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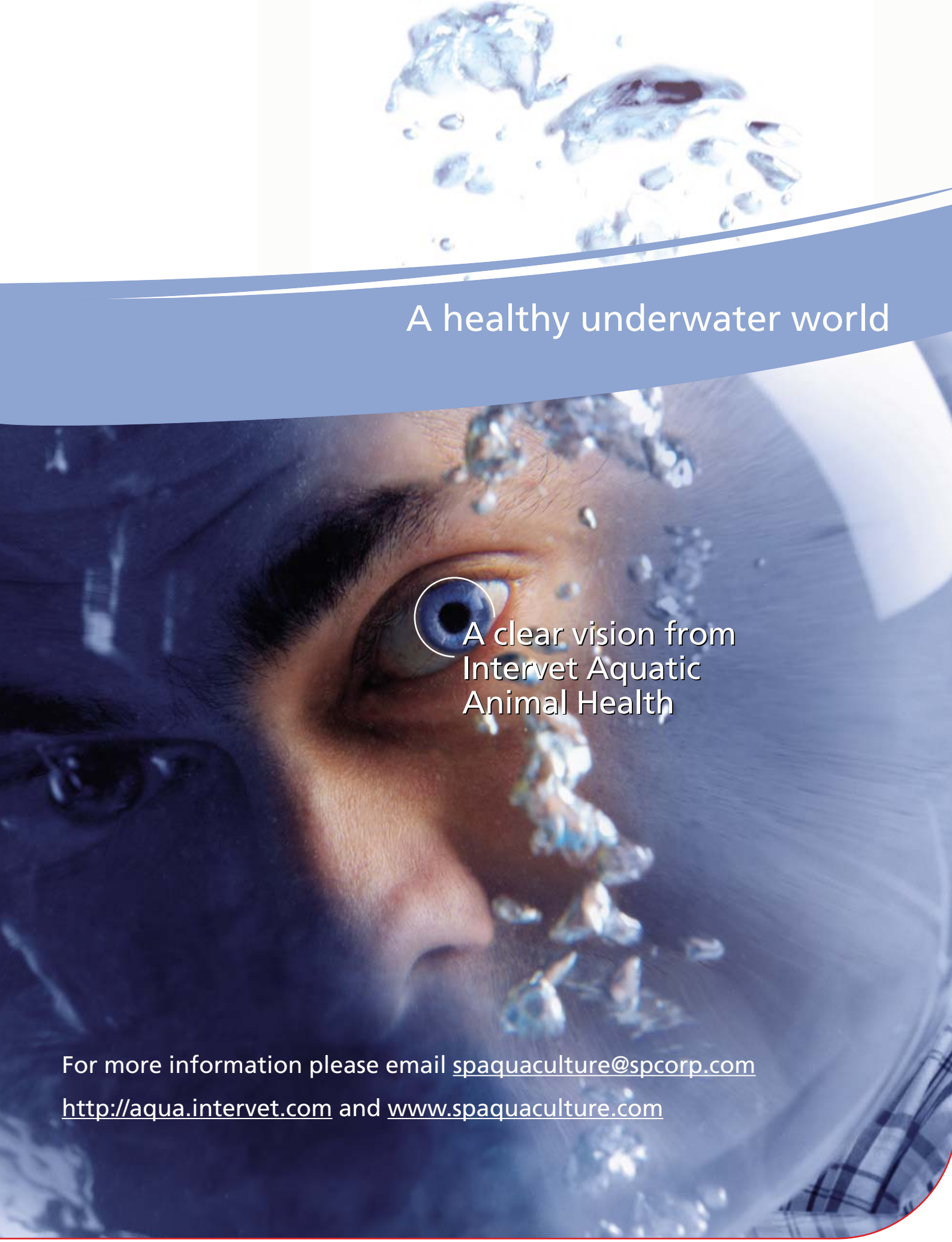

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Aquaculture certification authorities: A matter of trust

Over the last few issues I have covered the development of aquaculture certification standards. To complete the picture we really also need to take a look at the development of aquaculture *certification authorities* as well. In order to avoid getting bogged down in the problems that presently plague the development of credible aquaculture standards, which we have already covered, we need to travel forward in time to some future Earth where (we hope) that some widely accepted standards for major aquaculture commodities have been developed through a fair and transparent process and generally agreed on.

