. Market research suggested that the main factors affecting shrimp farming net foreign exchange earnings and the degree of comparative advantage are opportunity costs of shrimp operations and export prices received in the international shrimp market (Neiland, et. al., 2001). Historically, Thai shrimp producers had comparative advantage in exporting shrimp to US, Japan and EU markets, largely because of the premium shrimp price received in the market. Nevertheless, shrimp prices in the international market are often subject to the fluctuating trend of world shrimp supply and demand, and have been on decline in recent years.

Clearly, shrimp farming is a very competitive business venture. One of the key economic problems facing shrimp farmers is the decline in the world price. Producers normally are price takers and have to schedule their productions directly according to the market demand that they expected to meet. For some producers, the struggle to survive under fluctuating market conditions may in part reflect a lack of good investment appraisal by the industry. Shang et al. (1998) emphasized that in order to sustain economic growth, the shrimp farming industry must focus on markets and marketing, in addition to improving production efficiency and minimizing negative environmental impacts. In the current global shrimp trade, private food safety and quality standards, branding, contracts, certification, and agreements are axes around which food retailers are organizing competition based on quality (Busch and Bain, 2004; Hatanaka et al., 2005; Henson and Reardon, 2005). Shrimp supply chains are governed by lead firms in importing countries, who by and large have control on what happens in supplier farms in developing countries. For the small-scale farmers, adopting better management practices to supply quality shrimp at competitive price is a major challenge, but getting access to the lead firms in importing countries to market their quality product remains simply illusive.

Since shrimp is the major export fishery commodity for Thailand, it has a national initiative to promote the Farm-to-Table approach through a voluntary “Code of Conduct (COC)” and “Good Aquaculture Practice (GAP)” for responsible shrimp farming. The COC standards provide for a certification process for all operators and address a variety of issues including the use of feed, veterinary drugs and other chemical products. The GAP project targets the practices of smaller farmers and is less comprehensive. While the COC deals with both environmental management and controlling of product safety (and is more easily implemented in larger farms), GAP narrows the scope by focusing only on safety of the products. Despite being successful in bring shrimp producers under set guidelines of the COC/ GAP program the appropriateness of this scheme in improving marketability of the product and shrimp farmer's profit remains illusive. Evident suggests that without creating economic benefits to the farmers any legislative approach to introduce set of practices to produce safe and clean shrimp will not be sustainable. Moreover, recent slump in shrimp prices in the international markets have brought down the profit margin of farmers to the minimum and have put them in a compelling situation. Obviously, the hard hit group is the small-scale shrimp farmers, who are most vulnerable to the changes in the price structure.

Practical information to trainers

Intensive shrimp farming has introduced a range of side industries in Thailand involved at different stages of shrimp production: hatcheries, feed, pharmaceuticals, agro-chemicals, processing plants and exporters and thus, has created huge employment opportunities for the society. However, intensification of shrimp farming increased production and investment costs, transforming the industry from labor-intensive to capital-intensive. Small-scale farmers that often do not have sufficient capacity for capital investment or who suffer losses in business due to various reasons, including low price of shrimp, are being displaced by industrial farms. Large companies run most of these side industries, and are usually involved in several of these activities and thus, have higher competitive advantage over the small-farms. A study in southern Thailand reported that it was the larger farms that proved the most profitable in the longer run, due to scale economies and better management; the small-scale farms going out of business after initial profitability (Tokrisna and Benheam, 1995). Analyzing Thai Government policies on shrimp farming development Huitric et al. (2002) observed that the development of legislation has not followed the same pace as the development of the industry, neither temporally, nor in content, nor in implementation, and contradictory policies have arisen. The negative impact of government failure to address this issue is evident in a shift from shrimp farming predominantly being a small-family business in Thailand to corporate monopoly, where few multinational companies now produce two third of the total shrimp production. Obviously, the most seriously affected are the small-scale shrimp farmers who not only have lost their traditional livelihoods, but many have become labor on their own farms.

The social problems are strongly associated with the system of property and use rights existing in a country. However, where agricultural land has been owned, small-scale landowners have been willing to sell their land and reinvest in other productive activities, though this change of livelihood can also lead to social dislocation and reduced livelihood support. It is only through change in the economic, legal, social and political parameters of power in a country that real social progress can be made. More precisely, if shrimp farming development is perceived as a process through which improvements are made to the quality of life for society as a whole, rather than for certain classes or groups, current policies by national and international agencies need to be reconsidered.

Global environmental agencies, such as Aquacultural Certification Council (ACC), Global Aquaculture Alliance (GAA) and World Wildlife Fund (WWF), GLOBALGAP have launched their own certification schemes. Though all these agencies not situate themselves directly in marketing or supply segment of the commodity chain, they nevertheless have a monopoly over defining quality, sustainability of production, and managing environment, and therefore reflect a broader shift towards what Gereffi et al. (2001) call ‘‘a private layer of governance that moves beyond state borders to shape global supply chain”. For instance, major buyers of commercial shrimp such as Wal-Mart, Darden, and Lyons have committed to buy only ACC-certified seafood, and thus, have left no choice for shrimp farms in developing countries to be part of their trade. Overall, the race for shrimp farm certification is very pushy to small-scale farmers, who are not able to adopt the standards to meet the requirements laid by the lead firms in importing countries. In other words, certification has the effect of marginalizing those producers who cannot afford to participate, or do not have the cultural, social, and technical knowledge, and therefore subsequently leads to industry consolidation by eliminating small players (Hatanaka et al., 2005; Busch and Bain, 2004; Tanaka and Busch, 2003; Deaton, 2004; Mutersbaugh, 2002; Tanner, 2000). The dilemma is that the certification regime has emerged with a promise to protect communities affected by environmental externalities and to ensure human rights and community participation, but as its technical measures move towards industry consolidation, in practice it leaves almost no space for small-scale farmer’s participation. Further to this though shrimp farming is a profitable industry; however, it does not reward everyone involved in it. Stakeholders like small-scale farmer, farm and hatchery workers, depot workers, ice van operators, processing workers etc. are still in poverty and their incomes are not sufficient for their families. On the other hand, hatchery owners, large-scale farms owners, middlemen/traders, depot owners, processing plant owners, ice factory owners, exporters etc. are among the biggest beneficiaries.

Thailand has successfully maintained its historical position of leading shrimp exporter in the world by adopting various changes to suit the world market. In the recent years the Thai shrimp sector has been focusing to diversify its export and increase its export share to non-traditional markets. Notably, Thailand has doubled its market share of shrimps in the EU during 2004 to 2008. In this regard both public and private sectors have played, and will continue to play, a significant role in the industry. However, rising concerns over environmental and social impacts of shrimp farming development need greater attention for sustainability of the sector.

With the purpose to assist small-scale shrimp farmers to improve product compliance with the EU standards the Asian Institute of Technology (AIT) and the Network of Aquaculture Centres in Asia-Pacific (NACA) conducted a project under titled “Capacity building of small-scale shrimp farmers on adaptation of best management practices (BMPs) to promote Thai shrimp export to the EU” from September 2006 to December 2008. The project goal was to improve quality of shrimp produced by small-scale shrimp farmers through adaptation of BMPs to increase their participation in the EU export market. The project conducted farm survey in two provinces of Thailand to understand the social, technical and financial issues and challenges being faced by the small-scale farmers to adopt standards for responsible shrimp farming. The study revealed that lack of knowledge on standards, insufficient technical assistance program, assess to credit for investment, lack of information on market and declining market price of shrimp are the major issues to deal with to promote adoption of standards for responsible shrimp farming among the small-scale shrimp farmers. Findings of the study will be shared in detail with the participants during the lecture.

Conclusion

The current economic crisis continues to influence the world shrimp market. Generally, because of their relatively high price, sales of shrimp products suffer because of loss of purchasing power. Since fundamental problem is associated with the volatility of world shrimp prices, and therefore, knowledge of the price trends of world shrimp products is very important information for the sustainable shrimp industry. Such knowledge would be particularly useful in forming domestic shrimp policies. For example, the policy implications may be that the Government may provide minimum price guarantee to the vulnerable group of shrimp farmers, as long term plan the Government may seek to increase shrimp farming areas with small-scale farmers to develop the export market as well as serve the social cause following the underlying principle of fair trade. Further to this coordinated action would be required to launch market campaign in the importing countries to promote quality shrimp produced by small-scale farmers under fair trade principle. A way forward may be collaboration between Thai producers and shrimp importers, particularly developing direct contractual relationship between shrimp producer and importer through the famer organization would of great interest to safeguard the interest of the small-scale farmers. Further to this setting up a system for market research on consumers' tastes and preferences and timely dissemination of such information could assist in an expansion of the overall size of the export market and its export shares in the niche markets.

Though Thailand faces fierce competition from neighboring country it is anticipated the international market for shrimps will remain strong and that there is room for further growth in the industry. One exciting development is the increased opportunity for interaction and cooperation on shrimp trade among major shrimp producing nations. Trade associations from the world's four largest shrimp-producing nations namely, Thailand, Viet Nam, Indonesia and China have signed a multilateral cooperation agreement in May 2009 to develop and maintain a healthy farmed shrimp industry by encouraging socially and environmentally responsible shrimp-farming practices to ride out the economic downturn. It is expected that the alliance will also strengthen shrimp industries in these counties in developing strategy to cope up with the challenges posed by the volatile international shrimp market.

Further to this given the high competition and low price in the world market, redirection of support for shrimp culture development within the general agricultural settings will help both producers and domestic consumers in the country. For instances, availability of programs focusing on intensive information dissemination and training schemes on the various standards and technology choices will have positive effects on the adoption rate of standard practices. It is suggested that if shrimp aquaculture has to be seen as a sector to enhance the socioeconomic condition of the rural communities it would be required for the Government to regulate growth of the industry keeping pro-poor policy in mind. Overall, a well-coordinated capacity building program inclusive of export marketing and promotion with respect to import regulations, product development and market information will play an important key role in improving the production efficiency of small-scale shrimp farms and their competitiveness in international market.

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Climate change and aquaculture: potential impacts, adaptations and mitigation

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Abstract

This is a summary of a synthesis to address issues relating to impacts of climate change on aquaculture, the farming of aquatic species. In order to treat the subject matter comprehensively, the role of aquaculture in its contribution to the human food fish basket, in relation to that from capture fisheries is discussed. The food fish supplies is the only animal protein commodity that is still predominated through hunting, but its being gradually overtaken by farmed products, and currently the proportionate contribution of the latter to food fish consumption approximates 45 percent. In the above context and that of envisaged population growth the food fish supply requirements are estimated and the increasing contribution from aquaculture assessed. This change is also reflected in the increasing contribution of aquaculture to the total fisheries of the GDP in some of the main producing countries.

Aquaculture is not practised evenly across the globe. The current aquaculture practices in relation to three climatic regimes, viz. tropical, sub-tropical and temperate regions are assessed, and in turn in relation to environmental types viz. marine, fresh- and brackish waters and geographic divisions by continents. It is seen that aquaculture is predominant in tropical and sub-tropical climatic regions, and geographically in the Asian region. Furthermore, the most predominant cultured commodities are finfish, molluscs, crustaceans and sea weeds, and in turn predominated by species that feed low in the food chain. This geographic and climatic concentration of aquaculture entails the need to focus the development of adaptive changes to combat climatic change impacts to such regions, for the time being and primarily, if the predicted gap in supply and demand in food fish supplies is to be realised through aquaculture. However, we cannot disregard the potential for aquaculture growth in other regions.

The main potential elements of climate change that could impact on aquaculture production, such as sea level and temperature rise, change in monsoonal rain patterns and extreme climatic events, water stress, are highlighted, and the reasons for such impacts evaluated. All cultured aquatic species for human food purposes are poikilothermic and consequently temperature increases and or decreases would have a profound influence on productivity. By virtue of the fact the that the different elements of climate change are likely to be manifested/ experienced in different climatic zones, to varying degrees the direct impacts on aquaculture in the different climatic zones are considered. For example, it is predicted that global warming and the consequent increase in water temperature could impact significantly and negatively on aquaculture in temperate climatic zones, because such increases could exceed the optimal temperature range of organisms currently cultured, as opposed to possible positive impacts through enhanced growth and production in tropical and sub-tropical zones, but not without some possible negative impacts arising from other climatic change elements (e.g. increased eutrophication in inland waters). In both instances possible adaptive measures for reducing/ maximising the impacts are considered. An attempt is also made to deal with the climatic change impacts on different culture systems, such as for example, inland and marine and in turn different forms of culture practices such as cage culture. Furthermore, on the negative front is the possibility of an increase in the virulence of pathogens because

of the temperature rise that were dormant beforehand. Such changes will also mostly impact on temperate aquaculture.

Nearly 65 percent of aquaculture production is inland, and over 80 percent barring seaweeds, and concentrated mostly in the tropical and sub-tropical regions in Asia. Climatic change impacts through global warming on practices are likely to be small on such systems, and if at all positive brought about by enhanced growth rates of cultured stocks. On the other hand, climate change will impact on water availability, changes in weather patterns, such as for extreme rain events, and exacerbate eutrophication and stratification in static (lentic) waters. The influence of the former on aquaculture is difficult to project. However, based on the current practices, particularly with regard to inland finfish aquaculture that is predominantly based on species feeding low in the food chain, the greater availability of phyto- and zooplankton through eutrophication could possibly enhance production. On the other hand, adaptive measures are available for combating the potential negative impacts of the latter that could arise through resulting oxygen depletion in the early hours. These in inland waters would include of setting up of aquaculture practices in accordance with the carrying capacities of the water bodies, and continuous and regular monitoring of water quality for nutrients and stratification levels, that would enable the movement of the cage facilities for example to "safer" areas in the wake of major weather changes e.g. storms and potential upwelling. On the other hand, in marine cage culture the adaptive measures will revolve around introduction of better technologies in respect of cage design that would withstand storms and wave surges.

Sea level rise and consequent increased salt water intrusion in the deltaic areas of the tropics where there is considerable aquaculture production are likely to be impacted upon. Adaptations to these impacts will involve further inland movement of some of the existing culture practices of limited saline tolerant species (*Stenohaline* species) e.g. catfish (*Pangasianodon hypophthalamus*) in the Mekong Delta and utilization of the facilities already in existence to culture more saline tolerant (euryhaline) species, e.g. *Penaeid* shrimps. Equally, aquaculture is seen as an adaptive measure to provide alternative livelihood means for terrestrial farming activities that may be made no longer possible and or cost effective due to sea water intrusion and frequent coastal flooding.

One of the most important impacts of climate change, but indirect, on aquaculture is considered to be brought about through limitations on fish meal and fish oil availability for feeds through a reduction in raw material supplies, for cultured carnivorous species; the negative impacts likely to be felt mostly on aquaculture in the temperate regions, where the mainstay of finfish aquaculture is based entirely on carnivorous species. The fish meal and fish oil availability will not only impact on aquaculture but on all forms of animal farming, albeit to different degrees. Adaptive measures to combat these impacts are suggested. However, overall for aquaculture to be sustainable and ecologically cost effective it is suggested that a major shift from culturing carnivorous finfish species to species feeding low in the trophic chain is considered more desirable.

The ecological cost of aquaculture as opposed to producing other animal protein sources to meet the growing human food demands is presented. The general notion that aquaculture reflects salmonid and shrimp culture, two environmentally and energy costly farming practices is contested in view of the fact the great bulk of aquaculture commodities feed low in the food chain, and consequently the most popularly practiced aquaculture, particularly in the developing world, which also happens to be the main producers, is shown to be a considerably less energy consuming food production sector. Aquaculture is dependent on alien species to a relatively significant extent. In this regard, evidence is provided that fresh introduction of species should not only consider potential economic gains, which more often than not tend to be short term, but consider the energy cost of such introductions, hence direct and/or indirect contribution to green house gas emissions, in comparison to the other available options. This suggestion is backed up with data on shrimp aquaculture, where the options of introducing alien species are controversial and remains unsolved in respect of policy development for some major shrimp producing nations in Asia.

The indirect positive impact of aquaculture on the preservation of coral reefs that are predicted to be negatively impacted upon by climate change is considered. In this regard aquaculture is expected to meet the growing demand of the lucrative, live fish restaurant trade of high valued marine species such as groupers (e.g., *Epinephalus* spp.) and in doing so it will reduce the intensity of the use of destructive fishing methods. The latter will therefore, essentially remove a factor exacerbating coral reef destruction and contribute to conserving biodiversity.

Two of the most important aquaculture activities, primarily from an economic view point, are carnivorous finfish (e.g. salmonid) and shrimp culture, that generate export income to producing countries, and where the processing of these commodities provides a large number of livelihood options to communities that would otherwise will not be available. However, these commodities, based on life cycle assessments, are energy wise very costly, and contribute to net carbon emissions. The production of these commodities is market driven with the latter increasing in consequence to the increases in living standards and higher disposable incomes, both in the developed and developing world. As an adaptive measure to curtail the contribution to carbon emissions from these relatively high priced commodities it is suggested that the consumer is made aware of the degree of carbon emissions for the products, in the same vein as indicating traceability.

All farming systems have an energy cost, and in one form or another will contribute to the emission of green house gases, and thereby contribute to climate change, albeit to different degrees. In this context it is shown that the great bulk aquaculture is less energy costly, and indeed contributes to carbon sequestration than most other terrestrial farming systems. It is suggested that criticisms on aquaculture have been based on the consideration of, by and large, the farming of carnivorous finfish species and shrimp; two commodities that account for less than ten percent of global aquaculture production. On the other hand, it is pointed out that the positive aspects of aquaculture, particularly in relation to its impacts on climate change, perhaps the most burgeoning problem facing the world, is neglected by many.

Principles of developing, validating and adopting better management practices in aquaculture - Shrimp case study

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Abstract

The demand for quality and responsibly produced and certified aquaculture products is predicted to increase substantially in coming years and the most feasible, economical and acceptable way to achieve these goals is for small scale farmers to adopt Better Management Practices, collectively as a cluster, in a given locality. Better Management Practices (BMPs) in the aquaculture context outline norms for responsible farming of aquatic animals. In aquaculture, better management practices have been developed largely for shrimp and salmon aquaculture, although some efforts are presently being made to develop BMPs for other aquatic commodities. BMPs improve the quantity, safety and quality of products taking into consideration animal health and welfare, food safety, environmental and socio-economical sustainability. BMP's are management practices, and implementation is generally voluntary; they are **not** a standard for certification. However, implementation of BMPs will help to achieve compliance with standards set by international agencies, certification bodies and trading partners. It is expected that organization of farmers and the introduction of BMP approaches to their farming activities would be an important tool in enabling smaller-scale producers to enter certification systems. It is in this context, development, validation and implementation of BMPs is very important to ensure sustainable and responsible aquaculture.

Introduction

The importance of aquaculture to food security cannot be overstated. Aquaculture, therefore, has gained significant momentum in several parts of the world. Asian aquaculture, even in respect of the commodities that constitute major export commodities, such as shrimp, *Penaeus vannamei* and *P. monodon* (China, India, Indonesia, Thailand and Vietnam) and tra catfish, *Pangasianodon hypophthalmus* (Vietnam), and the growing rohu, *Labeo rohita,* farming sector in Myanmar are essentially small-scale farming systems, clustered together in a given locality. With increasing impacts of globalization small-scale aquaculture farmers need access to scientific knowledge, financial and technical services and market information in order to sustain their livelihoods and compete in modern market chains.

The WTO-SPS Agreement sets out the basic rules for food safety and animal and plant health standards. The basic aim of the SPS Agreement is to maintain the sovereign right of any government to provide the level of health protection it deems appropriate, but to ensure that these sovereign rights are not misused for protectionist purposes and do not result in barriers to international trade. The demand for quality and responsibly produced and certified aquaculture products is predicted to increase substantially in coming years and the most feasible, economical and acceptable way to achieve these goals is for small scale farmers to adopt Better Management Practices, collectively as a cluster, in a given locality.

It is in this context that development, validation and implementation of commodity specific better management practices for small holder farmers of Asia-Pacific is timely and appropriate.

What are BMPs?

Better Management Practices (BMPs) in the aquaculture context outline norms for responsible farming of aquatic animals. In aquaculture, better management practices have been developed largely for shrimp and salmon aquaculture, although some efforts are presently being made to develop BMPs for other aquatic commodities (e.g. tilapias, catfish, molluscs, eels). In shrimp aquaculture, the experience of the Consortium (FAO/NACA/UNEP/WB/WWF. 2006. International Principles for Responsible Shrimp Farming) shows that well designed BMPs can support producers to (a) increase efficiency and productivity by reducing the risk of shrimp health problems, (b) reduce or mitigate the impacts of farming on the environment, (c) improve food safety and quality of shrimp farm product, and (d) improve the social benefits from shrimp farming and its social acceptability and sustainability.

BMPs can be country specific, or developed for a particular location, taking into account of local farming systems, social and economic context, markets and environments. BMPs are often voluntary practices, but can also be used as basis for local regulations, or even certification programmes. It was suggested that these could also provide the basis for the voluntary and market-driven certification schemes.

In summary, BMPs improve the quantity, safety and quality of products taking into consideration animal health and welfare, food safety, environmental and socio-economical sustainability. BMP's are management practices, and implementation is generally voluntary; they are **not** a standard for certification. However, implementation of BMPs will help to achieve compliance with standards set by international agencies, certification bodies and trading partners. It is expected that organization of farmers and the introduction of BMP approaches to their farming activities would be an important tool in enabling smaller-scale producers to enter certification systems.

How to develop BMPs?

BMPs are not only commodity specific but also location specific. It is generally agreed that for all cultured commodities it is necessary to underpin the general principles for responsible farming that would cover environmental, social, ethical, food safety and husbandry issues. The first step in developing BMPs is gaining in depth understanding of the culture system and cultured species. This should be done at the population level and not in one or two ponds. Population based approaches to understand the problems and issues facing a cultured commodity in a specific farming area are gaining importance. Epidemiological studies (population based studies) help to identify variables that are associated with good (e.g. higher production, less disease, less environmental damage) and bad outcomes in a culture system for a particular commodity. Factors associated with bad outcomes are normally called as risk factors. Interventions developed to address the identified risk factors can be referred to as better management practices.

What is Epidemiology (Population based approach)?

In order to understand population based approach, it is necessary to understand some simple concepts in epidemiology. Epidemiology is population medicine. For the epidemiologist, the population is the patient. Epidemiology is the study of disease in population in its natural setting. All epidemiological studies are field based. In aquatic epidemiology, aquaculture ponds serve as the laboratory. This can be a great advantage over laboratory studies, which may not be easily extrapolated to field conditions.

Cause from an epidemiological perspective is interpreted in quite a wide sense. This is somewhat different to the more traditional view of the role of cause being restricted to etiological agents. An epidemiological definition of a cause of a disease is "an event, condition or characteristic that plays an essential role in producing an occurrence of the disease". Epidemiologists avoid defining the word cause for any disease outbreak, but prefer to use words such as determinants, exposures and risk factors. Alternatively, they will categorise causes as direct or indirect; necessary or sufficient; and single or multiple, rather than defining cause.

i) Concept of Cause

For most diseases, there is strong evidence that disease outbreaks occur only when a number of causal factors combine. The multifactorial nature of disease causation can be represented using the concepts of necessary cause, component cause and sufficient cause. Each combination of various causal factors (component causes) which together cause a disease collectively as a "sufficient cause" for that disease. It is important to recognise that, under different circumstances, different combinations of "component causes" may constitute sufficient cause for a disease. Disease outbreaks will occur only if there is a sufficient cause for that disease. Moreover, all sufficient causes for a particular disease have in common at least one component cause, known as "necessary cause". This necessary cause must always be present for that disease to occur. Mere presence of necessary cause alone will not always cause the disease.

Under such a definition, the presence of say WSSV (necessary cause) alone in a pond of shrimp may not of itself be a sufficient cause for WSS to occur. It may require a stress trigger to cause an outbreak. Under this concept, the WSSV is a necessary cause (no disease would occur if WSSV was not present) but not a sufficient cause of the particular syndrome, whereas the stress is neither necessary nor sufficient but can be a component of a sufficient cause. In fact, for any particular expression of a particular disease, there may be a range of possible sufficient cause complexes.

Similarly, presence of *Aphanomyces invadans* (necessary cause) alone is not sufficient for EUS to occur. For EUS to occur, combinations of causal factors must ultimately lead to exposure of dermis, attachment to it by *Aphanomyces invadans* propagules (the only currently recognised necessary cause) and subsequent invasion by the fungus of dermis and muscle. The resulting mycotic granulomatous dermatitis and myositis are, by case definition, EUS. Interventions aimed at eliminating any one of the component causes can prevent occurrence of EUS despite of the presence of the necessary cause.

On the other hand, the aetiology of a disease outbreak may be well defined, however, the cause of the same outbreak may be confusing. For example, two ponds may test PCR + for WSSV but only one pond may experience a disease outbreak. In this instance WSSV (necessary cause) must be present for the outbreak to occur but the presence of WSSV in the pond doesn't necessarily lead to an outbreak. Likewise in two PCR+ ponds, one may experience high mortalities while the other low mortalities. Therefore, there are other risk factors (component causes) which would determine whether the disease is expressed and if it is expressed, the severity of the outbreak.

ii) Risk Factors

Risk factors are those characteristics on the basis of population based evidence which, are associated with increased risk of disease. (Protective factors are those which are associated with decreased risk of disease based on a population evidence). Risk factors may be either causal or non-causal. Epidemiological studies have the objective of identifying these risk factors, quantifying their effect on outcome, and formulating intervention strategies on a pond, farm, region or country level. The challenge for the epidemiologist is to help identify some of the more important components of sufficient causes for a particular disease with the view to devising cost-effective intervention strategies at critical points to either prevent disease expression or reduce the production effects.