Many people think of aquaculture standards as 'green labels', however this is incorrect. Aquaculture standards are simply production specifications; they mean nothing unless they are accompanied by a credible certification process. The 'green label' is actually conferred by the *certification authority* that assures compliance with a given standard. When a consumer considers buying a certified product it is largely the credibility of the certification authority that is foremost in their mind. They probably won't know much about the content of the standard itself. So what makes a good certification authority?

The fundamental attribute of an effective certification authority is that they are trusted by all parties as a neutral and independent arbiter. It's that simple. The real business of any certification authority is actually *trust*, and it is this trust alone that confers credibility and recognition upon products that the authority certifies. In the context of aquaculture, this means that we (farmers, buyers, environmental groups, consumers and society at large) trust a certification authority to make a fair assessment as to whether farm production has complied with a particular standard or not.

To enjoy the trust of all sides, a certification authority must be unbiased and act in good faith. It cannot be a party or proponent in an application for certification, nor can it have any interest in the outcome. This is one of the principles of natural justice, expressed in the Latin maxim, *nemo iudex in causa sua* or "no man is permitted to be judge in his own cause".

Unfortunately, many of the aquaculture standards available today are 'self certified', meaning that the organisation that developed the standard also assesses compliance against that standard and decides whether to certify a product or not. In some cases the proponents of standards have sought to generate an air of credibility by designating an 'independent third party' as a certification authority, when in fact they are members of that authority or have some other interest in it. Both industry- and environment-led certification schemes have played this game, creating perceptions of bias and attracting heavy criticism. Such practices undermine confidence in certification, defeating the purpose of certification in the first place.

It is important to place certification authorities as distantly as possible from both the proponents of standards and applicants for certification, in order to preserve their role as trusted and independent arbiters. A certification authority that lacks the trust of important stakeholders is effectively useless.

Simon Wilkinson

AQUACULTURE ASIA

CONTENTS

Contrasting community management and revenue sharing practices of culture-based fisheries in Lao PDR

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Culture-based fisheries (CBF), a practice that utilises small water bodies, for the secondary purpose of increasing the food fish production far in excess of what is potentially achievable through natural recruitment, is gaining momentum in the region. CBF is environmentally friendly, using seed stock as the main external input, and that too of species that are mostly indigenous to the area or sometimes exotics that have been locally used over a long period of time[1]. It is essentially a stock and re-capture strategy in communal water bodies that are primarily utilised for irrigation of downstream paddy cultivation, where management is through community participation and engagement. The type of water body most suited for CBF is generally small, 3 to 15 ha in size, with a regime that holds water for six to eight months in the year and gradually dries up almost completely.

In Lao PDR, CBF activities in a very minor way have been going on sporadically in a number of areas. With the commencement of a project funded by the Australian Centre for International Agricultural Research (ACIAR) that brought in lessons of successful implementation of CBF practices from countries such as Sri Lanka and Vietnam[2,3], CBF development in Lao has reached a new impetus, gaining momentum all the while. As such CBF is increasingly being taken up by village communities to supplement their income and access to food fish on their own accord, but backed up by governmental support in the form training and technology dissemination.

Lao PDR can be considered as an aquaculturally emerging nation meeting its fish needs primarily from wild harvest from the Mekong and other water bodies. Lao PDR is blessed with large fresh water resources (renewable water resource estimated in 2003 to be 333.6 km^3; per capita availability as of 2000: 507 m^3 $year^{-1}$; https://www.cia.gov/library/publications/the-world-factbook/geos/la.html) that include small flood plain depressions along its river systems, reservoir coves that have become available with the impounding of major rivers and so forth. It is believed that these water bodies are ideally suited for CBF development, and such developments would benefit the communities - mostly farming communities - living in the vicinities of such water bodies, allowing their use as a supplementary livelihood activity using these water resources that were originally for downstream paddy cultivation. Indeed, the Lao government recognises CBF development as a major, low input strategy to increase food fish availability and increasing the livelihoods of rural communities.