Application of epidemiological principles for development of BMPs

Population based studies using epidemiological principles are used to understand the culture system and species. Different types of approaches can be taken in this direction. In observational studies nature is allowed to take its course while the differences or changes in characteristics of the population are studied without intervention from the investigator. Observational studies can be descriptive, longitudinal, cross-sectional or case-control. Descriptive studies describe the distribution and frequency of a outcome (e.g. disease) in a population. The described patterns may lead to a hypothesis (for example, EUS occurs normally during cooler months of the year). Longitudinal studies follow study units through time, observe and record the course of natural events, record frequency of outcomes (e.g. disease), look for differences (factors) between groups with and without the selected outcome (e.g. disease). Cross-sectional study gives a snapshot in time, prevalence of outcome (e.g. disease) is measured and compared among those with and without the risk factor of interest (ex: PCR positivity of PL). Case-control study selects units with the outcome (e.g. disease) of interest as cases and units without the disease as controls, frequencies of suspected risk factors are then measured for the two groups and compared. The most frequently used approach is conducting questionnaire based population survey and then using the information to identify risk factors.

i) Outcomes and Associations

Epidemiological studies define certain outcomes and use them for separating the population into groups for comparison. Frequently used outcomes in epidemiology are mortality and disease outbreaks. For example, shrimp ponds may be divided into successful ponds and failure ponds based on disease outbreaks, yield, weight at harvest, length of production cycle, etc. Using epidemiological and statistical tools, it is possible to identify variables (factors) associated with defined outcomes. Variables statistically associated with successful outcomes are regarded as protective factors. Variables statistically associated with failure outcomes are regarded as **risk factors**. The risk/protective factors identified based on a population are mere associations with the outcome and should not be regarded as either cause of the outcome or solution to the outcome.

Sampling is a crucial issue in epidemiological studies. The sample should be random and should represent the target population. The results obtained from the sample should have to be generalised to the whole population. In order to achieve this, the sample size should be such that the results could be generalised with 95% confidence to the whole population and should have the power to show the statistical differences between groups. Problems of bias and how to avoid it is of central importance to the validity of all epidemiological studies. Bias occurs when observations do not reflect the true situation. This is because of systematic error such as sample selection bias, sampling bias, measurement bias, etc.

The aim of data analysis is to identify risk factors for selected outcomes (e.g. disease outbreaks). Risk factor is any variable having statistical association with the outcome of concern. Positive association suggests increased risk (risk factor) while negative association suggests decreased risk (protective factor). Such identified associations are only statistical associations and not the same as the cause.

Interventions developed to address the risk factors can be called as better management practices (BMPs). For example not drying a pond can be a risk factor for poor production. Therefore, drying the pond before stocking seed becomes a better management practice. BMPs can be developed to address series of risk factors associated with various stages in culture operation (pond preparation, seed selection, stocking, water quality management, feed management, disease management, pond bottom monitoring, harvest and post harvest handling). Once a set of BMPs are developed based on scientific studies, stakeholder consultations and existing scientific knowledge, it is necessary to test the BMPs and validate them. This is normally carried out through farm demonstration studies. BMPs are constantly evolving and changing and it is necessary to consider approaches to continuously evaluate and improve BMPs.

How to promote adoption of BMPs?

Promoting the adoption of BMPs by small scale farmers is not easy and straight forward. Using appropriate extension methodologies to bring about change in the attitude of farmers and encouraging them to change their culture practices by incorporating BMPs are vital for successful adoption of BMPs.

A critical aspect of the introduction of BMPs has been the role of farmer groups, or other organizations, and the effective linkage between the public sector and such organizations. Provision of science based information to farmer groups through effective networking and communication is one important key to the success.

Implementation of BMPs-Shrimp

The broadest principles for sustainable aquaculture are provided by the Code of Conduct of Responsible Fisheries (CCRF). The Code has been the basis for the development of more specific principles and practices. Among these are the "International Principles for Responsible Shrimp Farming"[4]. The 'Principles' provide an international framework for improving the sustainability of the shrimp farming sector. Better management practices (BMPs) have been developed and used in several countries to put into practice the more general principles of responsible shrimp farming. Experience has shown that well designed and implemented BMPs can support producers to:

- Increase efficiency and productivity by reducing the risk of shrimp health problems
- Reduce or mitigate the impacts of farming on the environment
- Improve food safety and quality of shrimp farm product; and
- Improve the social benefits from shrimp farming and its social acceptability and sustainability

Shrimp BMP projects, in India, Indonesia, Thailand and Vietnam provide good examples of translating the international principles into specific BMPs adapted to local farming conditions and ensuring their implementation by relevant stakeholders, with consequent gains in production, quality improvements and market accessibility. They also show evidence of the advantages of small-scale farmers being organized (farmer groups/societies), sharing resources, empowering the stakeholders, helping each other and adopting BMPs. The implementation of the BMPs has provided benefits to the farmers, environment and society.

India Case Study

Since the early 1990s, the Indian shrimp aquaculture sector has been hard hit by viral diseases. To address rising concerns about the effect of diseases on the sustainability of the sector, the Government of India's Marine Products Export Development Authority (MPEDA) with the technical assistance of NACA and the support of the Indian Council of Agricultural Research (ICAR) and the Australian Center for International Agricultural Research (ACIAR) initiated a programme in 2000 on "Shrimp disease control and coastal management". The programme started in 2001 with a large epidemiological study aimed at identifying the risk factors for key shrimp diseases. It also undertook to develop and disseminate BMPs to minimize farm-level risk factors for disease outbreaks and to address shrimp farming sustainability more broadly. The programme, which is now in its ninth year, was implemented in a phased manner. Some of the key stages of the programme included:

- A baseline study of the major diseases affecting the shrimp aquaculture operations (2000)

[4] FAO/NACA/UNEP/WB/WWF (2006) International Principles for Responsible Shrimp Farming. Network of Aquaculture Centres in Asia-Pacific (NACA). Bangkok, Thailand. 20p. (Available in English, Arabic, Chinese, French, Portuguese and Spanish at www.enaca.org/shrimp)

- A longitudinal epidemiological study in 365 ponds in Andhra Pradesh, east coast of India, to identify major risk factors associated with WSD and low productivity in *Penaeus monodon* culture ponds (2000-2001)
- Development of farm level contextualized BMPs to address the identified risk factors (2002)
- Pilot testing of BMPs in selected farms (2002)
- Production of a simple and practical shrimp health management manual based on the outcomes of the risk factor study and piloting of BMPs, to support farm and village level extension programmes (2002)
- Development and testing of the concept of cluster farming for effective BMP adoption amongst farmers in a cluster, and expansion of BMP promotion to a large number of clusters (2003-2004)
- Extension of some of the BMPs to downstream activities like hatcheries
- Review and refinement of BMPs, and production of BMP extension leaflets for each stage of the culture operation (2005)
- Expansion of the BMP programme to clusters in five different states in India (2005-2006)
- Conceptualization of an institutional framework for maintaining the BMP and shrimp health extension programme (2006)
- Establishment and inauguration of the National Center for Sustainable Aquaculture (NaCSA) to carry forward the MPEDA/NACA programme activities (2007)
- NaCSA promoting BMP adoption using cluster approach in several states of India

To enhance BMP uptake and promote adoption in different coastal states of India, BMP brochures on ten key thematic areas were developed in English and translated to all the five state languages. For each of the thematic areas, the brochures describe the field procedures in fifteen simple steps in local language, with the aid of pictures from the field. BMP dissemination was principally through weekly farmers meetings and regular pond visits. All the ten BMP brochures can be downloaded from www.enaca.org/shrimp

1. Good pond/water preparation
2. Good quality seed selection
3. Water quality management
4. Feed management
5. Pond bottom monitoring
6. Health monitoring/biosecurity
7. Food safety (no use of antibiotics)
8. Better harvest and post-harvest practices
9. Record maintenance/traceability
10. Environmental awareness

Conclusions and Way forward

Shrimp BMP projects, in India, Indonesia, Thailand and Vietnam provide good examples of translating the international principles into specific BMPs adapted to local farming conditions and ensuring their implementation by relevant stakeholders, with consequent gains in production, quality improvements and market accessability. They also show evidence of the advantages of small-scale farmers being organized (farmer groups/societies), sharing resources, empowering the stakeholders, helping each other and adopting BMPs. The implementation of the better management practices has provided benefits to the farmers, environment and society.

BMPs for shrimp farming have been successful in improving shrimp production and profitability and reducing risk for smallholder farmers in India and in Indonesia (Java and Aceh). BMPs for marine finfish farming and for tra catfish farming are at advanced stages of development and are likely to be tested by the middle of 2009. It is also believed that use of BMPs by small scale farmers will enable access to better markets and address socio-economic sustainability. BMPs need to be grounded in valid scientific justification, rather than perception / experience. Thus there is a need for R&D to validate key BMPs, and to quantitatively assess their impact on farm production and economics. Equally, there is a need to develop implementation mechanisms to permit large-scale scaling up of BMPs to create impacts among large numbers of small-scale farmers. Implementation mechanisms should also, far as possible, be supported by and built on systems already in place in the relevant country i.e. the cultural contexts prevalent in each country have to be taken into consideration.

Market links are now being explored between BMP implementers and buyers, but considerable further R&D work is necessary on strategies that connect small-farmers to markets. Enhanced regional cooperation is required to build on existing experiences and promote wider adoption of better management practices across selected commodities and countries in the Asian region. The lessons learned from shrimp BMP programs in the region should pave the way for development and implementation of BMPs for other key aquaculture commodities. BMPs should be simple, science based and cost effective so that farmers can readily adopt them. Development, validation and implementation of commodity-specific BMPs should be seen as a way forward for promoting sustainable aquaculture in the region.

Developing communication and networking mechanisms for improving services to small scale farmers

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Abstract

Given the limited availability of traditional extension services, there is a need to investigate alternative approaches to improve communication and networking with small scale farmers. Effective communication requires clearly identifying the target stakeholders and researching their needs, interests and preferred methods of communication. This kind of information can be gathered through an information access survey. A blended approach to communication is often more effective than any single method alone. Approaches that encourage networking and 'self-help' between and within stakeholder groups, such as farmer associations or locally owned/maintained information centres, may offer effective starting points.

The internet does not have sufficient penetration to be a mainstream communication tool for communicating directly with the majority of farmers. However, it can be successfully employed through facilitated access, and is often an important tool for those working with farming communities. Online 'social networking' is providing an unprecedented level of connectivity and exchange between interest groups, and will become increasingly important as internet penetration increases amongst rural communities.

Introduction

Farming has never been easy, but in the era of globalisation it is getting harder. Rural communities that were once isolated are being drawn into national and global markets, competing for energy, fertiliser and feed inputs and facing ever more stringent food safety and environmental regulations. Farmers in the ASEAN region will need to continuously improve their efficiency and competitiveness to stay in business. They need to adopt better management practices.

Asian aquaculture is characterised by small-scale, family-operated farms that are typically very numerous and widely distributed. This presents challenges to training and extension services operating with limited personnel and resources. We need to find smarter, more efficient ways to deliver services and strengthen networking for small-scale producers.

This guide explores options for improving communication with and between small-scale farmers, in the context of facilitating adoption of better management practices.

Developing a communication plan

Communicating effectively with stakeholders is not necessarily difficult, but large organisations such as government departments are notoriously bad at it. The most important thing is to *consider the needs of your stakeholders and put that first*. What kinds of information do they want? How do they prefer to communicate? You need to find out.

Once you understand your stakeholder's needs and interests you will find it easier to communicate with them. The more relevant your message the more willing they will be to listen. Give your stakeholders something that *they* value and you will also get your organisation's own message across to them more effectively.
How? A good way to start is to develop a simple communications plan. The main elements of this are to:

- Clearly identify your stakeholders.
- Find out what they need.
- Find out how they prefer to communicate.
- Use your findings to develop an appropriate plan.

Clearly identify your stakeholders

It is important to clearly identify who you want to communicate with because this will determine the methods you use. Small scale farmers can of course be highly variable in terms of their farming practices, relative wealth and in the resources available to them.

- Who *exactly* are your target stakeholders?
- Where do they live / how are they geographically distributed?
- Are there any social, economic or geographic groupings amongst them that may be relevant?

It is useful to prepare an inventory of who you want to influence and to identify any natural groups or structures you can find amongst them. You may decide to focus on farmers in a particular area or who use a particular practice, or to work with existing farmer organisations, or people belonging to a particular social group.

Find out what they need

A second important step is to determine the needs and interests of your stakeholders. Government organisations often *assume* that their stakeholders are interested in the same issues that they are. However, the 'real world' concerns of farmers are *frequently* different. It is important to find out what your stakeholders think the real issues are.

It is best to gather information about your stakeholders concerns and interests directly if you can. Attend farmer meetings if possible. If you don't have access to them yourself, try to work through field staff or regional offices that do. Look for publications, prior studies and surveys your organisation may have conducted in the past, usually organisations will have quite a lot of existing information about their stakeholders on hand, but it may not be well organised or easy to find. In the context of the present project, formal needs assessments have been conducted as the foundation for the preparation of the BMPs.

If you understand the needs and interests of your stakeholders you will be much better placed to provide information and services that are *useful* to them. The more relevant your message, the more likely they are to listen, and the more effective you will be. Government organisations frequently try to 'take their policies to the farm' and expect people to adopt them wholesale. In reality, farmers may only be interested in a subset of the 'issues' most relevant to them. You need to identify the overlap, the areas of common interest between your organisation and your target stakeholders. That's your entry point for engaging their interest and also where you have the best chance to influence their views.

Find out how your stakeholders communicate

“...learning to speak in a human voice is not some trick, nor will corporations convince us they are human with lip service about "listening to customers." They will only sound human when they empower real human beings to speak on their behalf.” – The Cluetrain Manifesto.

Conducting an information access survey (IAS) is a good way to get accurate information about your stakeholders requirements, and to determine the best way(s) to communicate with them. The purpose of an IAS is to:

- Identify key issues about people and what information needs they have.
- Identify what media sources are available, what strategies people use to get their information and how cost-effective these are.
- Suggest methods of communication that are useful for different groups of people.

An IAS should:

- Take into consideration the needs of the target group; involve as many people as possible.
- Be socially and culturally acceptable; be flexible, so that it can be modified to suit different circumstances.
- Provide recommendations that are easy to put into practice.

For each stakeholder group, issues to consider/include in preparation of an IAS include:

- The geographical area of the survey.
- The existing communications networks available to target stakeholders.
- The needs and interests of the stakeholders.
- The kinds of information that would be useful to them, and why.
- How people prefer to get this kind of information.
- Mitigating social, political or cultural factors.
- What communication techniques work well (or not), and why?

An IAS will give you an indication of how effective different media are to reach your stakeholders and form the basis for developing a communication strategy. You may find a clear preference towards radio, TV, newspapers or email. For example, radio is very popular in Nepal as the mountainous terrain limits TV signals and distribution of printed media, literacy rates are low in many areas, and it has the advantage of being very cheap. You may find that digital media are not an effective way to reach your target group, or that they are only accessible to part of it.

It is quite likely that you will discover that a broader communication strategy using several different approaches will be more effective than any single method. NACA has conducted IAS for Cambodia, Vietnam and the Philippines, which may be of interest to participants.

Develop an appropriate communication plan

Once you have identified your stakeholders, determined their interests (and how these intersect with your own goals) and found out how they communicate, you should be in a good position to develop an appropriate communication plan consistent with the resources available to you.

If your budget is limited, a little creativity can go a long way, particularly with mass media: Newspapers and magazines will often print submitted articles for free if they are sufficiently interesting. Making content is expensive, so mass media providers are often happy to use ‘free’ content when they can get it – so long as it is relevant to their own target audience. You will need to consider their interests too.

Smarter approaches to networking and service delivery

As conventional approaches such as workshops, mass media and publications are well understood, they will not be covered in great detail here. Instead, we will mainly focus some alternative approaches to improving communications and networking that can help you make the most of limited staff or budget resources. We will also consider ways you can help farmers to help each other more effectively. Practically speaking, there are a lot more of them than there are of you so empowering farmers to help each other may be a lot more productive than trying to help them yourself.

Work with farmer associations and clusters

"People in networked markets have figured out that they get far better information and support from one another than from vendors." – The Cluetrain Manifesto.

Working with farmer associations and clusters (or helping them to form cooperative groups) is an approach that has demonstrated excellent potential as a mechanism to facilitate dissemination and adoption of BMPs, both within and between farmer communities. In India, MPEDA in cooperation with NACA, the Indian Council of Agricultural Research (ICAR), the Australian Centre for International Agricultural Research (ACIAR) and the Food and Agriculture Organization of the United Nations (FAO) has provided support to bring clusters of shrimp farmers together into cooperative associations to implement better management practices (BMPs) as part of projects on shrimp health and coastal zone management. The groups, locally known as "aquaclubs", were initially established to engage farmers in the development of locally appropriate BMPs and to demonstrate and promote the advantages of working as a group to plan their crops. The group collectively manages common resources such as the water supply, thus reducing inter-farm interference, reducing the impact of disease and substantially increasing survival, size, yield and price received for the crop. Similar approaches have been applied in Vietnam.

The benefits of collaborative farmer groups include that they:

- Provide a strong mechanism for farmer-to-farmer learning and "self help".
- Serve as focal points for extension services, leveraging the accessibility and impact of better farmers and available extension staff among small-scale producers. It's easier to deal with small scale farmers as groups rather than individuals.
- Provide a mechanism for rapid implementation of new technologies or BMPs across the group, such as food safety directives from export markets or traceability systems.
- Provide economies of scale in purchasing technical services, such as the testing of seed for health problems, which in turn facilitates the access of small-scale farmers to these services; provide a mechanism for self-regulation, as there is considerable economic incentive and peer pressure for farmers to participate and comply with the groups' management principles.
- Provide increased market power in negotiating prices for inputs and for the sale of the harvest.
- Are self-sustaining – as there are considerable economic benefits from farmer collaboration they may be independent of government support and maintained by the farmers themselves.

Farmer associations have good potential in situations where farmers have a strong common interest and can benefit from working together, for example in the procurement of inputs or the management of shared natural resources. Aquaclubs will be covered in more detail in a separate lecture.

Establish 'one-stop shops'

Farmer groups can also be linked to structures that facilitate sharing of experience or access to outside knowledge. Research reported in academic journals, often in English, is an important step to sharing new aquaculture knowledge and technology but has little development impact in itself. As a consequence there is increasing interest in "Research into Use" programmes. A particular communications and learning challenge is the exchange of learning with and among poor people who farm in rural areas.

The evolution of local-level institutions that facilitate learning and planning and the availability of accessible local language media are helping farmers to draw down the information and other support services they need and even beginning to provide a platform for policy debate and monitoring and evaluation from farmers' perspectives.

NACA established nine "'One-Stop-Aqua-Shops" (OAS) in eastern India, one in Pakistan and one in Viet Nam to provide local-level support. The OAS function under the guiding principle of a single-point, under-one-roof provision of services, but are managed by different groups such as NGOs and federations of Self-Help Groups (SHGs), farmer groups and local community officials. The OAS provide a variety of services according to local demand including information, training, fish fingerlings, and access to sources of micro-credit and loans necessary to enter into farming. Previously farmers had struggled and engaged in considerable travel to gain access to resources such as quality fish seed and market information and had often been unaware of governmental, inter-governmental and NGO support, and rural banking services.

To support these facilities, in particular with the media required to fulfil their communications role, NACA responded with the launch of OASIS (the "One-Stop Aqua Shop Information Service"). OASIS, like the OAS concept, intended to support changes to the way that information is made available to farmers and through the OAS network. The initiative:

- Offered farmers aquaculture and improved service delivery orientated better-practice guidelines.
- Enabled farmers to learn from each other's experiences and share these with other primary stakeholders throughout the Asia-Pacific through publications made available in local languages at OASs.
- Allowed farmers to find out who is who from a "contacts" database, including details of OASs, banks, departments of fisheries, NGOs, SHGs, insurance providers and input suppliers.
- Enabled farmers to gain access to information and facilitated access to web resources such as the NACA Virtual Library.
- Enable farmers to ask aquaculture-related questions and receive feedback via the NACA web-based "discussion forum".
- Offered awareness raising in aquaculture through documentaries; and offered exchange visits with successful aquaculture operations within the local area.
- OASIS aimed to make available information from farmers and fishers, service providers, news agencies, the Internet, academia (including databases of research and outputs from specific research programmes) and on-line communities of shared interest groups, as well as learning from other countries.

The OAS has become a focus of improved service provision in an age where previously unprecedented levels of communication are possible and has changed the way that information is being made available. The OAS enables service providers to get "closer" to communities through the development of information and service focal points.

Mass media

Regular television and radio programmes are utilised by both governmental authorities and the private sector as a mechanism to keep farmers informed of developments, emerging issues and improved practices. These range from current affairs segments in broader agricultural programmes (as in Australia) to dedicated documentary segments (as in Thailand) and talk-back programmes where farmers may "call in" (as in Cambodia). The Agricultural Information and Communication Centre in Nepal records a highly popular radio show called "Old Lady", in which a voice actor asks questions about agricultural techniques in mock discussions with experts, and farmers submit questions via post. Clearly such devices have enormous potential, although agricultural programmes tend to be broadcast outside of peak hours.

Printed publications

Printed publications are a mainstay of extension employed by virtually all governments as a (relatively) cheap mechanism for reaching large numbers of producers, although where cost-recovery policies are pursued, cost is still often a significant issue both for the publisher and for the end user. As stand-alone products, the usefulness of publications is constrained by many factors, including the literacy and technical ability of the target stakeholders, and so they need to be prepared with due consideration of the needs of the target group, for whom they often play a supporting role in training courses and other ways of learning. Government organisations tend to communicate in an 'official dialect' that reflects their *own* internal bureaucracy and priorities, and which is not suitable for communication with their (external) stakeholders, who speak a different, more natural 'language'.

An issue that remains understated is that the accessibility of printed matter is often a significant issue for people in rural communities, just as distribution can be an issue for the publisher. Producing a publication is relatively simple, but ensuring that it is widely available, accessible and affordable to the people that actually need it is far more difficult. In many ways, the problems that rural communities face in accessing printed media are not dissimilar to those they face in accessing the web.

Use of internet technologies for networking and service delivery

"A powerful global conversation has begun. Through the Internet, people are discovering and inventing new ways to share relevant knowledge with blinding speed. As a direct result, markets are getting smarter—and getting smarter faster than most companies." – The Cluetrain Manifesto

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Any discussion of internet technologies for small scale farmers needs to acknowledge its limitations. Internet penetration is low in rural areas and also in low-income earning groups. Internet penetration is *extremely* low among people who are both rural and poor. However, having said that:

- The same is true of printed publications, training courses and most other 'traditional' approaches.
- Internet penetration is growing rapidly and continues to accelerate, particularly amongst young people.
- Computer prices continue to fall, particularly for small mobile computing devices.
- Mobile phones and satellite internet services are bringing broadband internet speeds even to the remotest of areas.
- Within our lifetime it is likely that nearly all electronic devices will be networked into a single giant communication grid.

The internet is not yet 'mainstream' for direct communication with most farmers in the region. However, some initiatives such as the "Aquachopals" of India or the 'One Stop Aqua Shops' piloted by NACA have successfully provided facilitated access to the internet for farming communities.

There are also indirect applications – the internet is often an important mechanism for communication amongst those who work *with* farmers, such as extension agents and government officers. The 'Nabuur: Global neighbour' initiative (www.nabuur.com) facilitates access of rural villages to technical specialists such in medicine, engineering, education and anything else the village requires, connecting villagers with expert volunteers all over the world. Below we consider some of the emerging possibilities and some of the practical applications of the internet that you can use today.

The internet: Connecting everything and everyone

"The Internet is enabling conversations among human beings that were simply not possible in the era of mass media. These networked conversations are enabling powerful new forms of social organisation and knowledge exchange to emerge." – The Cluetrain Manifesto.

The Internet is the most powerful network for exchanging information that has ever existed in human history. Its coverage, accessibility and influence grow every day. With recent advances in web publishing and social networking technologies, it is possible for a small organisation or even an individual with a shoestring budget and limited IT skills to establish a *global communications network*. You can meet new people, talk, chat, share photos, videos, documents, audio recordings online.

Internet technologies are giving people a global voice. They are also allowing people to network and exchange ideas with people all over the world with a scale and speed that has never occurred before. The increase in 'social networking' and direct exchange of information is driving major changes in society:

- In the past people got most of their news from mass media such as TV, radio and newspapers. Now people are starting to get a lot more of their news from *each other* directly through blogs, community forums and social networking applications such as Facebook and Twitter.

- The newspaper industry is in decline in many parts of the world due to 'competition' with the internet. A number of high profile papers have recently gone bankrupt and the industry is essentially struggling to reinvent itself as an internet business.