The lessons learnt from Sri Lanka and Vietnam, enabled Lao PDR to test the suitability of most productive and appropriate species combinations, stocking densities to be used and other scientific inputs such as fry to fingerling nursing and rearing and so forth[3].

Communal harvesting taking place in Nong Sod village pond, Thongvane village, Paksan district, Borikhamxay province (type two community management).

Community structure and operation

The village communities in Lao are well organised entities and are primarily based on the political system that has evolved in the country over a number of years. Accordingly, the existing village level commune structures were crucial enabling factors in the promotion of the CBF activities. Basically, each village has an elected 'Head' and a Community Leader assigned for each of the community activities; for example managing the water regime of the village water source (s) that provides irrigation water mainly for the paddy cultivation. Working with these groups, the initial selection of communities for CBF development activities was carried out, then field visits to work out a management plan based on the characteristics of the water body and development of the most "appropriate CBF package". More generally, this approach is part of a transition towards more community based fisheries management (CBFM) under evolving governance mechanisms as part of a co-management framework with the government, here mainly the Department of Livestock and Fisheries (DLF) of the Ministry of Agriculture and Forestry.

Co-management comes in many forms but a key question relates to which management functions are most appropriately handled by the community and which by the government. Here most management was handled by the community based on government support. The government support took the form of activities such as dissemination of technical - knowhow and in some instances seed funding for procurement of seed stock and to encourage and train villagers in fry to fingerling rearing in 'hapas' when the water regime was at full supply, in order to ensure that the stock when released into the water body is grown to a size that would minimise mortality, primarily from predation. The government monitored the CBF activities with regular visits

(once per month) by district extension staff, organised exchanges among CBF communities, and established links with the external partners on a needs basis.

The Lao Government has developed a National Strategy for Fisheries to the Year 2020 including development goals and an action plan from 2006 to 2010. In order to reach its objective, the alleviation of poverty is a crucial factor for which urgent solutions are needed. One of the ways contributing to poverty reduction is by increasing the productive capacity in terms of agriculture, forestry and fisheries and thereby ensuring food security for the poor and also by assisting them to generate more income. As part of this strategy, plans to enact fishery laws were initiated in 2007. As part of this effort the Lao Government, recognising the importance of CBF as a major strategy to increase fish production in rural areas, has included relevant clauses to facilitate rural communities taking up CBF. In essence CBF will soon be legally recognised entities in Lao PDR and will therefore permit communities to engage in such activities with legislative recognition and support.

Harvesting in the conventional type of community managed water body (Nong Nok lake, Sivilay Village; Vientiane province) Harvesting will take place daily, for three to six weeks.

The main subject of the present paper is to highlight two contrasting revenue sharing CBF practices that are community managed. It is generally rather unusual to see such contrasting practices for revenue sharing, and to

Table 1. A preliminary comparison of the food fish yields and income generated from CBF under the two community management regimes. Where relevant, the percentages of profits and the amounts banked from the profits are given in parentheses.

Water body	Mgmt. type	Total harvest (kg)	Yield (kg/ ha)	Amount used (kg)			Income (x 1000 kip)			
				House holds	Social activities	Total	Profit	Funds banked	Household sharings	Social activities/ village improvement ***
Nong Nok	1	8071	231	268	72	74,243	48,348 (65.1)	5,180 (10.7)	23,898	22,392
Nong Sam Hok	1	43771	219	792	120	N/A	41,429	6,000	41,428	2,857
Sok Huy Xee	1	6781	226	48	52	8,060	4,030 (50)	2,015 (50)	201	870
Nong Sa Man	2	9071	302	679*	228	1,700	520 (30.6)	**	DAS	1,100
Nong Kok	2	9321	466	800*	132	1,900	420 (22.1)	**	DAS	1,380
Nong Nguak	2	11481	383	858*	290	4,800	1,600 (33.3)	900 (56.3)	DAS	3,530
Nong Sod	2	7651	383	585*	180	3,300	680 (20.6)	**	DAS	2,520
Nong Hoy Ho	2	8541	285	680*	174	1,108	387 (34.9)	157 (40.6)	DAS	871