- "Citizen journalism" via websites and social networking applications is beginning to supplant some aspects of professional journalism, simply because people with internet-enabled camera phones have become ubiquitous. People can relay photos, videos and text messages essentially live from the scene of a breaking news event, long before a news crew can get there. In the context of the present project, people can also publish information that the mainstream media may not be interested in, such as better agricultural management practices.

- Journalists are beginning to move towards becoming secondary compilers and editors of information published online by ordinary people rather than doing the original 'field work' themselves, because they simply can't move fast enough. CNN has used Twitter as its primary source for coverage of some major recent events.

Practical ways to use the internet

There are many different ways to communicate over the internet and more are being developed all the time. The good news is that most are available through free, high quality service providers, and even the paid services are available for just a few dollars. These are actually the easiest way to make use of the internet, as the technical issues are all managed for you. We will focus on some of the more popular free services here. There are many more, but these will get you started. Practical measures you can take include:

- Set up a blog or website

- Distribute an email newsletter

- Broadcast audio recordings ("podcasts")

- Share videos and photos through Youtube and Flickr

- Participate in social networking: The gorilla of the internet

Set up a blog or website for your work

"Web 2.0" refers to the second generation of web development and web design. It is characterised as facilitating communication, information sharing, interoperability, user-centered design and collaboration on the World Wide Web. It has led to the development and evolution of web-based communities, hosted services, and web applications. – Wikipedia.

"Web 2.0 is about databases that grow through user contribution...it's network-effect driven databases." – Tim O'Reilly, O'Reilly Publishing.

Establishing a website of some kind is a good first step in making your information more accessible to others, building a public profile and for attracting feedback. With careful planning, web publishing offers:

- Massively improved accessibility and circulation of information and publications. The massive scale and worldwide nature of the Internet means that even the simplest of web pages can be a highly effective communication tool.
- Control of the publishing process. The web offers the opportunity to publish information that may not otherwise be able to be made available in any form.
- Low publishing costs. Good web publishing tools are available for free and most of the costs are fixed.
- Fast publishing. It is often possible to publish a new document and inform people of its availability in only a few minutes, making "real time" reporting possible, as well as the provision of time-sensitive services such as market information.
- Community participation. Many web-based digital publishing tools are designed to be interactive, allowing groups of people to communicate and collaborate in the process of creating and publishing information via the Internet. This allows the publishing process to be decentralised, giving the creators of the content more ownership of the process.

There are, of course, limitations to using Internet as a mechanism for communication and networking:

- The Internet is not accessible to everyone. In most cases it is useful only to the subset of people that have access to the Internet and/or computers, which tends to be relatively low in rural areas and among farming communities, although in terms of absolute numbers this group can be very large.
- Internet usage tends to be better in the public/research sectors.
- Some degree of computer literacy is required to make effective use of a digital publishing system and deal with daily security issues such as viruses, and a somewhat higher level to plan, install and administer such a system. These skills are often limited or unavailable in public-sector organizations involved in aquaculture.

The easiest way to establish a website is to make use of one of the free 'blog' or social networking websites. These typically provide some simple tools you can use to post your own stories, photographs, videos and documents on a 'personal' webpage. Most are free (just fill in a form to sign up), and some provide simple yet sophisticated tools to allow readers to comment about your content or interact with one another. Recommended free sites worth trying out include:

- Blogger (weblog service): https://www.blogger.com/start
- Facebook (weblog service with sophisticated social networking): http://www.facebook.com/

Set up an email newsletter

E-mail is probably the simplest, most ubiquitous and widely understood Internet technology. Email newsletters can provide a personal and highly effective way to inform relevant stakeholder groups of new information published on your website or links to relevant web pages, publications and other information resources. It is a good idea to publish a link or sign-up form for the newsletter on your website, so that you can encourage people to sign up to it. Recommended service:

- Your Mailing List Provider: http://www.yourmailinglistprovider.com/. Includes tools to import/manage contact lists and to generate attractive html email newsletters.

Mobile phones, location-based services and SMS gateways

Mobile phones continue to develop rapidly and are a driving force in mobile computing. Nearly all modern phones ship with a built-in data modem that can be used to access the internet, either directly through the phone or through a computer linked to the phone via Bluetooth, infrared or cable. 3G mobile phone services offer broadband internet access speeds. This is expanding the reach of internet services into areas where cable and ADSL are not available. With larger screens and smarter interfaces, mobile phones are becoming a viable alternative to using a computer to browse the web and access email etc.

Web-to-phone and email-to-phone SMS gateways services are available for a few cents per message. These basically allow you to send an SMS message to one or many mobile phones at the same time. These can be used to provide convey short pieces of information or announcements to mobile-owning stakeholder groups. Clickatell is a reliable provider (http://www.clickatell.com). The Twitter social networking service (http://www.twitter.com) also allows you to post short messages directly onto a personal webpage by sending SMS from your phone, and also to receive messages posted by others that you have chosen to 'follow'.

An emerging trend is the development of location-based services for mobile phones. The approximate location of each phone is known to the carrier and more accurate GPS services are likely to become standard features in the near future. This has lead to the development of services where contextual information (eg. weather reports) relevant to the owner's location are provided.

Sharing videos and photos through Youtube and Flickr

Youtube and Flickr offer excellent free video and photo hosting services that you can use to upload and present material on the internet, to a wide audience. These services also deal with many technical issues such as encoding, compression and resizing automatically, ie. your materials will be optimised for presentation over the web. Both services provide HTML code you can use to display your video and photos on other websites (such as your blog) via link. If you have access to a digital camera or video camera you can experiment with producing short documentaries or clips on better management practices.

- Youtube: http://www.youtube.com/
- Flickr: http://www.flickr.com/

Broadcast audio recordings: Podcasting

Podcasting is simply publishing an audio recording on the web for people to download and listen to on their computer or MP3 player (some of the first podcasts were prepared on iPods, hence the name). It is an increasingly popular format and widely used to publish talk shows, lectures and presentations.

If you have a website, all you need to make a podcast is a cheap microphone and some audio recording software and some interesting discussion to record – interviews with progressive farmers, expert panel discussions, workshop presentations, even your own 'radio play' or documentary. Recommended resources are:

- How to podcast (tutorial website): http://www.how-to-podcast-tutorial.com/00-podcast-tutorial-four-ps.htm
- Audacity (free audio recording/editing software): http://audacity.sourceforge.net/

Social networking

Social networking websites take the web publishing concept one step further by allowing members of the public to participate as well. Instead of merely presenting information to people, community websites allow their members to communicate and exchange information among themselves. The most common form of community website is a "discussion forum".

Online communities are a unique tool in that they allow an individual to access the collective knowledge of a large group of people that may be scattered all over the world. They provide a "virtual venue" where people with similar interests can "meet" each other, share experiences and solve common problems. One of the most powerful applications of online communities is a "self-help" group. In a highly decentralised environment, empowering stakeholders to help each other through a community website may be more practical than trying to provide direct assistance to them on an individual basis.

As with other Internet technologies, online communities are only useful to a subset of most stakeholder groups. They must reach a critical mass of participants in order to become effective tools for technical exchange. Once activity reaches a certain level, the feedback and mutual interaction among members becomes largely self-sustaining. Achieving the critical mass of members needed to initiate an ongoing "conversation" can be difficult. The most important aspect is to identify an area of common interest to target stakeholders that will bind them together as a social group.

Recently 'social networking' sites such as Facebook have become the dominant force in online communities due to their inclusion of powerful integrated tools for networking and connecting people and locating mutual acquaintances. They also tend to be easier to use and understand (and more interesting) than the traditional discussion forums, and are by far the best way to start an online community. Starting a Facebook page, or even a Twitter page, for you or your organisation can be a very convenient way to interact and stay in touch with online stakeholders.

- Facebook: http://www.facebook.com
- Twitter: http://www.twitter.com

Further reading

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Principles of developing, validating and adopting BMPs in aquaculture - catfish case study

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Abstract

This document provides conceptual basis of Better Management Practices (BMPs) and methodologies to develop, implement and evaluate BMPs. In the case of catfish farming in Vietnam, a set of "draft" BMPs were developed for three sectors: grow-out, nursery and hatchery, based on data of an extensive survey, coupled with the use of risk assessment tools and stakeholder discussion. This "draft" will be then tested at demonstration farms, deployed and improved over time. Experiences from development and implementation of BMPs in India in the shrimp farming sectors are also being incorporated into the Vietnam catfish case.

What are Better Management Practices (BMPs)

BMPs refer to a set of guidelines that are developed, based on population based risk factor studies, in consultation with the practitioners and relevant stakeholders and on the evaluation of current practices. Adoption of BMPs will lead to an improvement in the overall practices, reduce disease risk, improve yields, and contribute towards sustainability and economic viability.

BMPs are a set of management guidelines and are not standards, and the BMPs ensure that adoption of the guidelines is relatively easy to achieve without increased costs. The word "better" also implies that BMPs are always evolving, open to improvement and indeed needs improvements as the culture practices progress.

Adoption of BMPs are known to bring about benefits such as:

- Reduction and/or a minimisation of disease occurrence,
- Improved growth performance,
- Decreasing cost of farming,
- Improved environmental conditions, and consequently minimise impacts on the local environmental,
- Attain food quality standards,
- Improve marketability of the produce, and
- Facilitate sustainability amongst others.

Although most BMPs have an overall similarity in the guidelines and the objectives, however, there is a significant level of variation between commodities and locations. Development of location specific BMPs and contextualisation are an important part of the development process of BMPs.

It is very clear that adoption of BMPs has brought about very significant beneficial impacts to farming systems, as best exemplified in the case of the revival and the continued sustenance of shrimp farming in India. In this instance not only has the BMPs been adopted by individual farmers, the collective actions of the "clusters" of farmers, through formation of the societies have had improved yields, nearly minimised disease occurrences, brought about increased profits among other benefits. The results of this development, both adoption of BMPs and the formation of clusters/ societies are schematically depicted in Figure 1.

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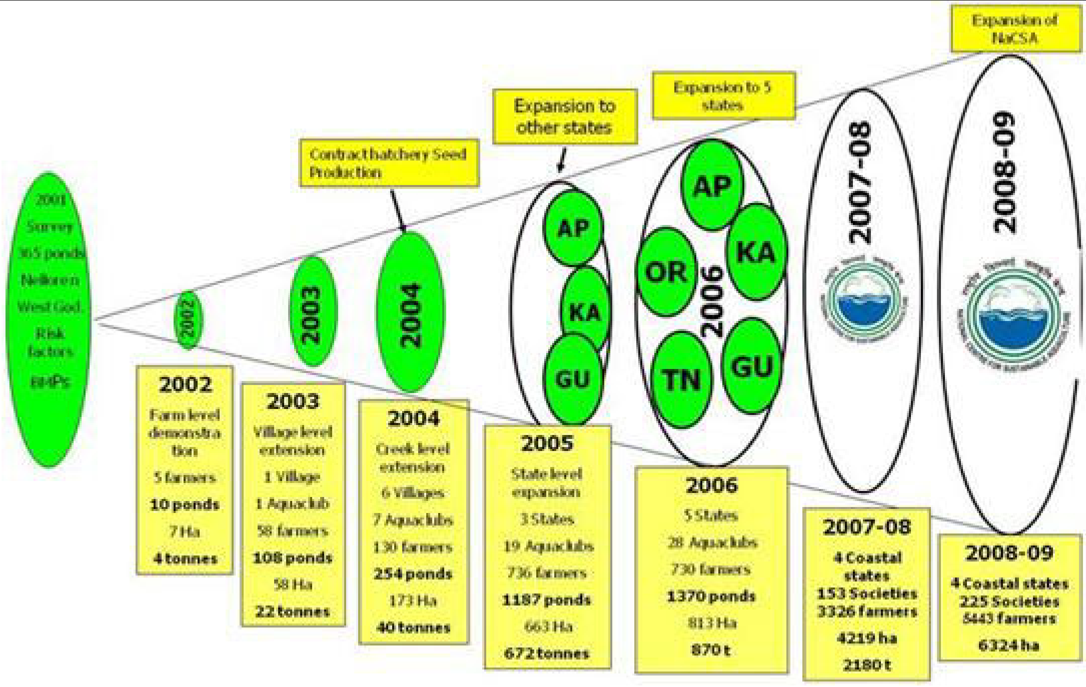


Figure 1. Figure depicting cluster/ society formations of shrimp farmers over the years

One question frequently asked by a wide range of stakeholder is:

"How do BMPs differ from other extension messages commonly disseminated to farmers?"

BMPs are science-based tools that are developed based on risk factor studies in farming systems. Interventions developed to address identified risk factors are collectively referred to as BMPs. Extension messages are often focused on ways to increase production and quality of the product. BMPs have an overall goal of promoting responsible and sustainable aquaculture, and not just promoting higher production. Thus BMPs can help producers to farm commodities in a more sustainable way taking into account also environmental and socio-economical considerations.

Good Aquaculture Practices (GAPs) are commonly used to address food safety issues in aquaculture. These tend to be farm management practices prepared to minimise the potential for farm-raised fishery products to be contaminated with pathogens, chemicals, or unapproved or misused veterinary drugs. GAPs can be defined as those practices necessary to address food safety concerns in isolation.

BMP are often voluntary practices, but can also be used as basis for local regulations, or even to meet and comply to standards set by third party certification programmes.

a) The term "better management practice"

The term "better management practices" is used in several ways. It has been used to refer to the best-known way to undertake any activity at a given time. In this sense, it probably refers to the practice or practices of only one or a very few producers. A second way, better management practices can be used is to define a few, often different, practices that increase efficiency and productivity and/or reduce or mitigate negative impacts. Finally, better practices are often required by government or others to encourage a minimally acceptable level of performance (and eliminate bad practices) with regard to a specific activity. In this sense, the term is used in opposition to unacceptable practices.

Past experiences show that a number of individual better practices relating to different activities on farm and of varying by intensity, scale and species have been identified. These practices were then analysed both to understand how they were developed (e.g. what problem did they solve and what result did they achieve), how they work, and what it would take for them to be adopted by other producers. In the process of undertaking these studies, it has become clear that better practices today still fall short both of what is needed and what appears to be possible. In all likelihood, today's better practices will be tomorrow's norm. The challenge is to encourage their further adoption while at the same time pushing even further to find better practices still.

In short, the goal must be to constantly seek out better practices, not just because they reduce negative impacts, but also because they are more efficient and more profitable. The goal is to improve the norm rather than to simply establish a bar and declare everything above it to be best or good practice and everything below to be bad or unacceptable. From the shrimp Consortium's work (this work was awarded the Green Award by the World Bank in 2007), we know that we may not have any 'best' practices at this time. We have, however, identified a number of better practices, and these practices are far better than the worse ones. Their impact on resource use efficiency can be manifolds better than worse practices. Their impact on productivity, and more importantly on profitability, can be similarly striking when compared to worse practices.

b) Are BMPs needed for tra catfish farming?

Uniqueness of the catfish farming in the Mekong Delta

Tra catfish farming occupies a rather unique status in global aquaculture. The uniqueness of this farming system could be summarised as follows:

- It is a farming system that is capable producing, on average, 300 to 400 tonnes /ha /crop; the highest recorded for any primary production sector in the world.
- It is a farming system that essentially occupies approximately 5,400 ha of land but produces for example as much as 65 percent of the total aquaculture production in Europe.
- It is essentially a pond farming system that is conducted in ponds of 4 to 4.5 m depth, with regular water exchange from the Mekong River and/or its tributaries.
- It provides many livelihood opportunities to poor rural communities, particularly women, significantly bypassing that seen elsewhere in aquaculture.
- The farming system is blessed with an adequate water supply through the year, but the farming system is obligatory to ensure that the water source is not overly nutrient loaded bringing about negative impacts on all users of this common, valuable resource.
- It is a farming system that for all intents and purposes is horizontally integrated, with specialised hatchery production, fry to fingerling/ nursery rearing and grow-out phases

- It is a farming system the produce of which is almost totally destined for export, being an acceptable substitute for "white fish', particularly for the Western palate/ taste, thereby catering to a "niche" market.

The need for BMPs for tra catfish farming

This unique farming system has had its share of problems, particularly in respect of diseases and marketing, at various levels. Marketing problems are likely to intensify in the foreseeable future, and most of all the produce will have to meet the increasingly stringent food quality and production standards, resulting indirectly from globalisation and increasing demands of consumers. It is also noted that the tra catfish producers, especially small scale farmers at this juncture do not have the negotiating power to influence the market chain. Fish price are often determined by the buyers and are unpredictable***. It is in the above context that tra catfish farming needs to develop and adopt, rather quickly, BMPs, which will ensure adoption of acceptable farming practices and most of all achieving the globally desired food quality standards,*** as had been achieved elsewhere. For example, the adoption of BMPs for shrimp farming in India, through a cluster based approach, has enabled the sector to attract new markets, and gain premium farm gate prices.

Adoption of BMPs, derived from science-based studies and agreed upon by all stakeholders, is a most logical way to meet the above challenges, and ensure long term sustainability of the sector and environmental integrity, the latter being almost consequential to the adoption of BMPs. Furthermore, ***experience elsewhere demonstrates that adoption of BMPs through farmer associations and aqua-clubs and or an equivalent organisational structure, is much more effective and enables better bargaining power to the group, in respect of purchases (e.g. feeds), marketing (e.g. negotiations with processors or importers), bringing about better environmental integrity and rational use of water resources, and most of all provides one voice to the group***; we are all aware collective action is a much more powerful tool and enables access to government and policy makers also in much more effective and a coherent manner.

The sector, particularly the **small-scale farmers, those that own, operate and manage their farms** are operating under much financial stress; the profit margins have decreased and in most instances, with fluctuating farm gate prices, but where the prices of inputs, such as feeds, have increased markedly, barely can make the ends meet. The current breakeven farm gate price of 16,500 to 17,000 VND (approximately 1US$) is often not obtainable, making the practices unprofitable and difficult to continue. The adoption of BMPs, which will enable cost reductions to be achieved, associated with farmer organisations is most likely to provide a gate way to making the practices economically and environmentally viable and sustainable.

c) The process(es) adopted in the development of draft BMPs for tra catfish farming

Realising the need to ensure that the tra catfish farming sector in the Delta, a unique system as it is, NACA together with Fisheries Victoria, and in conjunction with key national counterparts, RIA 2, Ho Chi Minh City and College of Aquaculture and Fisheries, Can Tho University, proceeded to seek the required funding under the AusAID Funded program, "*Collaboration for Agricultural Research and Development*" (CARD), and monitored by the Ministry for Agriculture and Rural Development (MARD) of the Government of Vietnam.

On availability of funds the following activities were undertaken between Feb 2008 until now:

- Planning meetings (HCMC and Can Tho) and technical workshop, Can Tho University(CTU), 3-4 Dec. & 8-11 Dec., 2008;
- Participation in 'Catfish Aquaculture in Asia' international symposium, CTU, 5-7 Dec., 2008;
- Design and test a questionnaire to understand the details of the existing farming systems;

- Survey 94 grow-out farms (89 owners), 45 hatcheries and 47 nursery farms between February to May 2009, through farm visits and discussion groups (**See** Annex 1 **for area surveyed of grow-out farms**);

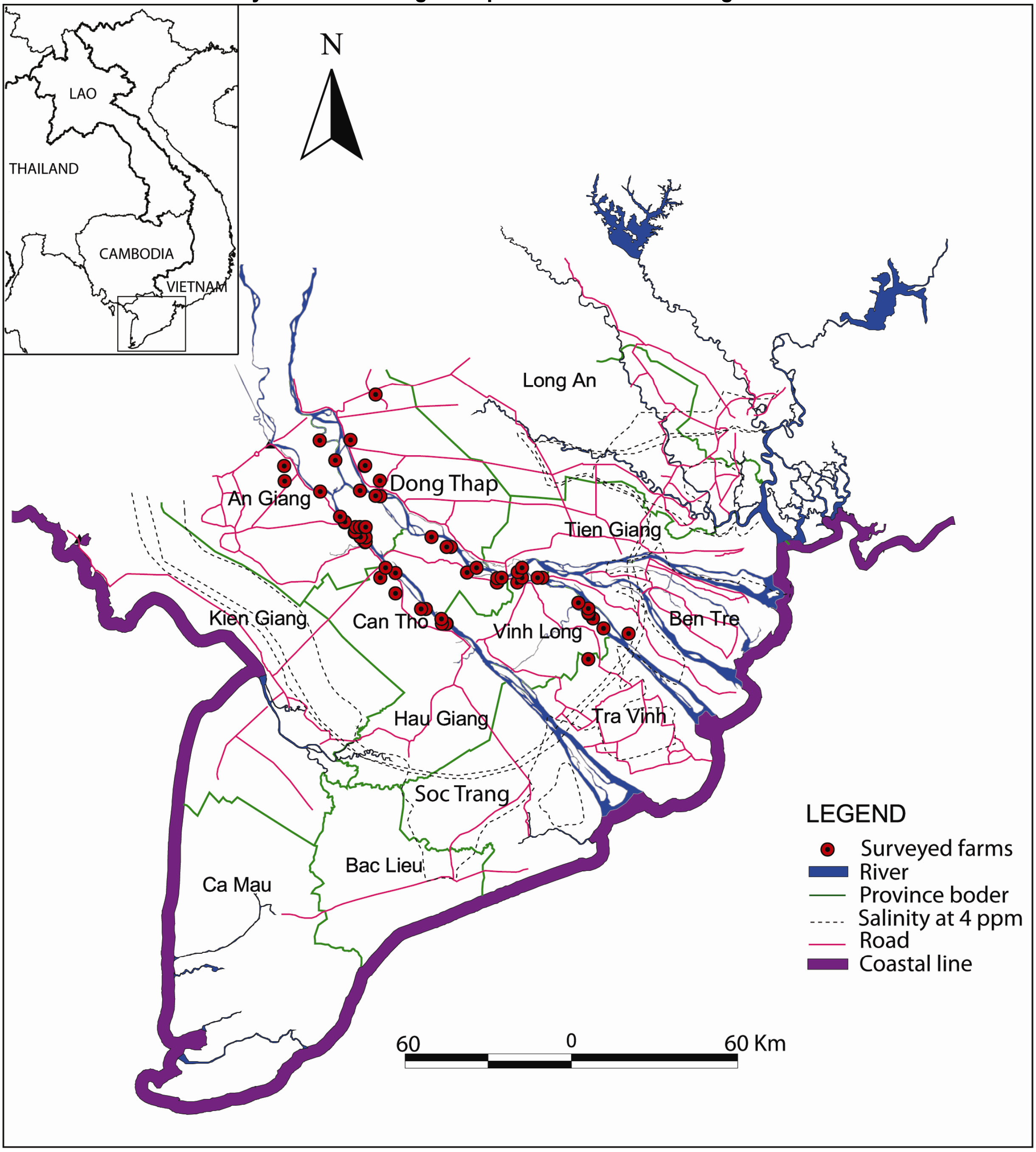
- Input the above data on farming practices using custom designed database and analyse using available statistical packages;

- The following subsidiary activities which had a bearing on the development of the draft BMPs were also undertaken:

A Risk Assessment Procedure for tra catfish farming in the Delta that incorporated the following elements:

- Compile initial Risk Register (list of key risks) categorised according to generic BMP framework, based on the farm data collected;
- Review score key risks in terms of 'likelihood' and 'consequence' of risks occurring to provide Risk Ratings;
- Risk Ratings are ranked (= sum of likelihood + consequence scores) to provide the Risk Ranking;
- Risk Ranking determines appropriate level of management response according to Risk Ranking Matrix and associated BMP outcome.
- Based on the above and numerous discussions with farmers and other stakeholders develop the current draft BMPs for catfish farming in the Delta;
- Ten selected catfish farmers and four Provincial/ District officials undertook a visit to witness and learn from the organisation, functioning and effectiveness of clusters/ associations of shrimp farmers in Andhra Pradesh, India.

Annex 1. The area surveyed for obtaining farm practices in the Mekong Delta



Feeds and feeding strategy in aquaculture

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Abstract

Feeds constitute the single largest input cost in the semi-intensive and intensive systems. Hence, feeds and Feeding strategies have been the prime focus to bring down the input cost and increase the profitability of farmers. Shrimps and the carnivorous fish culture industries have contributed in many ways for the development of fish feed sector because of the price they command in the export market. Several of the commercially important shrimps and fishes nutritional requirements have been studied under the controlled conditions and feed formulations are now available to get the best possible levels of production, particularly in the case of shrimps. Considerable progress also has been made to develop feeds for several of the carnivorous fishes. However, many of these available commercial feeds being fish meal based, with the declining fish meal and fish oil production and expanding aquaculture activity, search for other alternatives has been given the prime focus. Some progress has been achieved in developing all plant ingredient based feed for Pacific white shrimp. It is important to note that most farmers have been opting for high protein feeds, ignoring the fact that in tropical Asia, much of the natural food produced in the system provides considerable amount of nutrition and hence fortification of feeds with high amount of protein, vitamins and minerals may not be necessary. Feeds for groupers, sea bass have now become available and they can be used for growing these fishes in place of trash fish. In addition, simple on farm feed formulations are also available that can be used to formulate wet feeds using trash fish as the base. For growing tilapia, besides the readily available commercial feeds in the market, several feed formulations have been developed and they can be used to formulate feeds on farm using the feed ingredients available. Feeding strategies are considered to be very important to reduce the feed input cost. A number of such strategies ranging from the use of mixed feeding schedules to the latest approach of manipulating the pond environment by maintaining C:N ratio to produce bioflocs enriched with heterotrophic bacteria can be used to reduce feed input cost. As all the target species under the ASEAN project are commercially important and feed constitute the largest input cost, it is important to explore various options available to reduce production costs.