** This is the total harvest recorded, some of which are for household consumption, and the rest are sold.*
*** Some amount was contributed to the Village Development Funds, together with other agriculture activities.*
**** Often priority is given to social activities and village improvement before considering deposit in the bank. However, in Type 1 management revenues are high and as such bank deposit is important.*
DAS - Depend on Amount Spent

the best of our knowledge such practices have not been documented in respect of any aquaculture practice, including CBF.

Revenue sharing from CBF

In Lao PDR, where CBF is still under development, two contrasting revenue sharing practices are encountered, unlike elsewhere in the region. The two forms of revenue sharing practices are:

Type 1 (a more traditional management practice) that is seen mainly in Vientiane Province; here the stocked seed is nurtured (involving the prevention of escape of stocked seed, prevention of unauthorised fishing and poaching, regular repair and maintenance of the outlets etc.) until the fish reaches a marketable size, and then harvested within a short time frame, extending from one to four weeks, depending on the size of the water body. All the revenues are shared within the community on a proportionate ratio to inputs basis.

The above revenue sharing is best exemplified by the case of Nongnok Lake, Sivilay Village (see Box 1 for details). It is important to point out that this water body, as for most that have taken up CBF, in the 2008/09 CBF growth cycle, the gross revenue for the community was 74,273,500 Kip (approx: US$ 8,738), and importantly the latter amounted to an increase of 64% over the 2007/08 cycle, based on a corresponding 93% increase in fish yield, with 80% of the harvest completed.

Box 1. The fish harvest from Nongnok Lake in Sivilay village doubled from that from the 2007/08 growth cycle to 8.071 tonnes in the 08/09 cycle, of which 7.5 tonnes were sold to vendors earning 74,273,500 kip, or approximately US$ 8,738; a very high income for a Laotian village community, which only has an annual GDP of only US$2,000.00. Of this income 15% was deposited in the bank, 45% was used for inputs and labour and a portion of this also used to improve communal amenities, and the rest divided among the 112 households, based on a formula determined by the proportionate financial inputs to the activity, as the community agreed upon. Accordingly, the household receipts ranged from a minimum of 120,000 kip to a maximum of 700,000 kip. All households however, received an equal share of fish during the harvesting period.

Harvesting can be a family activity in water bodies with Type 2 management.

Box 2. Type 2 management case: In Thongvane Village, Paksan District of Borikhamxay Province 82 households practice CBF in Nong Sod water body, a 2 ha village pond. In the 2008/09 CBF cycle, a total of 580 kg of fish was harvested by people who purchased tickets from the community, in addition to 180 kg that was used for community social activities. A major proportion of harvested fish were sold and a small amount were used by the families. Because the harvest has been undertaken throughout the culture cycle, records on the total fish harvest are difficult to obtain/ monitor, which is also complicated by the fact that the actual amount sold is not reported. The only source of the communal income generated from selling fishing tickets, which totalled 3,300,000 kip and the profit was 680,000 kip. The share amongst households was not as well defined as in the case of Type 1 management, as it depends on the amount fish caught by each household. We are attempting to gather more information on these details and work with the communities to better understand their livelihood and nutritional needs.

The communal management committee expects to further improve the yield to 12 -14 tonnes in 09/10 cycle, and invest in a weir to partition the water body to maintain its own broodstock, and then it proposes to produce its own seed stocks in two to three years time, and indeed become a seed stock supplier to the surrounding communities. Already the success of this community has been noticed by others and four villages sought their assistance to commence CBF, which is now ongoing.