Introduction

With almost 70% of the global farming families living in Asia but with only about 25% of the arable land, intensification of the food production systems is essential to meet the growing needs of the population. Though bulk of the nutritional needs of the Asian population is met from the terrestrial origin of food, fish supplies about 20% of the animal protein requirement of the developing world. Until recently, fish needs of the population have been met largely from the capture fisheries production. However, with the stagnation in capture fisheries production, aquaculture has been supplementing the fish requirement of the population. Aquaculture is one of the rapidly growing farming sectors in the world. More than 90% of the global aquaculture production is contributed by Asia and over 70% of this production comes from the semi intensive aquaculture systems. Bulk of this aquaculture production is contributed by cyprinids and tilapia groups in the fresh water sector. Among the cyprinids silver carp, grass carp, common carp and big head carp contribute substantially for the global finfish production. Aquaculture is rapidly growing in China, India, Indonesia, Philippines, Thailand, Republic of Korea, Vietnam, Nepal, Cambodia and Laos PDR among the Asian countries. Though in Africa, aquaculture contribution at present is smaller, it is anticipated that with the improvement in aquaculture technologies, aquaculture might find a new place in several of the African countries. Since production from capture fisheries is almost stagnated, aquaculture sector has to contribute substantially to maintain this balance. In semi intensive and intensive aquaculture systems, feed is the single largest input cost, ranging even up to 80% depending on the quantity and quality of the feed used. Hence, the knowledge of fish nutrition is essential to manage the system effectively and reduce the feed input cost and also enhance production.

Aquaculture systems;

Based on the intensity of cultural techniques adopted, aquaculture systems are classified in to extensive, semi-intensive and intensive systems. In extensive system, excepting stocking, no other management practices are adopted and growth of fish depends on the natural food available in the pond. In the semi-intensive system, in addition to fertilization to enhance the natural food productivity, supplementary feed is provided to hasten the growth of fish. In intensive aquaculture systems, apart from these management practices, high stocking density of fish, continuous aeration, frequent exchange of water, etc., are resorted to obtain maximum production in limited space and time,

Feeding habits of fishes:

Broadly there are three groups of fishes; herbivores, omnivores and carnivores are recognized. Fishes belonging to herbivore group feed directly on plants, which is the primary source of food energy. These are considered to be the most efficient groups, since there is no loss of energy. Plants use sunlight to convert water, carbon dioxide, air and nutrients dissolved in the water in to organic matter. Phytoplanktons as well as macrophytes are the types of food resources used by the herbivore group of fishes. The second group of fishes are carnivores: fish and shrimp which feed on other smaller animals, insects, frogs, molluscs, fishes and crustaceans, zooplankton are classified as carnivores fish. They require more protein to eliminate nitrogen from the body. In general terms, carnivores are those which predate upon other fishes and derive energy required for survival. The third group is omnivores and the fishes belonging to this group feed on plant, animal, detritus etc., without specific preference to any of these groups. They are less efficient converters of plant energy than herbivores.

Elements contributing to fish / shrimp nutrition:

Like in terrestrial farm animals, farmed fish require over nearly 40 different dietary elements for the good growth. All the farmed fish / shrimp require qualitatively all the five major nutrient groups: protein, lipid, carbohydrates, minerals and vitamins. However, the quantitative requirement of these five nutrient groups varies depending on the culture system and age of the fish. In order to gain better understanding on the nutritional studies, it is important to know the role of each of these nutrient groups (De Silva and Anderson, 1995 ; Tacon 1988)

Protein:

Proteins are the building blocks of the body and they play an important role in both plants and animals. Proteins are made up of amino acids and fishes and shrimps have the capacity to synthesize some of the amino acids, However, ten amino acids are not synthesized and these are - Arginine, Histidine, Isoleuicine , Leucine, Metheoinine, Phenylalanine, Threonine, Tryptophan and Valine and they should be supplied through feed. Aminoacids composition of fish varies from species to species and the diets developed based on these amino acids composition of the muscle are known to provide better growth. Deficiency of these amino acids results in decreased growth. Optimum dietary protein is that which produces maximum growth. Carnivorous fish require higher protein as compared to herbivore fishes. Inclusion of non-essential amino acids is also important in the diet from the viewpoint of maintaining the palpability of the diet.

Lipids:

These are important energy source for fishes and also contribute to the taste of fishes. Like some of the amino acids, there are also essential fatty acids, which have to be supplied through the dietary lipid source since these can not be synthesized by fish. Polyunsaturated fats are more beneficial for fish. Linolenic (n-3) and Linoleic acids (n-6) are important for both the groups of fish and shrimp. The requirement of fat varies from species to species.

Carbohydrates:

Carbohydrates are the cheapest source of energy in the feeds. Starch; sugars, cellulose, gums are usually the types of carbohydrate sources. Fish are known to utilize simple carbohydrates like sugars more effectively than complex starches, while the shrimp are known to better utilize the complex carbohydrates. Carnivores are not efficient converters of carbohydrates. Catfish and several species of carps are known to utilize complex carbohydrates and some carbohydrates are normally not digested and these include fibers. Herbivorous fish are able to digest fiber because of the cellulase enzymes present in them. Fish in general are known to be not efficient utilizes of carbohydrates. However, this view is changing rapidly with the demonstration of efficient use of carbohydrates in carps and other groups of fishes.

Energy:

Like all other animals, fish also require energy. However, fish use much energy for protein synthesis than do warm-blooded animals because they do not need to maintain constant body temperature, need less energy to maintain position and less energy is used for excretion of ammonia. Optimum energy level is important in both fish and shrimp feeds. This energy required for maintenance of the body is obtained from burning protein, fat or carbohydrate. The energy thus liberated is used for mechanical work (muscle activity), chemical activity (chemical process taking place in the body); electrical work (nerve activity), osmotic work (maintaining body fluids in an equilibrium). Free energy is that which is left after using it for the maintenance of the biological activity. The energy level in the feed is calculated using the standard values available for the principal energy source components namely, protein - 5 Kcal/g, carbohydrate- 4 Kcal/g and lipid - 9 Kcal/g. Higher energy in the feed results in the less consumption of food and thereby resulting in less protein available for growth. Also, addition of excess fat results in the accumulation of fat in the body and bad odor. When the energy levels in the diet are less, protein is used up to meet the energy needs and consequently result in the poor growth of fish.

With the Increase in knowledge in fish nutrition, lipids and carbohydrates are increasingly used to spare protein for growth. In carnivorous fish diet by including fat as energy source at high level, protein is made available for growth.

Vitamins:

Both water soluble as well as fat-soluble vitamins are essential for prawns and fishes, Vitamins are complex organic compounds required in trace amounts for normal growth, reproduction, health and metabolism. Fat-soluble vitamins are recognized to be important in many ways for the animal for breeding, development, disease resistant etc. and Vitamin E has been found to be important for reproduction. Vitamin C has been found to increase disease resistance and improve the growth of fishes.

Minerals:

These are considered to be important both for body function and growth, They are important in providing rigidity and strength to the bones of fish and the exoskeleton of crustacean, The body fluids are involved, in the osmotic regulation, nervous and endocrine system. Seven major minerals, namely calcium, phosphorous, potassium, chlorine, sodium, magnesium, sulphur, manganese, nickel, cobalt, molybdenum and selenium are needed to be in a balanced diet. Fish and Crustacea absorb minerals from the water through skin and gills, Calcium is rich in seawater, but in fresh water its level is low. Since feed ingredients are usually rich in calcium, dietary deficiency is unlikely. On the other hand, phosphorous is low in water and hence diet requires phosphorous supplementation.

Nutritional requirement of fishes and shrimps :

A number of studies conducted in different laboratories around the world have generated information on the nutritional requirement of various components listed above for the cultured fishes and shrimps and these are readily available. However, it should be remembered that most of these results are based on the experiments carried out under controlled conditions without the influence of natural food. Hence, while these information could serve as basis for the formulation of diets, it is necessary to understand that the natural food also contribute enormous amount of energy as well as some of the essential elements like vitamins and minerals to the cultured fishes and prawns, Hence, the nutrient requirements of these species under the influence of the natural feed should be understood in order to reduce the feed input cost.

Role of natural food in the diet of fish and prawns:

In tropical climate, considerable amount of natural food is produced and these natural food items are recognized as equivalent to **"mother's milk"** in human beings as they are known to contain a number of essential elements required for the fish. The natural food in the system produced through fertilization contains rich source of protein. The average protein, fat and carbohydrate content of the natural feed is reported to be 52.1, 27.3 and 7.7%, respectively, with an average calorific value of 3.9 kcal/g. This level of nutrients is expected to meet most of the nutritional requirements of the fishes. The proximate composition of different types of natural food organisms studied so far indicate that most of the nutritional needs of the fish could be easily met from the natural food for fishes cultured under extensive and semi-intensive systems.

Use of different fertilizers, consisting of both organic and inorganic in nature to augment the natural productivity of fish is commonly used in tropical aquaculture systems. Inorganic nitrogen fertilizers are easily soluble in water and hence there is no difficulty in regard to application of nitrogenous fertilizers in to the pond, However, the solubility of inorganic fertilizers is reported to be very low and hence**,** fertilization application method is likely to have profound impact on the success of the fertilization regime used, If granular and powdered phosphatic fertilizers are allowed to come in contact with the soil, they will be rapidly adsorbed in to the soil particles and become unavailable to the planktonic algae. Hence, it is always recommended that phosphatic fertilizers should be first dissolved in water prior to application or they should be filled in perforated sacks and fixed in the pond for slow dissolution and dispersion. In all cases, in order to maintain fertilizer effectively, it is suggested to apply them in smaller quantity instead of applying them in a large single dose.

While chemical fertilizers act directly on the autotrophic food chain, organic fertilizers act through the heterotrophic food chain with manure serving principally as the substrate for the growth of bacteria and protozoa. C: N ratio of the manure will have influence on the manure quality. Best ratio for the growth of bacterial population is reported to be 20:1. In smaller size of the organic manure particles, faster will be the colonization of bacteria and protozoans. However, it should be remembered that addition of organic manures necessitates higher oxygen demand in the water. For each gram of organic matter decomposed, 1.*2* g of oxygen is consumed.

Farmyard manures are one of the easily available sources for pond fertilization. Animal excreta represents a nutrient packed resource containing 72-79% of the nitrogen and 61-87% of the phosphorous originally fed to the animal. The nutrient content of the different organic manures varies depending on the type of feed provided to the animal, age, environment, etc. In tropical countries, different types of manures are commonly available and among the various manures, poultry manure has been proved to be the best. The effect of manure will depend on the quantity and frequency of its application. It is reported that 100-200 kg manure on dry weight basis /ha/day could be applied in to the pond. This equates to 100-200 pigs weighing 100kg each/ha/day, 15-30 cows weighing 500 kg each / ha/ day or 2000-4000 poultry weighing 2kg /ha/day. It must be remembered that manuring rates are pond and farm specific and suggested values should only be used only as guidelines to develop appropriate fertilization schedules suitable to each farm. Application method of organic fertilizers will also have profound impact on the productivity and in order to have maximum effect, smaller dose application is strongly recommended.

Supplementary feeding:

Supplementary feeding is the supplementation of the naturally available food in the system through addition of feed from external sources. The need for supplementary food will be based on the intensity of culture practices adopted. Once the difference between the standing crop of the cultured organisms and the critical standing crop of the natural food organisms is increased, the deficit in natural protein supply has to be provided through supplementary feeds rich in protein

Following points should be considered in supplementary feeding strategy

- Market value of the species to be fed
- Financial resources of the farmer (if home made-aquafeeds are to be produced)
- Dietary nutrient requirement of the species to be fed (or closest relative)
- Natural feeding habits of the species in question
- Available feed ingredients sources, composition and cost
- Intended feed manufacturing process to be used
- Intended stocking density and expected production

Major factors determining the nutritional performance and success of an artificial diet-feeding regime are as follows

1. Feed formulation and nutrient content
2. Feed manufacture process and physical characteristics
3. Feed Handling and storage
4. Feed application method and feeding regime
5. Aquatic environment and natural food availability.

Locally available ingredients should be screened for inclusion in the diet and appropriate plans should be made for better utilization of such on-farm resources and reduce feed cost. Based on the nutrient composition of these ingredients, a number of on-farm feeds could be prepared and utilized in the cultivation practices.

Steps in the preparation of the fish feed:

1. **Selection of ingredients:** Choose the ingredients, which have good nutritional character and proved to be better digested by the fish and shrimp. Incorporation level of each of the ingredient has to be decided based on the nutritional content of the selected ingredient, Chosen ingredients should be toxic free, easily available and cheaper.

2. **Grinding:** Ingredients should be ground well, in order to increase the digestibility of the feed. Particles of less than 400-micron size are considered as good for fish and shrimp feed

3. **Mixing;** The ground ingredients should be mixed as per the predetermined ratio with water just adequate enough to prepare the dough. The amount of water to be added depends on the level of moisture in the feed ingredients, in general, for one kg feed mixture, addition of 350 mi of water is considered as adequate,

4. **Cooking:** Mixed feed should be preferably steamed. However, if steam cooking is not possible, cooking directly in a vessel would be possible, but continuous mixing is essential to avoid burning. A temperature of over 100-degree centigrade for a period of 20 - 30 minutes is adequate. Cooking time also depends on the

type of ingredients used, since some ingredients containing toxic materials require cooking at higher temperature. However, it should be noted that over cooking results in the loss of nutrients.

5. **Pellets:** Cooked dough should be allowed to cool and mixed with the vitamin and mineral mixtures. The cooled dough is allowed to pass through the pelletizer and pellets are dried. Pellets of 1-2 mm are fed in the initial stage and with the increase in growth, pellets size is increased to 2-3 mm diameter. Noodle making instruments could be made use of for preparing the pellets,

6. **Drying:** could be done in the sum or oven depending on the availability. Feed should be dried to contain less than 10% moisture.

As indicated already, there are a number of ingredients available in different countries and these could be screened through on-farm trials and used as fish feed.

While the dry sinking pellet feed production is possible on the farm, production of floating extruded pellets is yet to become reality because of the high investment needed in the processing machinaries and their unsuitability for small scale production units at present. With the improvements in feed production technology, this situation may change soon.

Feed presentation, feeding rate, frequency and feed acceptance:

From the compounded feed, the loss of nutrients will be rapid and hence it is necessary that fish and shrimp are trained well to accept the artificial feed soon they are presented in to the water. Loss of nutrients will also depend on the quality of the binders used and quality of the feed ingredients used. In order to avoid wastage of feed, feed is recommended to be presented in feeding trays or plastic / fertilizers bags. Feed is provided generally at 2-3% in the grow-out systems, however, in the early phase, when the fish/ shrimp are smaller, feed could be provided up to 10% and the gradual reduction in the feed could be adopted, feeding twice a day has been found to be more useful. In the case of shrimps, feeding more than twice a day appears to influence better growth. However, shrimp being nocturnal, evening feeding should be considered as a potential way to increase shrimp growth. Poor water quality decreases the feed acceptance by both fish and shrimps. Decreased dissolved oxygen, higher ammonia and other toxic gases, low water temperature are reported to decrease the feed acceptance.

Assessing the efficiency of formulated feeds

The most important factor to be considered in all feeding experiments is the food conversion ratio. It helps in understanding the efficiency of the feed in inducing the growth. It is the ratio between the amount of feed consumed on dry weight basis to produce one unit of biomass on wet weight basis. In tropical acculturate system, as there is production of plankton in the water, which is also consumed by the fish, measurement provides only apparent food conversion ratio and not the true food conversion ratio.

Potential ways to increase fish yield from small-scale aquaculture systems:

(A) Use of non-conventional feed resources as feed:

Fish require higher amount of protein compared to poultry and cattle. Fishmeal has consistently shown to be the best source of feed ingredient for inclusion in the feed. However, this ingredient is not only too expensive for use in small-scale aquaculture, but is becoming increasingly scarce. Use of low value fish for fish for fish meal production may no longer be acceptable and there is an urgent need to look for other alternatives, besides reducing the usage of fish to lowest level where it is absolutely essential (Naylor, et.al., 2000). A number of experiments conducted to evaluate the various plant sources of proteins have shown that the growth induced by these ingredients is not comparable to fish meal based diets (New, et.al., 1993). This is reported to be largely due to the lower protein content as compared to animal protein sources (60-80%). Further, plant proteins are known to contain imbalanced amino acid composition and contain several anti nutritional factors. Adoption of some of the treatment procedures like drying, soaking and cooking is suggested in different cases based on the nature and intensity of the anti-nutritional factors present in the feed. These research efforts have contributed to improve the various plants and animal based ingredients. Interestingly recent research results now indicate that Pacific white shrimp can be grown almost entirely on poultry byproduct meal or other plant sources by replacing completely fish meal. In the case of tiger shrimp too, it is shown that with just 10% marine protein source, it is possible to grow to the same productivity level by using other plant and animal sources of protein. Tilapia and other herbivore fishes can be now be grown largely by using the plant protein sources.

(B) Mixed feeding schedules:

The concept of mixed feeding schedules was developed by Sena S. De Silva (1985), based on the observed daily variation in the digestibility of dry matter and protein in tilapia. Based on the observation, he postulated that fish do not require same level of protein everyday in the diet and feeding feeding alternately with optimal protein diet, followed by sub-optimal protein diet could help in reducing the protein input by several folds. Initial trials conducted with tilapia demonstrated the benefit of feeding low and high protein at different intervals of time, instead of feeding only high or optimal level of protein on a continuous basis. Experimental results indicate that it is possible to save 15 -20 % protein input and much higher saving in terms of feed cost because of using proteins at two different levels. Most importantly, it also helps in the reduction of nitogen excretion (De Silva and Anderson, 1995). It should be mentioned here that nitrogen is not only a costly in put, but also contributes considerably for the eutrophication process with phosphorous. Alternate feeding theory has been now tested and confirmed its suitability not only in respect of protein, but also fat and phosphorous. This theory is yet to be applied in shrimp and it appears that there would be large savings in cost by applying this technique.

(C) Periphyton based system:

Farmers in Asia and Africa have been using different substrates to promote the growth of periphyton in rivers and lakes and thereby attract the fishes to these substrate enriched areas and harvest them by sudden encircling such places with nets.The value of periphyton is increasingly recognized in fishes, which have the grazing habit. Like rohu, which appear to have the fringed lips most appropriate for grazing, is reported to grow rapidly in the periphyton rich water. Addition of substrates is reported to enhance the periphyton abundance. Tree branches, which could serve as shelter to shrimps and fishes and prevent thieves, would also promote good growth of fishes. Bamboo poles, jute sticks, bamboo mats, bamboo scrapings could be other alternatives to explore as substrates. These substrates provide opportunity for the periphytic organisms to grow – fish like tilapia are known to grow rapidly by feeding on these substrates. Biodegradable substrates like water hyacinth, sugarcane bagasse, rice straw could also be used. Addition of carbon by these substrates and proper enrichment with nitrogen would contribute for the growth of heterotrophic organisms in the water column.

(D) Fermentation of feed ingredients:

Fermented products are known to be easily digestable and also enhance the quality of feed in terms of certain attributes. The technology has also been used to improve the quality of certain ingredients, which are not useful as quality feed ingredients, can be improved through fermentation process. Fermentation process would increase the palatability as well as the nutrient availability to both fish and prawns. Experimental results conducted with fermented soybean flour in shrimp diet have been known to improve the growth as compared to non-fermented product. For example rice bran is the most widely used feed ingredient and it is rich in fibre and contains complex carbohydrates in various forms. Efforts are now made to improve the growth through fermentation process.

(E) Biofloc technology:

This is a new approach used to build the organic matter content in the water by limited or no water exchange, thereby promote the growth of intensive microbial community (1 million to 1 billion cells ml). These bioflocs are used by varieties of fish and shrimp as a high protein feed replacing some of the formulated feed and essentially recycling protein in different form. Main focus is on effective aeration to avoid any points within the pond to prevent any anaerobic area. Provision for draining the excessive sludge is also essential and hence ponds have to be designed accordingly. Water exchange for intensive fish ponds (10-50 kg fish /m^3) should be 5-10% per day whereas ponds with a biomass up to 2 kg /m^3 can be managed without any water exchange. Carbonaceous material are added to remove excess nitrogen and maintain a ratio of 15-20 : 1 carbon: nitrogen ratio. The technology has been widely applied both in the case of tilapia and shrimp. It appears that this would be a good technology in areas with limited water availability as well as in locations where environment concerns are major issues to promote aquaculture technology.

(F) Low protein feeds in fish and shrimp farming:

There is a tendency among the farmers to use high protein feeds than that are essentially required for field based culture operations. Most nutritional requirement studies being conducted in closed door systems, particularly of early size and ages, feeding fish and shrimp in ponds of all sizes with same level of protein that too without taking in to consideration of the natural food available in the system is viewed as a waste of nutrient input in to system and damage to the environment. However, farmers without wanting to take any risk, always have a tendency to feed high protein feeds. In the Vannamei it is well established that it grows well in feeds containing less than 30% (Fox and Treece, 2008). In the case of omnivorous tilapia, it is know that the fish can very efficiently exploit various nutrient sources from the natural food available in the water column. For such fishes, use of expensive feeds not only adds cot to farmers, but also environmental qualities are affected because of the heavy discharge of nutrients.

(G) Vitamins and minerals in outdoor systems:

In outdoor pond systems, it is also shown that addition of vitamins and minerals may not be a necessity, particularly in semi-intensive systems where there is abundance of natural food. These vitamins and minerals add significant feed cost and farmers can well manage ponds without the addition of these nutrient elements Encouraging farmers to conduct on-farm trials on these types of findings would help them to decide for themselves and bring radical changes in the approaches. A number of experiments conducted in the case of shrimp and fish have clearly shown that addition of these vitamins and minerals is not needed.

(H) Growth based on sex:

Research findings indicate that female shrimp eat less, but grow faster as compared to males. The findings of Moss and Moss (2006) on effects of gender and size on feed acquisition in the vannamei indicated that size and sex matter in feed intake. Larger animals within the same gender ate more than the smaller animals. Females ate less than males even when the females were larger than males. When females and males were of similar size, males ate much more feed than females. The results clearly indicate that females are growing larger is not because of eating more.

(I) Pellet size and diameter:

Shrimp are fed with different lengths and diameter based on the age factor. However, a research trial conducted by Mishra (2006) in the Water Base Ltd company in India indicates that as the shrimp feed in the nature by holding any feed that attracts them by holding it with the second pair of chelated legs and cutting the feed using the mandibles, it may not be necessary to give them feed of different dimensions at different ages. Limited trials indicate that there is no need to use such varied pellet size. As the decreasing pellet size would increase the cost of feed considerably, taking the natural feeding behavior of shrimp, it would be possible to reduce the feed cost significantly.

(J) Presenting feed in trays:

In some of the South American countries, shrimp are fed completely on feed trays and this seems to reduce feed wastage considerably. Though in Asia check trays are mainly used to test the feed consumption and health status of shrimp, it appears that feeding trays could help in reducing the feed waste and reduce cost of production (Suresh, 2006).

(K) Probiotics and prebiotics:

The fish gut microflora composition; occurrence, dominance etc appear to be totally different from human gut microflora. This is a newly emerging discipline to understand the gut micro flora and evolve suitable robotics and prebiotics that can be delivered through feed or application in the pond to maintain good heath of fish and shrimp and promote healthy growth. While lack of regulation is making way for the entry of several spurious products, farmers ultimately decide on the fate of these products sustainability.

Conclusion

Feed being the costly input, it is necessary to educate farmers on the way feed cost can be reduced without affecting the yield. Empowering farmers with practical information and encouraging them to try various alternatives would help in the new innovative ways of reducing the cost. The perception of farmers to use only high quality expensive feed versus developing their own feed may be through cooperative efforts with focus on cost factor would help in reducing feed expenses. While tilapia are known to be effective utilizes of natural food available in the pond, it is possible to grow tilapia in ponds with farm made feeds. In the case of groupers and sea bass, several trials have shown that instead of using the trash fish, compounded wet and dry feeds can be used with equally effective results (Sim, et.al., 2005 ; Chang, et.al., 2008). The perception of the farmers need to be changed in regard to the absolute necessity of trash fish use for the growth of these carnivore fish to the use of compounded feeds. In the case of semi-intensive culture of shrimp in ponds, there is enormous opportunity to reduce feed cost and grow shrimp by taking advantage of the natural food available in the pond coupled with feed containing nutrients that will provide nutrients of what is not available in the pond. If the farmers are able to understand the ecology of their ponds and be able to modify the technology to suit their ecosystem, there would be sustainability for the technology introduced.