Type 2 is the practice that is adopted by certain communities particularly in Borikhamxai Province (see Box 2), whereby the community manages the stock, harvest and revenue generation in three stages:

- **Stage 1**: after a period of growth of the stocked fish seed (usually from June to September), community members are permitted to use hook and line, from shore, to fish for household consumption.
- **Stage 2**: Small scoop nets (see photos) are permitted from November to December, again to be operated from shore, primarily aimed at harvesting naturally recruited stocks, here again the catches are for household consumption.
- **Stage 3**: January onwards is the main harvesting season of the stocked species. During this period the community members are permitted to purchase a ticket as a license to fish; this cost of entry into the fishery being determined by the type and size of the gear. For example, to use a standard sized cast net, a ticket costs 10,000 kip (8,500 kip = 1US$) as opposed to a small scoop-net for which a ticket costs 5,000 kip.

All fish caught are the property of the ticket holder and are permitted to be used/ sold in any manner he/she wishes. This process continues for three to four weeks until the water level recedes completely and almost all the stock is harvested.

Tickets however, have to be purchased each day as they are valid for only one day. The community gains as harvesting is undertaken by groups/individuals, and the funds raised can be used for community purposes, including funds for procurement of seed stock for the oncoming season, improving community amenities such as the community hall and village temple.

How are the proceeds of CBF shared?

In general, in both of these cases, each community agrees on the manner of sharing the benefits as follows: net CBF income is the income from the fish sales after the deduction for the costs for procurement of fry, any fry to fingerling rearing costs (usually done in hapas), other labour costs of individual households such as for keeping watch of the stocks, and any other investments incurred e.g. purchase of harvesting gear etc. It is also important to note that about 5 to 10% of the harvest is often utilised for common communal functions. On average, these costs amount to about 45% of the total revenue. The community in general, will allocate 10 to 15 % of the revenue for banking, primarily to be used for procurement of seed stock for the following year. Of the rest of the revenue, the community will decide on common investments, such as buying hand-tractors for rice cultivation to be hired on a needs basis, buying land, and for improving social and or communal amenities such as the village temple, communal hall and the like, and the rest is distributed among all stakeholders on an equal household basis and/or based on the proportionate household provision of inputs.

For example, the Sivilay Village Community that practices CBF in Nongnok Lake, in 2008/2009 growth season, divided the proceeds as indicated in Box 1. In the case of the somewhat non-traditional practice, the community management unit will have only the revenue from the ticket sales from fishing for utilisation for communal activities, procurement of seed stock for the following year and so forth.

Why two types of revenue sharing?

The reasons for this difference cannot be easily discerned. One fact is that the average income/standard of living of communities in Borikhamxay Province is generally lower, and the CBF provides a mechanism for the village households to obtain daily food fish needs, for a period of up to six months. There is also a need to earn some extra income when the stocked seed is ready for harvesting / to be marketed and the community decides to permit access. The process adopted, however, limits the overall income that is available for communal activities, and possibly impacts negatively on the financial gains for individual households but increases the possibilities of increasing food fish consumption, even perhaps on a regular basis over a time period, because of the permitted open access to fish for household needs. Further details of this situation and its tradeoffs are being examined in the present culture cycle.

A preliminary comparison of the food fish yields and income generated from CBF under the two community management regimes is summarised in the Table 1. The yields ranged for Type 1 and Type 2 management systems from 219 to 236 and 285 to 466 kg ha^{-1}, respectively. It is difficult to attribute the differences to the type of management per se, on the basis of the presently available data but suffice it to say the yields obtained are generally lower than those obtained elsewhere in the region from CBF practices. This is understandable as CBF practices in Lao are still in their early stages of development. However, indications are that the yields have increased over a two year period in almost all water bodies (see Box 1) and perhaps as time proceeds and the management improves one could expect yields to become comparable to those obtained elsewhere in the region.

Conclusions

The two contrasting revenue sharing practices seen in CBF in Lao PDR both are driven by the community needs and decided upon collectively for the benefit of the community, and not necessarily entirely driven by profit / income generation motives. In the Type 2 case, it is apparent that the poorer communities give a higher priority to food fish needs of its members and as such provide a certain degree of free access to the water body to meet these daily needs, but at the same time ensuring that stock is not overly exploited during the fish growth phase. The regular negotiation of these arrangements by each community within its evolving local context combined with the continuing support/advice of the government provides an effective mechanism to continue to optimise this production system.