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Feeding schedule for shrimps

Days of culture	Average body weight (ABW)	Feeding rate (% of ABW)	Percent feed in check trays	Checking frequency in hrs
15-30	1.0-3.00	10.0-8.0	2.0-2.5	3.0-2.5
31-60	3.0-10.00	8.0-8.50	2.5-2.7	2.5-2.0
61-90	10.0-20.00	5.0-3.7	2.7-3.0	2.0-1.5
91-120	20.0-33.00	3.7-4.0	3.5-4.0	1.5-1.0

Source: Healthy Environment – Healthy shrimps, Aquaculture Foundation of India, Chennai, India

Organization of small scale farmers and its benefits

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Abstract

The small farmer especially in market economies, need the strength that groups can offer for their economic and social advancement. NaCSA is currently making efforts to unite farmers under a cluster based programme viz: aquaculture societies for popularization of Better Management Practices (BMPs) and sustainable production. The concept of participatory farming has become very popular among farmers. The farmers in organized societies moving from being passive recipients of information, services and regulations to a situation where they take full responsibility for their own development and use public and private institutions as resource providers. As of now, more than 270 aquaculture societies have been registered in various coastal states, and NaCSA is playing a significant and lead role in mobilizing and organizing the small scale farmers. The organization of small scale farmers into groups and then into more formal societies facilitated the adoption and implementation of the BMPs, providing opportunity for farmers share their experiences among fellow farmers, provided better bargaining power in purchase of quality inputs thus eliminating middlemen. The societies also offer better opportunity for common infrastructure development and to reduce cost of production. Societies are an ideal model for small scale farmers to meet the market requirements. Even the seafood buyers are looking for material produced from such sources as several of the market conditions are met by the farmer societies. Societies help define and operationalize an organisational management model for accessing international markets and improve technical, financial and environmental sustainability of farm operations. Increasing number of societies in India are providing an opportunity for increased stakeholder interaction and involvement for their mutual benefit. Through societies abandoned ponds have been revived helping to sustain livelihoods of small farmers.

Introduction

Coastal aquaculture in India is synonymous with shrimp aquaculture and mainly carried out by small scale farmers. More than 90% of the farmers belong to small scale category with holdings of less than 2.00 ha per individual (MPEDA). Small scale producers have inherent difficulties such as obtaining quality inputs, like shrimp seed and feed, at good prices, accessing resources and services, complying with market requirements (e.g. food safety standards, traceability, certification etc.) and accessing markets for their products. Marine Products Export Development Authority (MPEDA), Ministry of Commerce and Industry, Govt. of India, has felt the need to empower the small scale farmers at the grassroots level by organizing farmers into Aquaculture Societies and networking them with a centralized agency for adopting Better Management Practices (BMPs) and to help farmers avail many other benefits. In this background the National Centre for Sustainable Aquaculture (NaCSA) which is an outreach organization of MPEDA was established in 2007 with the objective of providing technical support to the primary aquaculture societies and build capacity among small farmers to produce quality shrimps in a sustainable manner.

The five year collaborative project work of MPEDA-NACA (2002-2006) provided the basis for the establishment of NaCSA. NaCSA is building capacity at grass root level through disseminating technologies and information on better practices, sustainable and judicious utilization of the resources to produce safe and sustainable shrimp. Initially farmers were motivated and persuaded to form the societies by the MPEDA-NACA and NaCSA staff but in later stages it has become a much more farmer driven activity. Other factors contributed to this process are continued networking and repeated interactions promoted self- assurance, trust and reciprocity; as well peer pressure, which in these small groups was important in reigning in free riders. Overall there were increased shared social and moral norms which helped transcend narrow self-interests. Interestingly this process also led to the emergence of farmer leaders in each group who were otherwise obscure until they organized as a group who play an active part in managing the societies.

Objectives of NaCSA

The broad objectives of NaCSA are,

- **a.** Promoting science-based management to improve aquaculture sustainability through participatory approach.
- **b.** Capacity-building and empowerment of small scale farmers
- **c.** Facilitating improved service provision
- **d.** Connecting farmers to markets to receive a better price for quality product
- **e.** Facilitating interaction among stakeholders

Farmer society

Farmer Society is a group of aqua farmers in a farming cluster or locality who implement and manage the aquaculture activities through participatory approach in order to accomplish their common goal of reducing risks, maximize returns and meet market demands through sustainable shrimp farming. Societies are setup according to a model established by the government and it is legally registered by the Ministry of Revenue and subject to annual audits by MPEDA to verify accounts and ensure a democratic and transparent management. In a society all the members register their farms with the Government. The society consisting of 20 to 50 farmers has a clear organization with strict conditions for membership, and elected board members. The members have to contribute admission fees of Rs,1000, and annual renewal fee of Rs. 250/- per ha in addition members have to pay 0.5% of their revenue for the society corpus fund. Membership to a society is purely on voluntary basis.

Society Management:

The decision making process in societies is through transparent, participatory approach which imparts inherent strength to these groups. Each society has a president who is normally a senior farmer in that society with many years of experience. Their helping attitude to neighboring farmers and respect for others makes it easy for them to lead from the front. They understand the concepts of BMPs and adopt them rapidly; They have vision and foresight in the shrimp farming field and more importantly have a personal interest in developing and managing the society. The presence of such leaders is very important for success of the societies. The president of the society is assisted by a Secretary and treasurer selected among framers.

The societies are audited every year by MPEDA for the implementation of BMPs. Societies which fail to implement them would lose their society registration. Each of the farmer society has one coordinator selected amongst the society members or from the community by society farmers. The Society Coordinator is trained in society management, BMPs and extension techniques by NaCSA, who will be responsible for implementing BMPs in societies and act as link between society farmers and NaCSA. Each of the NaCSA field managers coordinate and manage the activities of 10 such societies. MPEDA’s society scheme provides 50% financial assistance for farmers to employ society coordinator for two years.

Benefits of organizing as societies:

Empowering small-scale farmers

Organized farmer groups (Societies) are one of the key mechanisms for supporting farmer empowerment. They have the potential for cooperative action, which can change the position of the farmer in relation to the opportunity structures and thereby influence the business environment of the farming community. Moreover, small-scale farmers can, through organisation, gain the advantages of economy of scale in accessing services and markets, which are otherwise limited to large commercial farmers. The small scale shrimp farmer groups of India are in a better position today to gain these benefits compared to the situation when they were unorganised. The benefits of organising small scale farmers are as follows;

a. Through organization farmers get legal status
b. Improved technical and financial sustainability.
c. Improved information exchange and sharing of experience.
d. Middlemen/agents being eliminated at all levels.
e. Societies-ideal model for small scale farmers to meet the market requirements
f. Increasing stakeholder interaction and involvement
g. Revival of livelihood.
h. Increased social responsibility
i. Self propagating nature of the model

a. Through organization farmers get legal status

Prior to the organizing of farmer societies, the percentage of farm registrations was very low. Small farmers had difficulty in approaching government agencies and following all the registration formalities as well as most were also constrained in fuller access to suitable markets. NaCSA promoted a group registration of society farmers where all the society farmers applied at once. This approach was very effective for instance in registering farmers with the Coastal Aquaculture Authority of India (CAA). Presently all society farms and societies are registered with Government

b. Improved technical and financial sustainability:

Overall the processes that have been put in place have led to significant progress. The improved technical practices included reducing or coping with the risks of pathogens being introduced into the farms with such practices as synchronized water intake and discharge, simultaneous cropping, putting up and observing early warning signs of disease onset, learning from each other, assuring product quality and safety and, overall, acting collectively in their own interest. Implementation of simple, science based farm practices and adoption of cluster farming that promoted cooperation reduced disease risks in society farms significantly.

The prevalence of shrimp disease in the Society farms is reduced from 82 percent in 2003 to 17 percent in 2006, even when the BMPs were implemented in large scale in more than 200 societies in 2009 the disease incidence was limited to <20%, while in non-society ponds the reduction in disease prevalence was limited during the same period.

Increased profits: The society farmers could achieve better profit through increase in production, increase in size of shrimp, improvement in survival, reduction in disease prevalence, reduced use of chemicals and no use of antibiotics and sharing of expenses – society farmers share the common expenses related to deepening of canals, seed testing, transportation of inputs, lab, electricity etc. Societies also offer better opportunity for common infrastructure development.

c. Improved information exchange and sharing of experience.

Exchange of information, experience and ideas among farmers was the key for success of societies. We have noticed that in each society there are few farmers who are proactive and who grasp the importance of BMP implementation very quickly. These are the farmers who in turn talk to other farmers and convince them and help the NaCSA team to spread the awareness about BMPs to more farmers. Farmers in societies take decisions collectively; the functioning of society is a very transparent, democratic system. There is regular information sharing among farmers during weekly meetings and they cooperate in purchase of quality inputs.

d. Middlemen/agents being eliminated at all levels.

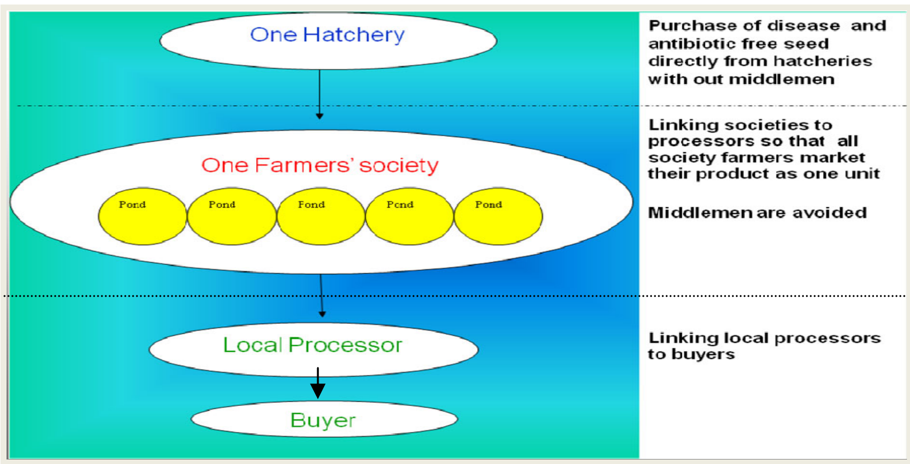
Societies are successful in eliminating middlemen. Middlemen are involved at three stages, in purchase of seed, providing credit and purchase of shrimp.

Seed agents- middlemen between hatcheries and farmers. In 2009 societies have purchased about 200 million shrimp seed through contract hatchery system, where farmers order quality seed in bulk for the whole society. Society farmers deal with hatcheries without the involvement of middlemen.

Loan agents- Agents who provide loan to farmers at high interest rate. Owing to lack of access to credit from banks, many small scale farmers are forced to borrowing from private money lenders. Such practices are tied in with buy-back practices, where in farmers tend to get low prices for their final harvest. Bank loans for working capital, which are not available now for most of the small scale farmers, are likely to be made available once the societies are linked up with the market which could happen within next six months.

Purchase agents- Middlemen between farmers and processors. Middlemen between farmers and processors. Farmers are being linked to local processors which would eliminate middlemen involved between farmers and processors.

The above is simplified in the diagram below.



e. Societies-ideal model for small scale farmers to meet the market requirements.

Over the years the approach to quality management has assumed greater significance and importance in the seafood sector worldwide both in production and supply chains. New trends are emerging in production and marketing such as traceability, eco-labeling and certification. For farmers and producers in developing countries, supplying goods for national and international markets can present a life-changing opportunity. Retailer demand is there – especially for products with ethical and green credentials. The difficulty lies in meeting those retailer needs and identifying the right products where developing country producers often lack the skills to deal with the high demands of the export markets and access to capital and business expertise. These factors collectively present a formidable barrier in entry to sophisticated markets. At the other end of the supply chain, retailers often lack the ability to be able to reliably source quality products that are required.

Farmer societies provide a good opportunity to link up with retailers following the existing controls that ensure that basic requirements of markets, including social and environmental responsibility and food safety, are in place:

- Legally registered farms
- Traceability back to shrimp farms and hatcheries through proper record keeping and use of GIS maps.
- Societies follow BMPs to control the hygiene and safety of shrimp produced.
- Society produced shrimp are safe- No use of Antibiotics at any stage in society farms:

Organic Cluster Certification:

National Centre for sustainable Aquaculture (NaCSA) and India Organic Aquaculture Project (IOAP), MPEDA took up Organic Fresh Water Prawn *(M. rosenbergii)* farming in two societies of West Godavari District of Andhra Pradesh. Total of 27 farmers, from Sri Venkateswara Aqua Farmers Welfare Society, Matsyapuri and Sri Sainadha Aqua Farmers welfare Society, Velivela were involved in the project covering 31.15 ha. area. These two society farmers were already following traditional prawn farming practices without using any Chemicals and Antibiotics in their farms. These farmers were technically supported by NaCSA, which involved implementation of Better Management Practices through its field officials and also through trained Society Coordinator to minimize the disease risks and improve food safety. This work was carried out for last 5 years.

Once the project started supply of critical organic inputs like seed and feed is taken up by IOAP. IOAP and NaCSA team conducted several meetings and successfully coordinated activities among all the key stake holders like hatchery, feed mill, farmer society and processing plant. Prior to the beginning of farm operations hatchery and feed mill were certified by Naturland for implementing Organic Standards. Later two societies applied to Naturland for Organic Cluster Certification in the prescribed format through IOAP.

Preparation of Internal Control System:

Societies were managed by Managing committee and controlled by Internal control System (ICS). ICS was developed by societies to implement Organic Internal Standards prepared in consultation with farmers by the project team consisting of IOAP and NaCSA officials along with the consultant for the project. Farmers, MPEDA, NaCSA officials and other stakeholders involved in the organic project were trained in the ICS. With the help of knowledge acquired from training, farmer societies prepared Internal control system along with NaCSA.

Implementation of Standards:

Coordination meetings among the society farmers were conducted regularly to coordinate all the activities of organic project. All decisions on the crop activity was reviewed during the meetings and it was properly recorded in society minutes book. Presidents of two societies led the Internal Control System team as ICS project coordinators in the respective societies and they were key contact persons in implementing the project.

Cluster Certification:

Societies implemented the organic standards under the supervision of MPEDA and NaCSA. Periodic meetings were conducted to emphasize the organic farming standards to every farmer. Internal Control System was implemented by both societies. Internal inspections were conducted by internal inspectors involving farmer, society coordinator and NaCSA staff and external inspections was carried out by NATURLAND authorized inspection agency, Indocert, Kerala to ensure the implementation of Organic standards. Both the societies were Cluster certified by Naturland for Organic scampi farming. This is the first of its kind in Aquaculture.


Naturland

Certificate of registration
2008 / 2009

This is to certify that
Sri Sainadha Aqua farmers Welfare Society
West Godavari Dist, A.P., Andhra Pradesh
INDIA
Code: 98407
is registered as grower group complying with Naturland standards.
Certification covers products resp. product groups* purchased according to the approved farmers list.

organic:	20.89 ha with	10,735 kg	of	freshwater prawn (Macrobrachium rosenbergii)

By signing the producer contract with Naturland Association Sri Sainadha Aqua farmers Welfare Society has committed to run the operation according to Naturland standards in their currently valid version, to comply with Naturland standards and all applicable certification procedures, and to undergo inspection at least once a year.
The operation is inspected by: Indocert.
Sri Sainadha Aqua farmers Welfare Society has run the operation according to Naturland standards.
Naturland is accredited under the European norm EN 45011 / ISO 65.

Certification documents issued:
Ze-Nr.:40081
Date: 26/01/2009
Validity of certificate:until renewed or cancelled, but at the latest until 31.01.2010

signed:
Certification Committee International (Angelika Raith)

Cluster certificate issued in the name of the society.

Opportunity for Fair-trade Certification

Of late farmers are under distress as shrimp prices at the farm gate fluctuate based on offer and demand. Under this context those small farmers who are entirely depending on shrimp farming put their livelihood at stake every time they stock their pond. A mechanism that would provide access to good markets and a fair price would allow small farmers to maintain their activity and livelihood. There is need for a Fair Trade Labeling of society produce so that society farmers can get a stable price, that covers at least production and living costs, which is an essential requirement for farmers to provide themselves and their families with a decent standard of living. NaCSA is also exploring opportunities to work with FLO-CERT, the fair trade certification body of Fair Trade.

f. Increasing stakeholder interaction and involvement

NaCSA is working towards developing societies as a potential business model through public-private partnership where all the concerned stakeholders help the societies to sustain for mutual benefit. The goal is to making society formation an attractive proposition which can motivate the rest of the farmers to organize themselves into societies. Smallholder farmers will benefit much from increased institutional coordination, capacity and support in assisting them in managing their societies. They will also benefit from more widespread application of proven technological, social, economic and governance innovations to reverse losses and improve livelihoods.

Farmers being the primary producers there is a need to link them to all other stakeholders in the industry both backwards and forward. Farmers are being linked to hatcheries, input suppliers, processors, scientists, Research Institutes, Government Institutes, Banks and others. Bank loans for working capital, which are not available now for most of the small scale farmers, are likely to be made available once the societies are linked up with the market. This initiative has helped create new policies that are more favorable to the small-scale shrimp farmer, for instance, increased financial and related support. The Ministry of Commerce and Industry has approved a scheme on Registration of Aquaculture Societies for adoption of Code of Practices for sustainable shrimp farming, with a total outlay of Rs. 2.50 crore (US$ 625,000) during the 10th plan period.

There is better flow of valuable information from field to research institutes. During any new disease outbreak it is easier to coordinate the quick flow of information and samples from field to research institutes and report back the outcome of the diagnosis and necessary precautionary measures to farmers. Seeing the efficient implementation of the program corporate companies are showing interest to adopt societies for further infrastructure development. Retailers from developed countries are showing keen interest in buying society produce which are now becoming increasingly well known for implementing sustainable farming practices in a socially responsible manner.

g. Revival of livelihoods:

NaCSA took up demonstration with the objective of reviving the livelihoods of those farmers in Krishna District of Andhra Pradesh where 1/3rd of the farming area developed was abandoned. The initial success in reviving abandoned ponds encouraged many farmers to organize societies and take up shrimp farming. More than 50 aquaculture societies have been organized in this district alone. This could pave the way for full scale revival of most of the abandoned ponds in Andhra Pradesh and set an example for other parts of the country.

Lessons Learnt:

- Abandoned ponds could be revived
- Instilling confidence in farmers through successful demonstration is the key
- Good quality shrimp seeds need to be made available for these farmers
- Cost of production could be far lesser in these areas as the farmer practice low input based farming
- There is an opportunity for full scale revival of all the abandoned shrimp farms and lead them towards sustainable path in Andhra Pradesh and elsewhere in the country.

i. Self propagating nature of the model:

Indeed today we are seeing the emergence of numerous farmer societies throughout India because of the farmers confidence in participatory group farming and the concept becoming mainstreamed. Society organization is progressing very well, this is mainly due to the belief among the farming community that if they have to succeed as shrimp farmers they have to organize themselves. The reasons for this confidence in group farming according to a farmer, "*we are strong as a group, we can address issues affecting us, but alone we cannot progress especially in shrimp farming*". Grassroots action in India demonstrates that group activities of the farmers can improve their well-being in many ways that individual approaches cannot. Farmer organization as groups is generating improvements for the individual producers in the following areas;

- Enhancing their incomes and their bargaining power in markets. Clusters offer economies of scale, buying inputs and improve market power when dealing with suppliers and selling product.
- Societies improve information exchange and sharing of experience among participants.
- Improved farming skills and technical knowledge
- Ability to articulate demands and interact with markets and market forces ,other political and social actors
- Access to financial services and ability to manage funds.
- Knowledge and tools to use information on markets, services, technologies and rights
- Self respect, social esteem and relationships to authorities and other social actors

Progress in organizing Aquaculture societies:

With better informed farmers, the spreading and awareness building about the Society concept, more farmers are approaching NaCSA to help them organize as societies. Details of farmer Societies organized to date are given in table below.

State	Total Of Societies	Farmers	Area (ha)
Andhra Pradesh	229	5424	5483
Orissa	28	750	1609
Tamil Nadu	9	215	185
Karnataka	11	249	245
Grand Total	277	6638	7522

Conclusion

The organization of small scale shrimp farmers in India is (a) empowering small-scale farmers, (b) increasing stakeholder interaction and involvement within the clusters, and (c) is an ideal model for small scale farmers to meet market requirements. The model is of a self propagating nature and most of all it is contributing to sustainability of small scale shrimp farmers livelihood in India. This example best exemplifies how small scale shrimp farmers could remain economically viable and are able to comply with the increasing demands of sophisticated markets, and most of all achieve sustainability. NaCSA by effectively, engaging with the thousands of aquaculture producers in India and helping them to develop farm level plans for sustainable development with the involvement and contribution of the many players involved in the supply chain, from producers to consumers has provided strength to the small farmers for economic and social advancement. This process will be further expanded until all small scale aquaculture farmers in India gets the benefit. NaCSA now makes considerable efforts in helping farmers with better market access, bank credit and helping farmers avail Government support providing a much wider set of tools to influence farmers decision making in such matters. It is envisaged in coming years there will be a increased influence of NaCSA on societies which can be used for regulated development of farmers and their societies.

Acknowledgements:

Thanks to Ms. Leena Nair, IAS, President, NaCSA and Chairperson of MPEDA and Mr. B. Vishnu Bhat, Director, MPEDA for their support and encouragement. I also acknowledges other MPEDA Officials for their whole hearted support for the work of NaCSA. Thanks also to NACA for giving me an opportunity to participate in this TOT program.

Market, Certification and Traceability: Emerging requirements for international markets

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Abstract

General trend of consumers is to eat more seafood for better health, however the economic recession is changing the trends of seafood consumption towards more cheap commodities and products.

Increasing concern of market and consumers towards food safety and sustainability of aquaculture products resulted in demanding traceable products and setting various measures and standards by government, retailers and certification schemes.

It is challenging situation for small scale aquaculture sector, but some of the successful models starting to show that clustered/organised group of farmer can access the better market through innovative and collective approaches.

Market and Consumer Trends

Global economic recession appears to be responsible for altering global seafood market and seafood consumption patterns, particularly visible in the major seafood importing country such as EU and USA. Generally speaking, price of seafood is lower than 2008 and there is a consumption shift towards lower price commodities, and this can be observed as a downwards trends of import volume of high value commodities (Table 1) and increasing volume of non high price commodities such as *Pangasius* and tilapia (Table 2). However, it is important to note that consumption of seafood as a whole is in increasing trends, most likely due to increased health conscious consumer, Japanese food boom, and result of recent several food safety scares (i.e. BSE, bird flu).

Table 1: EU shrimp import, Globefish July 2009

EU-27 Shrimp Imports, by country

	Jan-Mar					
	2004	2005	2006	2007	2008	2009
	tonnes					
Grand Total	155 047	157 860	166 598	175 543	159 453	154 459
DENMARK	27 906	31 480	32 843	26 560	23 886	23 286
SPAIN	27 564	24 513	30 412	34 433	25 892	22 000
FRANCE	21 451	20 469	19 706	21 438	24 076	20 980
UNITED KINGDOM	18 124	20 612	20 471	18 187	17 407	17 122
BELGIUM (and LUXBG -> 1998)	13 304	12 812	13 667	17 035	15 999	16 379
NETHERLANDS	12 694	10 758	9 244	11 815	10 525	13 950

Source EUROSTAT

Table 2: US Tilapia import, Globefish July 2009

Imports

Fresh Tilapia Fillets: USA

	2003	2004	2005	2006	2007	2008
	(1000 tonnes)					
Ecuador	9.4	10.2	10.6	10.9	11.9	8.5
Honduras	2.9	4.0	6.6	7.3	7.9	8.3
Costa Rica	4.0	4.1	3.7	2.7	4.8	5.6
China	0.9	0.0	0.0	0.0	0.0	3.1
Taiwan PC	0.3	0.1	0.0	0.0	0.0	0.6
Brazil	0.2	0.3	1.0	1.0	0.2	0.5
El Salvador	0.2	0.3	0.3	0.2	0.3	0.5
Panama	0.1	0.1	0.1	0.1	0.0	0.0
Others	0.1	0.4	0.5	0.9	1.1	2.1
Total	**18.0**	**19.5**	**22.7**	**23.1**	**26.2**	**29.2**

Source: GLOBEFISH

The common concern in fishery sectors are 1) Sustainability of capture fisheries & aquaculture, 2) Role of aquaculture in food security and 3) Social impacts and environmental sustainability of commercial or industrial aquaculture. Market and consumers are therefore trying to source the products and production processes that ensure “Sustainability, Safety, Quality, and Equity”.

According to FAO, it is estimated that fish consumption, production and trade for 28 countries in Europe from 1989 to 2030 shows an increasing demand for seafood products: rising consumption per capita, coupled with the population increase, means that the net supply will have to increase by 1.6 million tons. Consumer preference looks for good quality portion-size fish, boneless, skinless, odorless fish fillets, steaks, prawns and other products that are quick and easy to prepare (i.e. Ready-to-cook, partly-cooked or even ready-to-eat). Another characteristic is that most European countries generate well over half of their total seafood turnover through supermarket sales (over 70% in UK, France and Germany).

On the other hand, Japanese market is in downwards trend. According to a house hold survey conducted by Japanese Fisheries Association, consumption of fish are reduced and majority of family with children eats fish dish only less than 2 days per week for a dinner. The top 3 reasons/perceptions were 1) fish is more expensive than meat (due to more waste during cooking preparation), 2) children do not like fish, and 3) more efforts needed for preparing and cooking. However, it is interesting to note their favorite dishes are mostly fish related ones (i.e. Sushi, Sashimi) and terrestrial meat comes in only at 6th favorite meal in their ranking (Table 3).

Table 3: Favorite meals for Japanese people

#	Dish/meal	Vote [%]
1	Sushi	73
2	Sashimi	67
3	Ramen (noodle)	62
4	Miso soup	62
5	Grilled fish	60
6	Grilled meat	59
7	Curry & Rice	58

Source: NHK, 2008

Traceability

Traceability ?

- The Codex Alimentarius has defined traceability as the "ability to trace the history, application or location of an entity by means of recorded identifications."

Rationale?

- Sanitary: To allow Hazards Management and product recall or withdraw if necessary.
- Quality product information: Traceability can provide relevant Quality Information asked by consumers.
- Support any Quality Standards: To insure the

Due to the various situations and concerns on food safety in recent years (e.g. GMO, mad cow disease, dioxine contamination, and Bird Flue), number of regulations and standards were put in place by the governments, importers and retailers. Traceability is now a “must” for accessing export market and most likely for many domestic markets in the years to come.

Implementation of the traceability system in developing countries are challenging due to long and segmented market chain, particularly involving small scale aqu-farmers. There are various ongoing attempts and efforts by the sector and government in the region to support implementation of traceability system. For example, Department of Fisheries Thailand has initiated a computerised traceability program call “Traceshrimp”.

1.Certification Schemes

In respond to consumers and market concern about food safety, environmental and social sustainability, food safety standards have been elevated and international trade regulations tightened. Policy and regulations governing environmental sustainability have been put in place in many countries, requiring aquaculture producers to comply with more stringent environmental mitigation and protection measures. There is increasing interests and trend in certification of aquaculture production systems. For example, recent legislation in both Europe and the US require mandatory certification to identify whether aquatic products are produced from aquaculture or wild. These markets increasingly recognize that some form of certification scheme are a way of assuring buyers, retailers, and consumers that fishery products are safe to consume and originate from aquaculture farms adopting responsible management practices.

However, there are concern with increased number of standards and schemes. It is not only confusing for the producers but also becoming additional burden for small scale farmers and businesses in developing countries. One of the key approaches may be to 1) clearly define the boundaries between responsibility of private and public sectors, and 2) make sure a scheme do not eliminate the possibility of those small scale farmers who are innovative and willing to comply, however at the same time shifting the whole industry toward sustainable production.

2.Pilot project in Thailand

The pilot project is ongoing to support a small scale farmer group (cooperative) in Samroiyot, *Prachuap Khiri Khan* province to access European market through group/cluster concept and partnerships. The project started to demonstrate the small scale farmer to obtain better market price for their products by ensuring the sustainability of production system and complying with various additional requirements by EU buyer (e.g. environmental protection and monitoring, detailed recordkeeping, etc). As a result of close cooperation with all partners, small volume of production was successfully sold to the buyer with some premium, compare to the market price. The project is started discussion with the Fairtrade Labeling Organisation to explore the possibility for participating to their scheme, and also supporting the development of Shrimp Aquaculture Dialogue standard (coordinated by WWF) by assessing feasibility for small scale farmers to comply with their standard.

The outcome of this project is showing a good potential and a model for small scale farmer to access better market.

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Farmer organization as models for promoting adoption of BMPs and accessing markets

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Abstract

Majority of shrimp farmers in India are small scale farmers. The work on the development of Better Management Practices (BMPs) on the country's shrimp culture sector stemmed from the recognition of the need to strengthen the sector, particularly the numerous largely unorganized small farmers, so that they could combat disease which has been the major cause of on- farm losses. The core technology around which the BMPs were developed was health management. The key BMPs developed during MPDA-NACA project are disseminated and implemented through group approach where the training is imparted for group of farmers. To quote a farmer leader, "until now we did not know what to do, how to control the disease and get successful crops. With the plan of organizing farmers as a society and techniques such as using a crop calendar (where all farmers of the society stock in one particular period, with fixed stocking density and with good quality seed) we can definitely succeed as a group. The facilities like water quality labs are provided through societies where farmers can monitor water quality on daily basis. The work of NaCSA of late getting the attention of sustainability conscious buyers who are showing interest to buy the chemical free, sustainably produced shrimp from aquaculture societies and sell under premium brand. This will further help farmers by getting them assured market price for their produce and avoiding middlemen who are exploiting the small farmers at present and it would also insulate small farmers from price cycles, fluctuating supply/demand, fluctuating exchange rates, overproduction, speculation etc. The successful marketing tie up with overseas buyer would also help us spread the "Sustainable Aquaculture Practices" to more and more farmers and help thousands of small farmers sustain their livelihood.

Introduction

Aquatic environments are complex ecosystems and understanding and managing the underlying causes of disease is often difficult. Disease outbreaks and poor production are usually the end result of a series of linked events involving environmental factors, the health condition of the stocks, the presence of an infectious agent and poor husbandry and management practices. The ability of farmers to deal with these problems depends not only on technical factors, but also on socio-economic factors such as access to extension services, technology, better inputs, information and finances. To understand aquatic animal diseases and reduce the risks of their occurrence, a systems approach should be adopted so that the whole aquatic system, including its ecological processes and social, economic and institutional factors, is considered.

The key to putting the BMPs into sustained practice was the farmers being associated and motivated. Thus the process commenced with the organization of small scale farmers into groups- clusters, grouping farmers in a given area, drawing on common resources such as a common water supply channel for example, and making them realize the benefits of acting collectively rather than individually. Such clusters subsequently became Societies with a legal status.

Better Management Practices (BMP):

Management practices aimed at improving the quantity, safety and quality of products taking into consideration animal health and welfare, food safety, environmental and socio-economical sustainability. BMP's are management practices, and implementation is generally voluntary; they are not a standard for certification. The term "better" is preferred rather than "best" because aquaculture practices are dynamic and continuously improving. The core technology around which the BMPs were developed was shrimp health management. The specific ones included preventive measures without resorting to use of chemicals, maintenance of the quality of water and substrate, and proper nutrition and feeding. The broad practices included reducing or coping with the risks of pathogens being introduced into the farms with such practices as synchronized water intake and discharge, simultaneous cropping, putting up and observing early warning signs of disease onset, learning from each other, assuring product quality and safety and, overall, acting collectively in their own interest.

Key BMPs developed and implemented through participatory approach are:

Good pond/water preparation- All the society farmers plan to prepare pond as per crop planning schedule. Wherever possible the machineries like tractors and earth moving equipments are hired on contract basis for the whole society thus reducing cost and making it possible for all farmers to prepare the ponds in time for the crop.

Good quality seed selection- Society farmers purchase through contract hatchery seed procurement system where all the group farmers purchase quality seed for whole group.

Feed management- All society farmers use good quality commercially produced feed. FCR is monitored through record keeping all ponds of the society.

Water quality management- Each society sets up basic water quality analysis lab at farm site to monitor parameters like dissolved oxygen, pH and Alkalinity.

Pond bottom monitoring- During weekly meetings the condition of all society ponds are discussed and where necessary farmers are asked to take actions to improve pond bottom condition.

Health monitoring/Biosecurity- No draining or abandoning of disease affected stocks. Farmer groups are encouraged to discuss common actions that can be taken during disease outbreaks to avoid spreading of disease from one farm to another.

Food safety- All society farmers agree not to use any harmful/banned chemicals like pesticides and antibiotics.

Record maintenance/Traceability- All farmers in the society agree to maintain pond management record book which are provided by NaCSA.

Better Harvest and post-harvest Practices- Through linking of societies to local processors steps like quick harvesting during early morning hours, chill killing of harvested shrimp and quick transport to processing plant can be implemented.

Environmental awareness- Improved environmental awareness about mangroves, pollution and waste management among society farmers. Steps initiated against polluting industries along the common creeks through collective efforts of farmers.

Dissemination of BMPs:

NaCSA disseminates BMPs mainly through farmer groups/societies. The key dissemination activities of NaCSA includes,

- **Daily field visit by the NaCSA-** To facilitate farmer involvement, ensure commitment and instil confidence, the NaCSA field staff visit societies on daily basis.

- **Farmer meetings-** The BMP dissemination was principally through farmers meetings and society coordinators. During 2009, 1085 village meetings have been organized to educate farmers in BMPs and to create awareness about benefit of organization. Local language power point presentations on BMPs were presented during the meetings.

- **Farmers field days:** Farmers field days are organized during successful harvest to disseminate the success of more farmers in the region.

- **Farmers as trainers-** Key farmers from successful societies were invited to new villages to share their experiences. Where ever possible field visits were arranged for farmers to other villages for first hand information exchange among the farmers.

- **Extension material–** To enhance BMP uptake and promote adoption in different coastal states of India, BMP brochures on 10 key thematic areas were developed in English and translated to all the 5 state languages.

Implementation of BMPs through group approach

Key aspects for successful implementation of BMPs are,

- Organize farmer group consisting of about 20 to 50 farmers.
- All society farms should be registered with competent authority
- Plan crop activities well in advance of the cropping season using society.
- Plan the crop within the financial capacity and farm management skills of individual farmers and consider local environment capacity such as water quality and water availability.
- Follow crop calendar system for shrimp farming.
- Implement BMPs in a disciplined and cooperative manner.
- Adopt better management practices (BMP) for shrimp farming
- Farmer society should meet at least once a week at a fixed time in a fixed place to discuss the crop activities, problems and solutions.
- Improve the sale price of the crop by improving food safety and quality.
- Establish better market access by collaborating with a reliable and good local processor and buyer abroad.

BMPs are implemented through participatory approach starting with preparation of crop calendar two months before the crop starts where farmers discuss and plan their crop activities for the whole group. The process starts with conducting society farmer meeting where BMPs and improvements in crop that can be achieved are explained to society farmers and consensus is built among farmers on adoption of important BMPs.

An example of key BMPs agreed by the farmers for implementation in societies is provided below.

BMPs for pond preparation

- Sludge removal and disposal away from pond site
- Pond drying
- Ploughing on wet soil if the sludge has not been removed completely
- Water filtration using twin bag filters of 60 mesh size
- Water depth of at least 80 cm at shallowest part of pond
- Water conditioning for 10−15 days before stocking.
- Maintaining good plankton bloom before stocking

BMPs for seed selection and stocking activities

- All Society farmers stock only hatchery produced seed
- All farmers agree to buy “Contract Hatchery” seed
- All farmers in society stocking seeds at same time within a week period
- All farmers agree to stock within the max density fixed for the society.
- Brood stock must be screened after spawning for WSSV by PCR test. Nested PCR negative PLs for White Spot Virus
- Select active and strong shrimp seed
- Seeds must be tested for banned antibiotic residues
- Seed transportation within 6 hrs
- Stocking into green water and avoiding transparent water during stocking.

BMPs for post-stocking and grow-out activities

- No use of any harmful or banned chemicals such as pesticides and antibiotics
- Use of feed check trays to ensure feeding based on shrimp demand
- Feeding across the pond using boat/floating device to avoid local waste accumulation
- Water exchanges only during critical periods
- Weekly checking of pond bottom mud for blackish organic waste accumulation and bad smell
- Regular shrimp health checks and weekly health and growth monitoring using a cast net
- Removal and safe disposal of sick or dead shrimp
- Inform all society and neighbouring farmers if there is any disease outbreak
- Agree practices to be followed during disease outbreak in society or in surrounding ponds
- Emergency harvesting after proper decision making
- No draining or abandoning of disease affected stocks
- Pond daily management record maintenance.
- Better harvest and post harvest practices which involves completion of harvest by early morning and chill killing of harvested shrimp.
- Quick transportation of harvested shrimp to processing plant
- Selling of all society shrimp to one local processor with whom society has agreement

The practices under each BMP are as follows:

Good pond/water preparation-

Before a pond can be stocked for a new crop, the excessive wastes accumulated in the pond during the previous crop must be removed and the soil and water conditioned. Stocking of shrimp in a poorly prepared pond may lead to several problems including disease, poor growth and bad water quality. Good pond preparation is key to reducing disease risks and improving shrimp production.

a. Pond preparation:

1. Drain the pond water completely to dry
2. Use the pump to remove any water logged inside the pond
3. Remove the organic waste from pond bottom It results from decay of excessive feed, dead and decaying plankton/algae and faecal matter of shrimp.
    - It is in the form of layer on the soil with black color and bad smell.
    - Completely remove it especially from the feeding areas, corners of the pond and from trenches in extensive system ponds.
    - It is easy to remove it when the soil is semi dried (slightly wet).
    - Displace it in the ditch created on the top of embankment and cover it with good soil or deposit far away from the farm site.
    - The pond is allowed to dry in hot sun for 15 to 20 days till the soil cracks
    - Be careful if using mechanical means to remove the sludge. This may expose acid sulphate soils. Request technical assistance, and test the soil.
    - If it is difficult to completely remove the black soil (tilling), turn the soil when it is wet and let it dry.

b. Water Preparation.

- After liming depending on soil pH, the pond should be filled to the maximum depth through a screen with fine mesh (300 micron) to prevent the predators and competitors from entering the pond.
- Plankton bloom is essential to successful shrimp culture. Ten days before stocking, if the color of the pond water is clear, the pond must be fertilized with organic fertilizer to stimulate the plankton bloom.
- Make sure pond is filled with minimum 80 cm water prior to stocking seed
- When the color of the water is green the pond is ready for stocking

Good quality seed selection:

Stocking high quality and healthy seed is fundamental to success of a crop in shrimp farming. Small-scale farmers find it a daunting task to procure good quality seed. To select small quantity of clean seeds for their individual requirement, farmers visit several hatcheries, spend considerable cash on testing the seed batches and still are uncertain of the seed quality they finally get. This process of seed selection is time consuming, expensive and still has the risk of farmers not being able to get quality seeds at the right time. To proactively address this serious problem, NaCSA is following the "Contract hatchery seed production system" to meet the seed requirements of farmer societies and to avoid the difficulties in procurement of good quality seeds.

What is contract hatchery system?

Under this system, Society farmers place bulk orders to a Government registered hatchery, 45 days in advance of the planned stocking date, for production of required quantity and quality of seeds. Through a consultative process, initially facilitated by the NaCSA team, mutual agreement is formed between selected hatcheries and Society farmers. These agreements include agreements on better management practices to be used in hatcheries and other terms and conditions for production and procurement of quality seed.

How it was done in Societies?

Farmer leaders of Societies visit 4-5 registered hatcheries about 45 days before the stocking date. They observe the hatchery facilities and discuss the quality requirements and production procedures with the hatchery owners and technicians. Once the farmers have reviewed hatchery facilities, production processes, qualification and experience of technicians they enter into an agreement with the hatchery owner on the terms and conditions and farmers place the order for supply of seed in bulk quantities. In addition, they may also offer an additional premium

(20-30% more than normal market price) for shrimp seed produced according to their requirements. By offering a premium price for bulk purchase of quality shrimp seed both the hatchery and farmers benefit.

Production and quality criteria agreed by hatcheries and Societies:

The following are some of the important production and quality criteria mutually agreed by hatchery owners/operators and Society farmers:

- Screening of broods and post larvae for WSSV and MBV
- Maximum feeding with high quality Artemia (10 kg/million PL) and reduction of artificial feeds
- No use of banned antibiotics. Seeds are screened for presence of banned antibiotics by ELISA test before packing.
- Reduction of stocking density in PL tanks (60-80 animals/litre)
- Maintenance of hatchery management (tank-wise) and trace-ability record
- Complete access to a Society farmer representative for entire seed production period of 30 days thus bringing transparency in hatchery production activities.
- Choice to farmers to reject the seed at the time of packing if the batch fails quality tests.

Society farmers and hatchery operators are highly appreciative of this transparent and mutually beneficial system.

Visual Standards for PL Selection:

- Observe the PL's in a bowl by taking samples from different locations in the PL tank.
- The PL's should be uniform and active (PL's jump against tapping of the bowl and swim against the current in a swirl)
- Tanks having dead pieces or showing reddish coloration should be rejected, PL tanks having good survival indicates good health of the stock.
- Select the PL's giving >90 survival in Salinity Stress test (by subjecting the seed to 50% drop in salinity and observing the survival after 1 hr)
- Selective sampling of weak PL's in the tank would make the PCR test more accurate (targeted/biased sampling)

Laboratory Standards for PL selection:

Parameter	Standard	Method
WSSV	Absent	2 step Nested PCR
MBV/HPV	Absent	Wet mount/PCR
Stress Test	>90%	50% Salinity drop & 100 ppm formalin for 1 hr
Muscle to Gut Ratio	4:1	Microscopy
Hepatopancreas	Full with oil globules	Microscopy
Gut	Full & without Gregarines	Microscopy
Necrosis and Fouling	Absent	Microscopy
Dorsal Rostral Spines	>5	Microscopic
Total Length	>12mm	Physical
Size variation	<5%	Physical

Seed transportation and Stocking:

- Do not mix the seed batches from different seed tanks of a hatchery.
- The salinity of seed tank water and pond water should be the same and should not differ by more than 5 ppt.
- Prior to packing the seed adjust the salinity of the seed tank water to the salinity of pond water. Start adjusting the salinity at PL-10 stage and complete the process of adjusting at least one day prior to seed packing.
- Transport during cool hours of the day (6 PM – 7 AM)
- Seed should be released in to pond during cool hours of the day, i.e., after 6 PM or before 8 AM.
- Acclimatize the seed in pond water before releasing

III. Feed management:

Feed management is one of the most important aspects of successful shrimp production. Poor feed management is also responsible for increased production cost and shrimp health problems.

- Farmer should use only commercially produced shrimp feed pellets. Feed should not use feed after the expiry date of feed.
- Feed should be stored in a cool and dry place under shade. The storage facility should be kept clean and well protected from sunlight, rain and humidity.
- Start feeding from the day of seed stocking
- Use feed check trays (4 trays/ha) to monitor the feed consumption by shrimp.
- Determine the pellet size based on the size of shrimp.
- Do not give excessive feed. The excess feed will decay and release toxic gases which are stressful to shrimp.
- Spread the feed all over the pond by using boat/floating device
- Do not feed raw or boiled meat / fish / shrimp / crabs / snails etc.
- Do not use poultry or cattle feed in shrimp ponds.
- Never mix any chemicals especially antibiotics with the feed.

VI. Water Quality Management during grow out:

Maintaining good water quality is very important to reduce disease risks and to achieve better shrimp production. NaCSA is setting up society wise water quality labs using easy to use test kits at farm site. Water quality is analysed by trained society coordinator. Some of the key aspects of water quality management in societies are,

- Do not exchange or in-take water frequently.
- For first month, there should not be any water exchange. Starting second month, if necessary, water exchange can be done but try to minimize it as much as possible.
- Release the water when the plankton bloom is too thick (dark green water).
- Do not release or in-take more than 15-30 cm depth of water per day.
- Take the water in only when there is no disease in the society or neighbouring farms.
- Always use double layer water filter net of 300 micron mesh size to filter the in-take water.

Regularly check the water quality parameters.

- pH of water should be 7.5 - 8.5. Use Universal Liquid Indicator for pH measurement.
- Ideal water salinity for shrimp is 10-25 ppt.
- Dissolved oxygen (DO) concentration should be 5-6 ppm.

- Water colour should be green / brown colour
- Alkalinity should be between 100 to 150 ppm. Use alkalinity instant test kit.
- Ammonia should be less than 0.5 ppm. Use ammonia instant test kit.

V. Pond bottom management:

The pond bottom soil should be monitored on weekly basis, especially at the feeding area or trench for black soil, benthic algae and bad smell and corrective actions should be taken.

- Remove any benthic algae. If not removed, they will decay in the pond bottom and release toxic gases stressful to shrimp. The best approach is manual removal.
- Check the pond bottom soil on a regular basis and avoid feeding in areas with black and badly smelling soil.

VI. Health monitoring/ Biosecurity

Key factor in control of disease in societies is in case a disease outbreak is suspected, the shrimp farmers immediately go into proactive monitoring and alert neighbouring shrimp farms. At the same time, contaminated water from the affected pond is not drained without disinfection. In case of emergency harvest the other farmers are informed not intake water for next couple of days.

Common Biosecurity systems should include,

- Crab Fencing for ponds on all four sides to prevent entry of crabs in to ponds
- Non lethal Bird fencing which involves tying of nylon ropes at 6 inch interval horizontally above the pond to prevent birds picking sick/dead shrimp and contaminate other ponds.

VII. Food safety:

Food safety measures are strictly implemented in societies. The antibiotic monitoring programme of NaCSA actively involves the farmers and giving them the responsibility of controlling the antibiotics in the shrimp produced in the societies. This programme apart from building awareness among the participant farmers is enlisting their support to control the antibiotics proactively. Below are the key steps involved,

1. During the crop planning meeting of the societies farmers are asked to short list the common chemicals/ probiotics being used in the society. These short listed chemicals are analyzed for presence of antibiotic residues in accredited LCMSMS laboratory on cost sharing basis by society and NaCSA.

2. Framers are discouraged not to use any other chemicals other than the short listed chemicals analyzed for antibiotics.

3. Shrimp seed samples are tested by farmers in ELISA labs prior to stocking. Only antibiotic free seed purchased through contract hatchery system (seed from one hatchery to one society) will be stocked in societies.

4.The societies are encouraged to use maximum one or two feed brands in society. The Shrimp feed used in societies are analyzed for antibiotics.

5. All the inputs used in society are closely monitored by society coordinators and NaCSA staff.

6. In societies each pond is given unique pond ID number so that shrimp can be traced back to the pond level. The complete pond records are maintained by each farmer pond wise in the societies.

7. Presently 100% of the society pond samples are tested for antibiotic residues in ELISA labs before harvest. Farmers are bearing the cost of analysis.

8. MPEDA/NaCSA is also working on to implement comprehensive traceability system in societies. The process for the pilot project has already started.

VIII. Traceable shrimp from societies:

NaCSA staff train society farmers and society coordinators in keeping records. Most of the farmers maintain records. Among the societies more than 80% of the farmers are literate who keep the records in rest of the cases society coordinators help them to maintain the records. The pond record books are printed and given to society farmers free of cost by NaCSA. Internal records are maintained in contract hatcheries and in society farms on general management and key parameters. Satellite Maps of societies are used to trace the ponds which are given unique ID numbers

For eg: 111011001, 321031009

First 6 digits – society ID, which includes
Digit 1 – State Code
Digit 2 –District code in the Particular state
Digit 3 – Block/ Mandal/ Taluk code in District
Digit 4 & 5 – Village code in Block/Taluk/Mandal
Digit 6 – Society code in village
Last 3 digits –-Pond ID in Society.

Better Harvest and post-harvest Practices

- Co-ordinate the harvest with other farmers in the cluster. Make sure the neighbouring farmers are informed about the harvest.
- Do not feed the shrimp 6 hours prior to harvesting to keep the gut empty and improve the shelf life.
- Complete the harvesting process (draining and harvesting) within 6-8 hrs. Harvest between 6 PM to 6 AM. Avoid harvesting and packing shrimp during hot time of the day.
- Chill killing: After washing the harvested shrimp in clean water dip the harvested shrimps in slurry of ice for not less than 15 minutes. If possible use fresh water to make this ice slurry. This process leads to more freshness.
- Do not use any chemicals while washing the shrimp or chill killing.
- Use ice liberally to keep the shrimp chilled after the harvest. Pack them in transport tubs with crushed ice at 1:1 ratio for better preservation.
- Load the packed crates quickly to the truck and send to the processing plant immediately without any delay.

X. Eco-friendly Sustainable shrimp production.

The society shrimp farms are situated away from wetlands and mangrove areas. The stocking density of shrimp ponds in societies (2 to 10 shrimp per m^2) is on lower side. The environmental risks were also reduced by the decrease in pollution resulting from minimal and efficient use of resources (energy and feed), reduced use of chemicals, antibiotics and limited discharge of sediments and water exchange. NaCSA assisting society farmers with the help of other stakeholder organisations to switch from diesel based energy to electricity. The target for next one year is to assist 200 societies switch to electricity which will save nearly 2.4 million ltr diesel (5400 tons reduction in CO_2 emission from 200 societies). NaCSA has taken up Organic cluster certification program with

NATURLAND, Germany to produce Organic fresh water prawn and shrimp in societies which are following extensive farming practices.

Efforts in linking farmer societies to market:

NaCSA is working with Sustainability conscious buyers in USA who are interested to procure chemical free shrimp produced by Society farmers and planning to sell these products under a premium brand. The shrimp marketing plan of NaCSA is to link each society to processors/exporters identified by the buyer so that all the shrimp from the particular society is marketed to one exporter. The benefits for the society farmers is there will be better price realization as there is no agent or middle men involved, for the processors they can buy all the produce from the society as one unit which provides the advantage of larger integrated units where the harvests can be coordinated and better harvest and post harvest practices can be implemented in societies to improve the over all quality of the shrimp and traceability can be maintained. NaCSA is working closely with exporters and keep them abreast with farmers organizational effort. There is a growing awareness among exporters community that this model is the best way to address many food safety and quality issues and they have shown interest to adopt societies for backward linkage. Once the incentives (better price) is paid to good quality, antibiotic free, traceable shrimp, the better practices will be followed by more and more farmers. We are expecting about 5000 MT of BMP shrimp production during 2009.

Market requirements:

Responding to demands by environmental organizations supermarkets are increasing their efforts to sell fish from sustainable sources. The retailers are looking for the following key indicators;

- Producers comply with local laws
- Minimize the impacts of shrimp farming on the environment by protecting sensitive habitats such as mangrove forests and wetlands
- Monitoring water quality to prevent pollution
- Farm to fork traceability is required from the hatcheries where the young shrimp are first hatched, to the ponds where they are raised and to the plants where they are processed
- Antibiotics, hormones and toxic chemicals should not be used
- Producers must provide detailed information on farming practices and pass independent third-party audits.

Society farmers in India meet most of the market requirements thus in a position to realise better price for their produce.

Conclusion

Crisis (disease and water quality problems) pushed farmers to cooperate; so perhaps the main lessons learnt centre around the power of social organization rather than the impact of more technical changes. Many of the disease problems were earlier related to lack of cooperation among farmers, who were using a common water canal and their need for cooperation in the timing of release of waste pond water and the intake of “clean” pond water both via this shared canal. Experiences of MPEDA-NACA and NaCSA shows that adoption of farm level Better Management Practices (BMP) through cluster farming are promising models for small scale farmers to work together to reduce risks and earn their livelihood by helping the industry to meet customer demand through adoption of sustainable and environmentally friendly farming practices. The better market access for society produce would further motivate more and more farmers to grow the shrimp to the buyer specifications and ensure steady supply of best quality, chemical free, traceable shrimp. This market recognition for the society produce would help NaCSA spread the message of “Sustainable Aquaculture” far and wide to more areas across India and would help in sustaining shrimp sector there by contributing to a new vision for the aquaculture sector in support of small farmers livelihoods in India.

Ref: MPEDA-NACA BMP brochures

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Strategies to produce and distribute quality seed

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Abstract

This paper presents the strategies to produce and distribute quality seed, based on research findings. These strategies include provision of proper nutrition and management of broodstock, appropriate larviculture techniques, and effective networking and seed transport methods.

Introduction

The quality of fish seed (fry and fingerlings) has significant effect on the production and income from grow-out culture operations and on the ecosystem if the seed is used for restocking or stock enhancement. Inasmuch as wild fish stocks is declining, research efforts have increased in recent years to develop techniques to artificially produce seed for grow-out culture and stock enhancement purposes. However, in some cases, the quality of seed produced from captive brood-stock has not been good because the right strategies were not available or followed.

One of the objectives of the project in which this training of trainers (ToT), is to improve sustainability of farming systems, particularly tilapia culture in cages and ponds in Thailand, shrimp culture in Vietnam, sea bass and grouper culture in Indonesia, seaweed culture in the Philippines, and snakehead culture in Cambodia. Sustainability of these farming systems would be dependent on the availability of quality seed. The strategies presented in this paper are based on research findings and would be useful in producing quality fish seed needed for aquaculture development.

Proper nutrition and management of captive broodstock

Seed quality is dependent on brood-stock nutrition and management (Izquierdo et al., 2001). Proper brood-stock nutrition is very important because many species decrease food intake during final development of the gametes, making it necessary for the fish to withdraw nutrients and energy for ovarian growth and other functions from its body reserves (Zohar et al., 1995), importance of a balanced ratio of n-3/n-6 polyunsaturated fatty acids (PUFA).

Specific strategies related to broodstock nutrition and management include:

a. **Supplementation of diets with marine fish oils rich in n-3 PUFA.**

   Broodstock diets with more vegetable oils rich in 18:2(n-6) will have an effect on egg and larval quality. Docosahexaenoic acid (22:6n-3; DHA) and eicosapentaenoic acid (20:5n-3; EPA) are essential fatty acids which have important functions in brood-stock diets and eggs (Carillo et al., 2000; Sargent et al. 1995). There should be a balanced ratio of n-3/n-6 polyunsaturated fatty acids (PUFA) in the diet. It has been reported that juveniles of marine species in which the broodfish were fed diets rich in essential fatty acids produced eggs of significantly enhanced quality compared to controls in red seabream (Watanabe and Kiron, 1995), and the grouper *Epinephalus tauvina* (Dhert et al., 1991).

b. **Minimizing stress on the broodfish**

Stress brought about by the capture and holding of broodfish under controlled conditions can affect broodstock reproductive performance and eventually seed quality, thus, broodfish should be kept at low density with sufficient food.

c. Reduction of the likelihood of pathogen transfer from the environment and broodstock to seed by:

a. Screening of broodstock for bacteria and viruses which can be transferred between broodstock and eggs.
b. Isolation of hatchery stocks and location of hatcheries to reduce risk of cross-contamination by infected and/or feral organisms and/or water sources.
c. Disinfection, pre-treatment and recycling of water and quarantine before transfers are all in regular use as disease-prevention methods.
d. Development of domesticated stocks that are genetically improved and are free of specifically listed pathogens (Argue et al., 2002).

d. Induction of spawning at optimal period

Due to the requirement of aquaculture producers for seed all-year-round, production of seed outside of natural seasons have been induced but this also has implications for the quality of seed produced. For example, spawns from early and late-season batches of hybrid catfish (*Clarias macrocephalus* x *C. gariepinus*) and carp seed are known to be of poorer quality than those from the main season. This variability has been explained by incomplete maturation and the onset of atresia (Ingthamjitr, 1997).

e. Maintenance of genetic quality

Inbreeding is a major genetic problem in captive hatchery stocks and it is often identified as a major cause of quality deterioration. To keep inbreeding rates low (about 1% per generation), a minimum of 50 pairs of breeders should be selected and the number of progeny tested should be restricted and standardized to not less than 30–50 progeny per pair (Bentsen and Olesen (2002).

Appropriate larviculture techniques

Another major cause of poor seed quality is the lack of appropriate techniques for larviculture. Research studies have provided useful information for the development of appropriate larviculture techniques such as:

- Use of microalgae, the rotifer (*Brachionus plicatilis)* and the brine shrimp (*Artemia*) as initial feed especially for marine species of finfish, crustaceans, and mollusks.
- Use of algal substitutes in shrimp larviculture and are a key part of 'green water' technology used even for carnivorous fish species. Although the algae do not constitute the major food source for these fish, this approach appears to improve results, probably for a variety of reasons (Lavens et al., 1995).
- Enrichment of live larval feeds either indirectly by enriching the microalgae themselves or directly by raising rotifers or *Artemia* on enriched artificial diets. The basis of enrichment is the use of (n-3) HUFA, and especially the correct balance of EPA and DHA. Fish seed produced using these diets show better survival and tolerance of stress.

Effective networking and seed transportation

Establishing a network with other seed producers, grow-out farmers and service providers can lead to sharing of effective seed production techniques, market access, and improved availability of materials, equipment and resources that can stimulate improved management, efficiency, and ultimately seed quality.

Seed distribution requires transportation which, if done improperly over long distance, causes stress and deterioration of seed quality. In general, the guidelines for fish transportation are the following:

- Stop feeding fish for 24-48 hours prior to transport to allow the gut to clear and thus decrease the bacterial and faecal load placed on any holding and transport system.
- Prepare all transport containers, oxygen and other equipment.
- Harvest fish during coolest part of the day (very early morning).
- Quickly, but gently, load harvested fish into a transport container. Do not overstock. Use bottled oxygen if possible.
- Insulate from heat during transport.
- Transport fish on the fastest, smoothest means of transportation available.
- Upon arrival, adjust fish to their new surroundings slowly by gradually exchanging water to avoid temperature and ionic shock.

Conclusion

The strategies to produce and distribute quality seed include provision of proper nutrition and management of brood-stock, appropriate larviculture techniques, effective networking and seed transport methods. Proper brood-stock nutrition and management involves supplementation of diets with marine fish oils rich in n-3 PUFA, minimizing stress on the broodfish, reduction in the likelihood of pathogen transfer from the environment and brood-stock to seed, induction of spawning at optimal period and maintenance of genetic quality.

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Enhance women participation in aquaculture to ensure sustainability

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Abstract

Role of women in agriculture is better understood and in some continents like Africa, women are known to be responsible for majority of the food produced. However, the visible and invisible role played by women in aquaculture has only begun to receive attention recently with the efforts made by various organizations. The visible role of women and their active participation in aquaculture can be seen in some countries, while in others they have been deprived of their participation until recently. Even in societies where they have been participating in aquaculture, they have been deprived of access to information, resources, markets, etc and as a result, they are serving more as mere implementers of the activity rather being the active partners in the production process. Research and development efforts made in the last two decades have helped to recognise the constraints experienced in various societies for the participation of women in aquaculture and have access to the resources generated.

Based on the research findings, it is recognised that access to information and access to credit are the two most priority issues that need to be addressed to enhance active women participation in aquaculture. Access to information is critical and development institutions must recognise that both men and women in the family must be trained and this can be accomplished by adopting family approach to ensure that both men and women participate in trainings, knowledge sharing events, etc. Fixing physical targets for training of women and ensuring their compliances recommended as one of measures in development interventions. Provision of credit to women and allowing them to use the resources for the purpose for which the credit drawn has been recommended as another important step to empower women. It is also suggested that development agencies ensure women not only have access to credit, but help them to have control on the resources generated from the activity.

Provision of knowledge and credit to women have already demonstrated on how the nutrition of the families, education of children, improved health of the people, etc., have changed to bring greater benefits to the society as a whole. It has also been recognised that when women are given knowledge and their participation is ensured, resources are used wisely and sustainability of the activity is greater. In view of the positive benefits of women participation in aquaculture, development interventions must ensure both men and women in the family are targeted for provision of knowledge and skills and flexible training and intervention approaches are used taking in to consideration of women needs and necessities.

Introduction

In agriculture, women are known to be responsible for more than 50% of the food production activities (Williams, et.al., 2005) Women have played key role to preserve the biodiversity of agricultural crops in many ways. Similarly, aquaculture has also benefited from the involvement of women in the activity either directly in the field or by providing support to men who are involved in developing this new form of food production system by taking care of other house hold activities, which are often not valued economically. Aquaculture is the fastest growing food producing sector in the world with an average growth rate of over 9%. By 2012, more than 50% of the global fish production is expected to come from aquaculture. More than 90 % of this aquaculture production originates in Asia and nearly 70% of this production is contributed by China alone. Interestingly, major portion of this production comes from small scale aquaculture wherein the involvement of women is maximum. The history of aquaculture, though has more than 2500 years, the rapid growth of aquaculture is only seen during the past three decades.

Aquaculture has an advantage of learning from the lessons of Agriculture sector and make sustainable development plans. The demand for fish is increasing due to the increasing awareness on the health benefits of eating aquatic products including seaweeds as compared to terrestrial meat products. This increased demand is predicted to drive people in to farming of water bodies, to meet the increasing demand. Hence, to ensure sustainability to aquaculture and safeguard environment, it has been recognized that women should be empowered with aquaculture knowledge and skills (Williams, et.al., 2001).

Aquaculture has been largely carried out in most part of Asia as a subsistence farming to meet the family requirement of fish. In this type of farming, though aquaculture is still largely dominated by men in many countries of the world, women have been an unrecognized contributors to the development of this system in countries like China (Zhiwen, 1999) and several Southeast Asian countries (Kusakabe and Kelkar, 2001). However, with the increasing simplification of the culture techniques and integration of aquaculture in to the farming system of the farm families, women involvement in aquaculture is gradually increasing in many countries and cultures. Importantly, though participation of women in aquaculture is increasing in most countries, control on the activity and access to the benefits emerging from the commodity produced from the sector remain still largely with men since many of the critical activities are controlled by them.

It is important to note that participation of women in aquaculture also varies greatly from country to country and even within the country from region to region depending on the culture and traditions. In China and some of the Southeast Asian countries with the influence of Chinese culture, participation of women in aquaculture activities is significant. In these countries, encouragement of women participation in various farm activities to produce products of economic value has helped women to improve their position positively as compared to other regions. In contrast to this, in South Asia, with the conservative environment, women participation in aquaculture has been traditionally poor and women have been largely engaged in the unvalued household and child care activities. However, in the last two decades, gender focused interventions in Bangladesh and India have created many good examples. In Africa, women remained neglected in the aquaculture technology introduction process and this is also possibly one of the reasons for the poor success of aquaculture in early years in that continent. Interestingly, gender focused interventions have made significant impact in countries like Zambia and Malawi (Mbozi, 1991). In Latin America, aquaculture is a relatively new activity and, it is learnt that women have been actively involved in carrying out the activity.

Key gender issues in aquaculture

Globally, the role of women and the need to consider gender issues in aquaculture development was first recognized by the FAO-NORAD sponsored workshop on " Women in Aquaculture " in 1987 (Nash, et.al., 1987). In this workshop, the scope to productively engage women in aquaculture and help them to be important contributors to family economy was examined. The workshop recognized that aquaculture being not a labour intensive industry, the opportunity to employ more women in the sector is limited. However, the economic benefits of the crop being higher than most other agricultural crops, it was recognized that targeting women could bring multifarious benefits. Provision of required skills to women to carry out the activity and making available adequate credit to carry out the activity were identified as the most important components to trigger aquaculture development through the active participation of women. This global workshop recognized the need to influence policies to be gender sensitive from the early stage since aquaculture is in developing stage in many countries. However, conscious efforts to address the gender issues in aquaculture sector and involve more women through explicit support to their participation is yet to be undertaken intensively.

Asian Fisheries Society strategic interventions

Asian Fisheries Society has made consistent efforts to address gender issues in aquaculture by identifying key researchable areas as well as areas to influence the policies of the Governments for more than a decade (Williams, et.al., 2001, Williams ,et.al., 2002; Choo, et.al., 2006). The efforts made to measure the participation of women in aquaculture and identify areas for intervention have brought out the potential of aquaculture to improve family nutrition and economy by suitable gender based intervention in many societies. Lack of focus of the development institutions on women in developing aquaculture was recognized and the efforts made to spread this message among the various Indo-China countries by establishing the women in fisheries network with the support of the Mekong River Commission supported project has brought major benefits to the region in terms of increasing awareness of the people on gender issues hindering aquaculture development. Scaling up this activity to Asian level by the Asian Fisheries Society through the triennial organization of the scientific events on women in fisheries since a decade has helped to assess the status of women participation in aquaculture on periodic basis. The movement that started as Women in Fisheries has now transformed itself in to “Gender in fisheries” recognizing the need to lay emphasis on both men and women. The support provided by the World fish centre has helped in the establishment of Gender and Fisheries network. This network is now an important source of information and a Platform to discuss various issues. These scientific events have provided an opportunity to bring various potential issues and provide the information base for various developmental projects. This effort of the Asian Fisheries Society along with the efforts of the Institute of aquaculture, University of Stirling, UK and the Asian Institute of Technology have brought out a number of key issues that need to be considered by the research and development institutions to intensify developmental programs. Asian Fisheries Society recognized the need to address the gender issues through well planned research and in 2007 global symposium on Gender and Fisheries had the theme “**Gender and Fisheries: solutions through research”**. The selected papers of this symposium were published in an issue of the journal "Development", totally dedicated to fisheries.

Increased burden to women or enhanced status?

One of the important questions often asked is whether the introduction of aquaculture has brought more burden to women along with the routine tasks that they need to carry out in the family or has really increased the position of women within family and her status in the society as she has been able to contribute additional source of income?. Though the time required for management of ponds would depend on the size of pond and the level of technology adopted, certainly it calls for dedicated involvement of women to get the desired output. The new activity introduced will always be generally in addition to their normal household activity being carried out, unless the women witness the benefit, if not to themselves, but to the family, they consider the activity as a burden. For example, in Cambodia women felt that walking long distance to collect feed for fish like termites, azolla, etc. as a burden, particularly in view of the security risks involved in such long distance travel in search of fish food. However, once when the women began to see the benefits from aquaculture in terms of increased easy availability of fish for consumption as well as a source of income, same groups considered this as the most potential activity to help them in solving their problems (Nandeesha et.al.,1994). In many parts of the world evidences generating indicate that when women are involved in aquaculture, there is considerable improvement in family nutrition, use of the income generated for the productive areas like education of the children, etc. Further, evidences also indicate that additional skill acquired by women to grow fish and extra income being earned has brought them enhanced status within the family as well as the community (Nandeesha and Hanglomong, 1997; Murray, et.al., 1998; Bhujel and Pant, 2004; Bhujel, et.al., 2008; Siason, et.al, 2006; Debashish, et.al., 2001). Development interventions must ensure that women and men in the family have equal access and control on the benefits emerging from aquaculture.

How to enhance women participation in aquaculture ?

(a) Enhance access to information

The key constraint experienced by women is the access to information that helps them to gain confidence to grow fish successfully (Kusakabe, et.al., 2003) Most often women are not invited to attend the training programs since the target of various programs is men in the family to receive that information/training. Unfortunately, men who attend the training do not freely share that information with other members in the family. To address this problem, it is suggested to target women in particular. However, in such cases, often the organizers of the training do not take in to consideration of the women needs like scheduling the training that is convenient to them, arranging the venue that is closer to their families, needs of the children when mother has to attend the training, etc. (Nandeesha et.al., 1994; Nandeesha, 2004) Most importantly, the educational level of women in most of the countries being low , the trainings need to consider this aspect and organize trainings that provide an opportunity to learn by doing. Considerable success has been achieved in designing the tactile tools to educate men and women with low literacy level or illiterates in Bangladesh (Shelly, et.al, 2001; Debashish, et.al., 2001).

(b) Enhance access to water resources

Landless women were encouraged to undertake cage farming of fish by creating an opportunity to have access to open water bodies in Bangladesh. This was considered as one of the major accomplishments since in Bangladesh there are many open water bodies that can be made available. However, this cage culture activity is yet to be seen as a sustainable activity being carried out by women due to various other social and technical constraints. Women were also successfully organized in to groups and encouraged them to undertake aquaculture activity by taking ponds on lease (Nathan and Apu, 1998). Though initially many hurdles were faced to procure access to water, consistent efforts have led to involve them actively in pond culture programs in Bangladesh. In this conservative society, today many women can be seen involved in pond fish culture activity, particularly in carrying out all the activities by themselves from stocking to harvesting and marketing. In most cultures, land ownership is held by men. Though this cultural pattern will require time and appropriate policy changes to give ownership to both men and women, the major hurdle faced in many areas for aquaculture development is the multiple ownership of pond and multiple use of pond. Development interventions must take these factors in to consideration and introduce appropriate technologies that will survive under these circumstances.

(c) Enhance access to credit

Aquaculture activity to be successful, provision of adequate input is critical. While some on-farm resources could be used in aquaculture, considerable amount of off-farm input needs to be purchased in most cases. Hence, provision of credit along with appropriate training is essential to ensure that family derives benefits from the activity. Self help groups established in many Asian countries have contributed very effectively to aquaculture activities. Keeping the groups intact over longer period of time and developing leaders to take on the leadership are the major constraints. In addition, aquaculture crops in most cases requiring longer growth phase, most credit systems available in different countries do not suit well to aquaculture crops. In Bangladesh, efforts have been made to evolve credit systems that take in to consideration of this longer gestation period of crops (Nandeesha, 2004).

(d) Enhance access to female extension staff

To increase communication between women farmer and the extension personnel, it is recognized that in many cultures that it is desirable to have women staff. Large scale experimentation by CARE Bangladesh in the conservative Society by aiming to have almost 1:1 ratio of male and female extension staff resulted in the high level impact of the project programs. Particularly, in the conservative areas, having female staff helped in a big way to change the perception of the people. While having gender balanced staff is bound to help in many ways and it is essential, the experience of the CARE projects in Bangladesh indicate that once the confidence of the community is gained, both men and women extension person are accepted by the community and women will have no difficulty to share the information with men (Debashish, et. al., 2001)

(e) Change in organisational culture

Most organizations are dominated by men and many of them are yet to be aware of the gender issues because of the cultural inheritance, particularly in Asia. As a result, with lack of knowledge and experience in gender, gender blind policies and interventions are common. Even in Philippines, Thailand, Vietnam wherein women constitute major percentage of staff, the need for gender sensitive policies and actions is felt. Hence, to bring change in an organizational environment, it is necessary that top management must be educated on gender and constant efforts should be made to develop gender sensitive policies and programs to address the issues confronting the system. CARE Bangladesh management recognized this as an organizational issue and introduced policies to ensure not only gender balanced staff recruitment, but also make conscious efforts to ensure gender is part of all projects (Debashish, et.al., 2001). When women extension staff were recruited and given small bike to reach villages, these staff were faced with many challenges since men did not want to see the women driving the bike. Constant support from the management helped the staff to overcome the problem and today driving a vehicle by women in rural Bangladesh is no longer considered as an uncommon activity.

Benefits from the increased participation of women in aquacultue

(a) Enhanced social status of women

Participation of women in aquaculture activities is generally not viewed as a womanly activity, particularly in many of the conservative societies of South Asia. In this cultural context, often women are not even targeted by various agencies, assuming that aquaculture is an activity for men to be carried out by men. In Bangladesh, efforts made by a number of NGOs have contributed for a major change to include women in aquaculture activities. Acquisition of knowledge and skill and active participation in aquaculture activities have changed the status of women within the family as well as in the society. However, in these conservative societies, in the early stages, their participation in aquaculture was viewed negatively and heavily criticized. Persuasion with the community leaders and families to participate in this activity that can be carried out most easily has resulted in good output (Debashish et.al., 2001).

(b) Improved position of women in the family:

When women acquire knowledge and skill on aquaculture and contribute to family income, it has been seen that the position of women in the family improves visibly (Vimala, et.al., 2004). Women in Bangladesh involved in culture of freshwater prawn depended on men in the family to manage the ponds before they acquired knowledge and skill in the area. However, once the women participated in the learning sessions and gained practical skills, they were viewed more as equal contributors to family income by men in the family (Nandeesha, 2004). Further, once the women were able to carry out the activity independently, they also began to gain control on the income earned and decide on the way the resources spent on the family improvement. In the Oxbow lake project too, it was observed that once women were able to initiate aquaculture activity and earn income, their position in the family changed. Women were able to buy the personal and family necessities using the resources available at their discretion. In several instances in Cambodia, women had gained substantial voice in the family management with the extra income they could earn through involvement in aquaculture (Nandeesha, et.al., 1994).

(c) Improved nutrition of the family:

Involvement of women in aquaculture has always ensured higher priority for consumption of the fish produced from the backyard pond for consumption within the family. This has been very common in Cambodia where women themselves could harvest fish by using simple nets like hook and line, scoop net, drag net, etc. Considerable portion of the harvested fish was shared with relatives and friends. Such distribution of valuable food item like fish also has contributed for the enhanced image of the family in the community. In the cage culture project in Bangladesh, women who were actively involved in cage management always ensured, harvested fish utility for family consumption. Cage culture of fish also provided an opportunity to treat guests and relatives by easily harvesting fish from cages without depending on men in the family. Women have expressed great interest in managing cages by placing them in ponds located close to the houses or in open water bodies close to their place of residence.

(d) Education to children:

The involvement of women in aquaculture has helped in many cases to improve the education of children. The priority women have always given to utilize the income earned from aquaculture is to spend on the education of children. In an aquaculture project under operation in Tribal area, the women prioritized the benefits of aquaculture as an income source to cover the family education and health expenses (Nandeesha, et.al., 2006). As the fish of any size can be sold at any of the year in eastern part of India and Bangladesh, farmers always viewed, fish pond as a **live bank** as they can harvest fish and sell whenever money is needed. Harvesting of fish from the cultured ponds is still considered as the main domain of men. This contributes the dependence of women on men to harvest the fish when needed. In Bangladesh, women were trained to harvest fish by cast netting or by dragging. Though society viewed this as a manly attitude in the beginning, with the passage of time recognition for the new skills acquired by women is seen.

(e) Increased sustainability to aquaculture:

Aquaculture activity has been found to sustain and expand when women are actively involved by realizing the practical benefits from the activity (Kusakabe and Kelkar, 2001; Nandeesha, et.al., 1994; Nandeesha, 2004). The pond fish culture activity in Cambodia is sustained by closely linking with village level seed production and nursing activity. Several hatcheries have been established by the farmers themselves, particularly through innovations that have contributed for the evolution of several new type of practical hatcheries. In Bangladesh, rice –fish activity in the poor regions of Northwest has been found to be sustained with the active involvement of women. In freshwater prawn farming, education to women to adopt environment friendly aquaculture practices like reduction in the usage of snail meat, growing paddy along with prawn as a concurrent crop. Most importantly, large dykes left unused have now been used for raising vegetable crops. All this has contributed reduction in risk and increasing sustainability of the activity. Pesticide usage in paddy cultivation has been brought down to minimal and many farmers grow paddy without using the pesticide. This has been mainly accomplished by educating wife and children and exerting indirect pressure on the family to avoid using any harmful substances.

(f) Efficient utility of the wastes through aquaculture:

Participation of women in aquaculture has shown that all the wastes available from the kitchen and the farm are best utilized for growing fish. In Bangladesh, cage culture project experienced the growth of fish in women managed cages through the better utility of wastes. Women ensured regular feeding of fish with the left over material from kitchen. In Cambodia, women utilized various types of weeds like Lemna, Azolla, termites, etc as feed to the growing fish and the bio-resource map developed indicated that farmers used more than twenty different wastes as feed to grow fish.

Key policy and implementation issues to enhance women participation:

Aquaculture need women, but whether women need aquaculture?. This is a pertinent question raised by Felsing et.al (2000). Clearly, increasing household responsibilities and work load of women without ensuring that women derive the benefit from the new activity will not ensure sustainability. However, aquaculture when carried with adequate care and investment, yielding much greater return on investment as compared any other agricultural activity carried out by farmers, there is a need to consider aquaculture as a tool to empower women. It should also be noted that in small scale subsistence aquaculture women involvement is seen, but with the increasing intensity of aquaculture, women are excluded from the system (Kusakabe, 2003). This is an important issue that need to be considered. With the increasing intensity of aquaculture, as the system call for greater degree of management and negotiation with outside agencies for supply of inputs as well as marketing of the produce, requiring greater negotiation appear to reduce women participation. FAO report (2001) points out that time and labour can constrain women's greater participation or greater involvement in aquaculture. However, Kusakabe (2003) opines that these are not the major obstacles in terms of women increasing their decision making power in aquaculture activities or having more self confidence through their involvement in aquaculture. The critical factor is the resources and knowledge that women have relative to their husbands. Hence, the empowerment programs must keep this in mind and do the needful.

In small scale aquaculture, women are often excluded from the system and often they are restricted to just to carry out some marginal activity like feeding and fertilization, largely because of the poor knowledge of women about aquaculture. Hence, development interventions should specifically target women and fix numerical numbers as targets to ensure that women are reached through such interventions. Prevailing social perceptions that hinder women participation in aquaculture should be addressed through strategic interventions.

Provision of right input and their proper usage should reduce the risk from aquaculture. To reduce risk further, integrated farming systems should be promoted that encourage the resources available on the farm along with the off farm inputs to increase productivity to appropriate levels so that w omen involved feel suitably rewarded from the aquaculture activity.

Creating suitable market access to the fish and other products produced from the system would help assured return to farmers. Organising farmers in to groups and helping them to undertake group marketing would bring greater benefits. Any activity introduced would only be sustained only when it brings good economic returns. Focus of any marketing system should aim at tapping the local market and ensure that product produced economically viable with local prices.

Adopt flexible training to train women based on their convenience. Participation of women in training programs at a distance from the village made participation by women impossible in Eastern India under the DFID programs. Hence, training of women through on-farm participatory approaches with flexible short meetings with early adopters were found to be successful in Vietnam (Voetan, 1996). Women seem to benefit far better than men when they see the videos related to aquaculture in Northeast Thailand.

Aquaculture has been perceived to be an activity suited more for men in many societies. To harness the power of this activity realized centuries ago by Fan Li in China, there is urgent necessity to influence Governments and development agencies to evolve suitable policies that promote gender balanced development. Fortunately, with the increasing awareness raised on the gender issues in aquaculture, beginning with the FAO workshop in 1987 on “Women in Aquaculture”, there have been some conscious efforts to address the issue, particularly by the NGO community. In Bangladesh, perspective plan developed for the aquaculture development does state about the need for specific focus on women in aquaculture development. With a number of donors involved in development work and most of them paying due attention to gender issues, the approach of the Government has been gender balanced. Several of the NGOs working in Bangladesh have played major role in changing the society perception on women and have provided support to their active involvement in various activities. In Southeast Asian countries, the Women in Fisheries Network established in various countries and supported by the Mekong River Commission have been playing active role at the national level in terms of influencing policy by generating adequate amount of research information raising relevant issues on women in fisheries and aquaculture and influencing the Governments to evolve suitable programs. In Africa, ALCOM project of FAO made an attempt to raise relevant gender issues in aquaculture and influence the Governments in evolving appropriate policies.

Clearly, so far no Governments have come up with suitable policies and programs to address the issue. However, with the increasing recognition of the issues, there is opportunity to influence the relevant agencies to have gender sensitive policies. To appreciate the issues related to gender, the employees of the Department of Fisheries need to be sensitized on gender issues. Gender sensitization is an urgent necessity and should be done at all levels. Once the staff involved in development recognize and understand the issue, there will be better sustainability for the programs initiated.

Gender balanced staff recruitment is another key issue that needs to be considered and encouraged. In many Governments, there are very few women staff and in several cases, even when there are women staff, they are mainly based in the Head Office of the Government and assigned with paper work. Aquaculture development would see greater success when there are gender sensitive staff in the field. In Philippines, Thailand and Vietnam wherein women staff constitute significant percentage in the Department are also confronted with many challenges. Here too, women recognize the gender sensitization of staff as the key necessity and field problems are not addressed due to lack of gender sensitive administration.

Lessons learned and good practices:

(a) Aquaculture is a powerful tool to alleviate poverty, improve nutrition of the family and improve the overall livelihood of the family when used wisely with respect to environment and focus on gender issues (Vimala, et.al., 2004; Nandeesha, 2004).
(b) Indigenous knowledge, culture and traditions should be respected. However, by analyzing the local culture and traditions from the global perspective and introducing changes gradually after gaining the community confidence, it is possible to change the cultural practices that impede in bringing gender equality (Debashish, et.al., 2001).
(c) By using family approach in training and intervention, it is possible to increase productivity and sustainability. In all training programs, make sure that both men and women are included in the training. While men can participate in trainings easily, trainings focused on women should have flexible approaches and such trainings should be held close to their residences (Nandeesha, 2004).
(d) In many countries, literacy rate is low and particularly that of women. Hence, in training programs, focus should be on learning by doing and use of as many tactile tools as possible. On farm training in real practical situation would be most useful (Kibria, 2004).
(e) Credit is a useful component to promote good aquaculture practices. Provision of credit without training has not benefited aquaculture. Recovery rate from women being almost cent percent in most cases, most credit programs target women to provide credit. However, when credit providers ensure that women take control of the income earned from aquaculture, there is greater empowerment impact seen (Nathan and Apu, 1998; Shelly, et.al., 2001).
(f) Projects should facilitate people to assess their own risks and determine their own levels of investment, use of external inputs on both on farm and off farm.
(g) Utilization of participatory approaches provide greater opportunities for the development interventions to succeed.

Monitoring and Evaluation Indicators:

Some simple monitoring and evaluation indicators to measure women participation in small-scale aquaculture

Indicators	Sources of verification tools
Percentage of women in training programs	Records of attendance
Variety of training tools used in training	Number of tactile tools developed, videos, used in the training
Levels of utility on-farm and off farm resources	Bio-resource map and culture records
Improvement in general nutritional well-being of lactating women, girls in puberty and well being of boys	Measurement of weight; amount of fish consumed; measurement of upper arm radius; eye sight, etc
Degree of women participation in aquaculture	By measuring their perception percentage
Access to the resources generated	Perception measurement of women and the community

Overall status of men and women in the family on the gender sensitive aquaculture practices promoted.	Men: Very happy / happy /Unhappy Women: Very happy / happy /Unhappy
Community perception on the benefits derived by women in terms of access to the resources generated	Participatory discussion

Conclusion

Development projects must make conscious efforts to empower women through the program. Empowerment will occur only when women are given additional skills and the necessary support to utilize the skills to generate income. Keeping this in view, under the ASEAN project, efforts should be made to ensure participation of women in the project activities and build their knowledge and skills by understanding their needs. The monitoring and evaluation indicators suggested above can be used as guidelines to make interventions.

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Compliance to international standards and agreements in relation to trans-boundary pathogens and food safety

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Abstract

Live aquatic animals are moved actively to support subsistence and commercial aquaculture in Asia. Live aquatic animals though appearing healthy, often carry serious pathogens. The movement of live aquatic animals carries an inherent risk of moving aquatic animal pathogens contained in those commodities. International trade is of particular concern because of the large volumes of live animals and products moved. Various global instruments, codes of practice and guidelines (either voluntary or obligatory) exist that provide certain levels of protection, all aimed at minimizing the risks due to pathogens/diseases associated with aquatic animal movement. International standards and guidelines describe both preventative (for example, certification and import risk analysis) and reactive (for example, contingency plans) measures to minimize the impact of trans-boundary diseases. The WTO-SPS agreement and the standards developed by the World Organisation for Animal Health (OIE) are important.

The issue of food safety and quality is of concern to all consumers in both producing and importing countries. Potential risks to human health and food safety from aquaculture products can come from various reasons. Food-borne parasitic infections, food-borne diseases associated with pathogenic bacteria and viruses, residues of agro-chemicals, veterinary drugs and heavy-metal organic or inorganic contamination have been identified as possible hazards in aquaculture products. Internationally adopted food standards, guidelines, codes of practice and other recommendations are set by FAO/WHO Codex Alimentarius Commission.

Compliance to WTO-SPS agreement and their associated standards will help to minimize the risk of international spread of trans-boundary pathogens and ensure food safety of fish and fishery products.

Trans-boundary Pathogens

Aquatic animals have been moved around the world for various reasons. There are many examples of positive socio-economic benefits from introductions of aquatic species, including improved livelihoods, increased production and trade. However, there are equally examples where serious negative impacts have resulted. Where introductions are necessary, they have to be conducted in a responsible way using appropriate risk assessment and management measures. Trans-boundary aquatic animal diseases are a major risk and an important constraint to the growth of aquaculture. Aquatic alien species could either be pathogens, which may cause trans-boundary aquatic animal diseases, or could harbour aquatic animal pathogens that lead to diseases and epizootics in aquaculture following introduction of alien species. Aquatic animal pathogens, are trans-boundary problems with potential to impact on international trade, aquaculture and fisheries and the people whose livelihoods depend on aquatic resources.

Live aquatic animals are moved actively to support subsistence and commercial aquaculture in Asia. Live aquatic animals though appearing healthy, often carry serious pathogens. Examples of introduction of pathogens to new aquatic systems and hosts leading to serious consequences in the Asia-Pacific region include epizootic ulcerative syndrome (EUS) in fresh and brackish water fishes, white spot syndrome virus (WSSV), taura syndrome virus (TSV) and Infectious myonecrosis virus (IMNV) in cultured shrimp and viral nervous necrosis (VNN) in grouper and koi herpes virus (KHV) in koi and common carp. Careful examination of the history and spread of these diseases in the region indicate how irresponsible or ill-considered movements of live animals can impact aquaculture and wild fisheries resources. In many cases, these impacts are a direct result of absence of national and regional disease management strategies or non-compliance by stakeholders to regional and international agreements and standards.

International Agreements

Various global instruments, codes of practice and guidelines (either voluntary or obligatory) exist that provide certain levels of protection, all aimed at minimizing the risks due to pathogens/diseases associated with aquatic animal movement. There are a number of international agreements that directly relate to health management and trans-boundary movement of live aquatic animals, or include provisions that consider the risks and management of risk associated with introduction of aquatic animal pathogens through trans-boundary movement. These include:

a) FAO Code of Conduct for Responsible Fisheries, created in 1995, sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity.

b) ICES Code of Practice on the Introductions and Transfers of Marine Organisms, created in 1973 and updated in 1994, gives recommended procedures and practices to reduce the risks of detrimental effects from the intentional introduction and transfer of marine (including brackish water) organisms. ICES code is endorsed by FAO Regional Fishery Bodies.

c) Cartagena protocol on Bio-safety, adopted in 2000 under the Convention on Biological Diversity and in force from September 2003, seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology.

d) Convention on Biological Diversity, adopted in 1992 and in force from 1993, its objectives are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

e) World Trade Organization (WTO), established in 1995 is the only global international organization dealing with the rules of trade between nations. The WTO Sanitary and Phyto-sanitary agreement (SPS) specifically addresses the management of diseases and pathogens associated with trans-boundary movements. The WTO-SPS Agreement sets out the basic rules for food safety and animal and plant health standards. The basic aim of the SPS Agreement is to maintain the sovereign right of any government to provide the level of health protection it deems appropriate, but to ensure that these sovereign rights are not misused for protectionist purposes and do not result in barriers to international trade. The Agreement on the Application of Sanitary and Phytosanitary Measures (the "SPS Agreement") entered into force with the establishment of the WTO on 1 January 1995 (WTO 1998). The SPS Agreement sets out the basic rules for food safety and animal and plant health standards. "Sanitary and phytosanitary measures" are defined in the SPS Agreement as follows:
"… any measures applied:

(i) to protect animal or plant life or health within the territory of the Member from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms;

(ii) to protect human or animal life or health within the territory of the Member from risks arising from additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs;

(iii) to protect human life or health within the territory of the Member from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests; or

(iv) to prevent or limit other damage within the territory of the Member from the entry, establishment or spread of pests."

These include sanitary and phytosanitary measures taken to protect the health of fish and wild fauna, as well as of forests and wild flora. Sanitary and phytosanitary measures, by their very nature, may result in restrictions on trade. The basic aim of the SPS Agreement is to maintain the sovereign right of any government to provide the level of health protection it deems appropriate, but to ensure that these sovereign rights are not misused for protectionist purposes and do not result in unnecessary barriers to international trade. Members are encouraged to use international standards, guidelines and recommendations where they exist. However, Members may use measures which result in higher standards if there is scientific justification. They can also set higher standards based on appropriate assessment of risks so long as the approach is consistent, not arbitrary.

f) World Animal Health Organization (OIE), established in 1924, in association with WTO helps, *inter alia,* guarantee the sanitary safety of world trade by developing sanitary rules for international trade in animals and animal products. For animal (including aquatic animal) health and zoonoses, the WTO recognises the standards developed by the World Organisation for Animal Health (OIE) as a reference within the SPS Agreement. The OIE develops normative documents relating to rules that its Member Countries can use to protect themselves from diseases without setting up unjustified sanitary barriers. The main normative documents produced by the OIE for aquatic animals are the *Aquatic Animal Health Code* (*Aquatic Code*) and the *Manual of Diagnostic Tests for Aquatic Animals* (*Aquatic Manual*). The aim of the *Aquatic Code* is to assure the sanitary safety of international trade in aquatic animals (fish, molluscs and crustaceans) and their products. The code provides details of health measures to be used by the veterinary or other competent authorities of importing and exporting countries so that the transfer of pathogenic agents for animals or humans is minimized but unjustified sanitary barriers are avoided. The Aquatic Code provides general and disease specific provisions that OIE Member Countries can adopt to prevent and control aquatic animal disease. The *Aquatic Code* is updated regularly, and a new edition is published each year, both in hard copy and on-line (see www.oie.int/eng/normes/en_acode.htm). As per the WTO-SPS agreement, diseases listed by the OIE should be reported by member countries and are subject to specified health measures that are intended to limit disease spread and assure sanitary safety of international trade in aquatic animals and their products.

g) Asia Regional Technical Guidelines: Through cooperation of FAO, OIE and NACA and with the aid of additional regional and international expertise, guiding principles for responsible movement of aquatic animals and aquatic animal health management were established. The guiding principles in the "Asia Regional Technical Guidelines on Health Management and the Responsible Movement of Live Aquatic Animals" were adopted by 21 governments in the Asian region in 2000. Within Asia, The Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and their associated implementation plan, the Beijing Consensus and Implementation Strategy (BCIS), (FAO/NACA, 2000) provide expert guidance for national and regional efforts in reducing the risks of disease due to trans-boundary movement of live aquatic animals. There is strong endorsement by many regional, inter-governmental, and global organisations, and a shared commitment from national governments to support its implementation. The main elements of the Technical Guidelines are as follows:

- Scope, purpose, and background
- Definitions and guiding principles

- Pathogens to be considered
- Disease diagnosis
- Health certification and quarantine measures
- Disease zoning
- Disease surveillance and reporting
- Contingency planning
- Import risk analysis
- National strategies and policy frameworks
- Regional capacity building
- Implementation of the technical guidelines
- The Beijing consensus and the implementation strategy

The above framework provided by the guidelines is a comprehensive one that includes all major requirements for managing risk associated with live aquatic animal movements

Food Safety

The issue of safety and quality is of concern to all consumers in both producing and importing countries. Food safety must be an integral part of any aquaculture production system. In most fish exporting countries, special attention is paid to the safety of products meant for export, while products for domestic consumption receive less attention. This trend needs to be rectified through appropriate awareness and capacity building activities and supporting legislation.

Potential risks to human health and food safety from aquaculture products can come from various reasons. Food-borne parasitic infections, food-borne diseases associated with pathogenic bacteria and viruses, residues of agro-chemicals, veterinary drugs and heavy-metal organic or inorganic contamination have been identified as possible hazards in aquaculture products. These hazards are usually associated with the aquaculture habitat, the species being farmed, the general condition of the local environment, and cultural habits of food preparation and consumption.

International Agreements

Various global instruments, codes of practice and guidelines (either voluntary or obligatory) exist that provide certain levels of protection, all aimed at ensuring the safety of food for human consumption

a) FAO Code of Conduct for Responsible Fisheries: The 1995 FAO Conference adopted the Code of Conduct for Responsible Fisheries which calls for, inter alia, food safety and quality of aquaculture products. The Code's Article 9 *Aquaculture Development*, and in particular its provisions for *Responsible Aquaculture at the Production Level*, address the need for safe and effective use of feeds, feed additives, fertilizers, manure, chemo-therapeutants and other chemicals.

b) WTO-SPS Agreement: The rules that govern international trade in food were agreed upon during the Uruguay-Round on Multilateral Trade Negotiations and apply to all members of the World Trade Organization (WTO). With regard to food safety, these rules are set out in the *Agreement on Sanitary and Phytosanitary Measures* (SPS Agreement). According to the SPS Agreement, WTO members have the right to take legitimate measures to protect the life and health of their people from hazards in food, but these measures may not be unjustifiably trade restrictive. Also, these measures have to be based on risk assessment, taking into consideration the risk assessment techniques developed by relevant international organizations.

c) FAO/WHO Codex Alimentarius Commission (CAC): In regard to food safety, the relevant international organization is the FAO/WHO Codex Alimentarius Commission (CAC). In order to facilitate and harmonize risk assessment, the CAC has adopted a number of definitions in relation to risk analysis. In this context, it is particularly important to recognize that a *hazard* is a biological, chemical or physical agent in, or condition of, food, with the potential to cause harm. In contrast, *risk* is an estimate of the probability and severity of adverse health effects in exposed populations, consequential to hazard(s) in food.

Identification of hazards in food and the determination of their relevance for health as well as their control is the function of the science of risk analysis. Risk analysis is an emerging discipline in food control; the methodological basis for assessing, managing and communicating risks associated with food-borne hazards is, at the international level, still in a developing phase.

Within the Codex system, broad issues relating to food safety that are also applicable to products from aquaculture, fall under the general subject committees, such as the Codex Committees on Food Additives and Contaminants, Food Hygiene, Pesticide Residues, and Residues of Veterinary Drugs in Foods.

The Codex Alimentarius Commission is an intergovernmental body with more than 180 members, within the framework of the Joint Food Standards Programme established by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO), with the purpose of protecting the health of consumers and ensuring fair practices in the food trade. The Commission also promotes coordination of all food standards work undertaken by international governmental and nongovernmental organizations.

d) Codex Alimentarius: The *Codex Alimentarius* is the result of the Commission's work: a collection of internationally adopted food standards, guidelines, codes of practice and other recommendations.

e) Code of Practice for fish and fishery products: The *Code of practice for fish and fishery products (WHO/FAO 2009)* is intended for all those engaged in the handling, production, storage, distribution, export, import and sale of fish and fishery products. The Code will help in attaining safe and wholesome products that can be sold on national or international markets and meet the requirements of the Codex Standards.

Carbon footprinting and labelling: Opportunities or barriers for aquaculture

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Abstract

Carbon foot-printing has emerged as a tool for assessing the life cycle greenhouse gas (GHG) emissions associated with a product, service or organisation, expressed in terms of kg CO_2 equivalent. By taking the life cycle approach (covering raw material extraction, production processing, use/consumption, waste disposal including transport in all stages – which is the element of Life Cycle Assessment or LCA technique), it will take into account of all possible GHG to reflect the most realistic situation. The "hot spots" (i.e. life cycle stages and processing activities contribute the high impacts) can be identified leading to management strategies for GHG reduction.

The concept of carbon foot-printing is internationally accepted, mainly for assessing GHG emission and set targets of GHG reduction. In addition, some countries have applied the result of carbon foot printing for communicating about the carbon emissions of products via carbon labeling. It is expected that the carbon foot-print labeling system will stimulate the carbon profile improvement in production and caution the consumers about the carbon emissions they contribute to through their purchasing choices and consumption styles. By informing and influencing the key players along the whole food supply chain (i.e. producers, retailers and consumers), the carbon labeling strategy is expected to stimulate reduction of greenhouse gas emissions both at production and consumption levels.

Carbon foot-printing and labeling schemes have already been implemented in several countries, such as UK, France, US, Canada, Japan, Korea, Thailand, etc. The existing ISOs (14040, 14044, 14025, and 14064) are mainly used as national guidelines for developing carbon footprint methodology. At the same time, ISO 14067 Carbon Foot-printing (Part I – Quantification, and Part II – Communication) is being developed so as to discuss and finalise the methodological issues that will be internationally accepted.

Food products are given the priority of applying carbon foot-printing and labeling in many countries, thus it is interesting to discuss the opportunities to introduce in aquaculture products and to discuss concerned issues/barriers that may have for considerations

Annex 1: List of participants

Country	#	Name and address	Email
Cambodia	1.	**Mr. Neang Savuthdy,** Officer of the Department of Aquaculture Development Fisheries Administration, No. 186 Norodom Blvd, Sangkat Tonic Bussae, Hhan Chancai Mon, Phnom Penh, Cambodia P.O. Box 582	savuthdy@yahoo.com
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Annex 2: Agenda

Date	Time	Presentation by	Title of the talk
3.8.09	9.00-10.00	ASEAN Head of programs Director General NACA R and D Manager NACA	Opening session
	10.00-10.30	**Coffee break**	
	10.30-11.30	Sena S. De Silva	Aquaculture successes in Asia, contributing to Sustained Development and Poverty
	11.30-12.30	C.V. Mohan	Bio-security and health management in aquaculture systems
	12.30-13.15	**Lunch**	
	13.15-14.15	M.C. Nandeesha	Knowledge at the base of the pyramid
	14.15-15.15	Koji Yamamoto	Communication and networking mechanisms for improving services to small farmers (Aceh Model)
	15.15-15.30	**Coffee break**	
	15.30-16.30	Thuy Nguyen	Maintaining genetic quality of fish and shell fish under small holder farmers in ASEAN countries
	16.30-17.30	Derun Yuan	Training small scale farmers –challenges and opportunities
4.8.09	8.30-9.30	Supalak Lewis	Disease diagnosis and prevention strategies in aquaculture including vaccination
	9.30-10.30	Supranee Chinabut	Major diseases of finfish in Asia and practical measures adopted in controlling the diseases
	10.30-11.00	**Coffee break**	
	11.00-12.00	Dhirendra Thakur	Accessing better markets – improving competitiveness of small scale farmers
	12.00–13.00	**Lunch**	
	13.00-14.00	Varunthat Dulyapurk	Profit VS Profitability: helping farmers to improve economic sustainability of aquaculture operations
	14.00-15.00	Somkiat Kanchanakhan	OIE and EU standards for trade in live aquatic animals and their products
	15.00-15.30	**Coffee break**	
	15.30-16.30	Sena S. De Silva	Climate change and aquaculture: potential impacts, adaptations and mitigations
	16.30-17.30	Cambodian team	Culture of snakehead in Cambodia : Opportunities and constraints

5.8.09	8.30 –9.30	C.V. Mohan	Principles of developing, validating and adopting better management practices in aquaculture - Shrimp case study
	9.30-10.30	Simon Wilkinson	Developing communication and networking mechanisms for improving services to small scale farmers
	10.30-11.00	**Coffee break**	
	11.00-12.00	Thuy Nguyen	Principles of developing, validating and adopting better management practices in aquaculture – Catfish case study
	12.00-13.00	**Lunch**	
	13.00–14.00	M.C. Nandeesha	Feeds and feeding strategies to improve production in small holder farms of ASEAN countries
	14.00–15.00	N.R. Umesh	Organization of small scale farmers and its benefits
	15.00-15.30	**Coffee break**	
	15.30–16.30	Vietnam Team	Shrimp culture in Vietnam and ways to revive the activity
	16.30-17.30	Philippines Team	Seaweed cultivation in Philippines and building capacity of farmers to enhance productivity and profitability
6.8.09	8.30-9.30	Koji Yamamoto	Certification and traceability : emerging requirements for international and domestic markets
	9.30-10.30	N.R. Umesh	Farmer organization as models for promoting adoption of BMPs and accessing markets
	10.30-11.00	**Coffee break**	
	11.00-12.00	Indonesia team	Sea bass and grouper culture in Indonesia and proposed strategies to improve profitability from the systems
	12.00-13.00	**Lunch**	
	13.00-14.00	Chalor Limsuwan	Shrimp diseases and their management
	14.00-15.00	Wenresti G. Gallardo	Strategies to produce and distribute quality seed
	15.00-15.30	**Coffee break**	
	15.30-16.30	M.C. Nandeesha	Enhance women participation in aquaculture to ensure sustainability
	16.30–17.30	Thailand team	Tilapia culture in Thailand : issues and strategies proposed
7.8.09	8.30-9.30	C.V. Mohan	Opened discussion – further project activities
	9.30-10.30	Rattanawan Tam Mungkung	Carbon foot-printing and labeling: Opportunity or barrier for aquaculture
	10.30-11.00	**Coffee break**	
	11.00-12.00	Dr. Filemon A. Uriarte, ASEAN Executive Director	Closing Ceremony
	12.00-13.00	**Lunch**	
	12.00–18:00	Derun Yuan	Field visit to tilapia cage culture and pond culture units

Annex 3: List of resource persons

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