It is reiterated that we have chosen to present this preliminary data as we believe that this is the first instance that two distinct forms of benefit sharing are seen in CBF, and for that matter in any form of community managed aquaculture activity. We believe it is interesting and unusual and hence the desire to bring it to the public domain, even though the available data are insufficient to be subjected to robust statistical testing.

References

1. De Silva, S. S., 2003. Culture-based fisheries: an underutilized opportunity in aquaculture. Aquaculture, 221, 221-243.
2. Nguyen S. H., Bui, A. T., Le L. T., Nguyen T. T. T., De Silva, S. S., 2001. The culture-based fisheries in small, farmer-managed reservoirs in two provinces of northern Vietnam: an evaluation based on three production cycles. Aquaculture Research, 32, 975- 990.
3. De Silva, S. S., Amarasinghe, U. S., Nguyen, T. T. T. (Eds.) (2006) Better-practice approaches to culture-based fisheries development in Asia. ACIAR Monograph 120, 96 pp.

Floodplain aquaculture in Begumgonj: New horizon for rural livelihoods in Bangladesh

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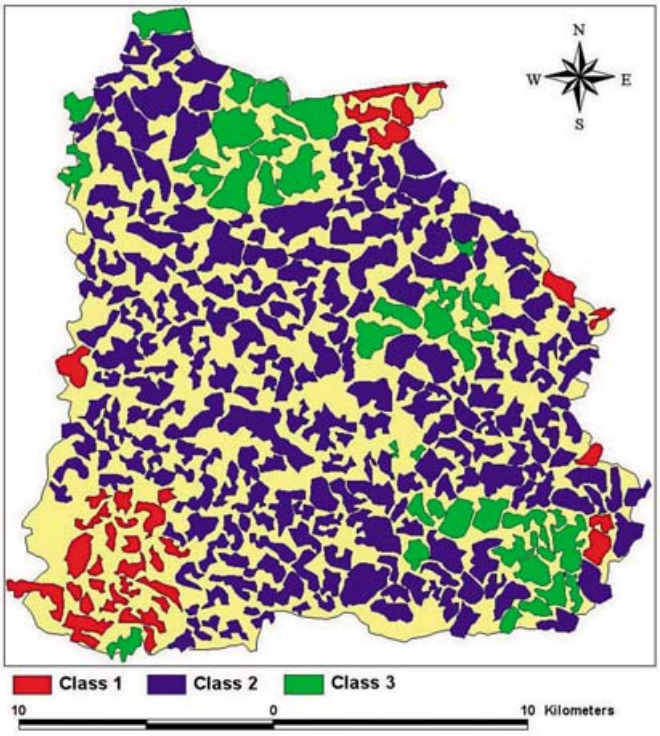
Aquaculture activities have been improved significantly in recent years, although emphasis has been largely placed on increasing production targets. The socio-economic benefits derived from aquaculture expansion include the provision of nutrients, employment and income generation for the poor, diversification of production and generation of foreign exchange earnings through export of high-valued products. Aquaculture also has the potential to compensate or substitute for stagnation of capture fisheries. It can also be a force for the prevention and control of pollution since production depends on the availability of good-quality water resources.

A major feature of the Begumgonj Thana under Noakhali District, Bangladesh is the rice cultivation during the dry season (November to March), but it becomes a vast waterlogged floodplain during the wet season, reducing agricultural productivity. In the absence of livelihood opportunities during the waterlogged period, poor people are forced to move out of their villages to seek alternative employment as day laborers or in such occupations as rickshaw (pulling a van). It is perceived that the seasonal floodplain of Noakhali has significant unrealised potential for aquaculture development, especially for prawn culture[1,2]. Chowdhury *et al*.[3] highlighted the possible environmental impact of stocking prawns on the floodplain biodiversity and its social impact on poor households dependent on aquatic resources to derive their livelihoods during the monsoon season.

The floodplain supports a multitude of aquatic flora and fauna. Fisheries are a major source of employment as well as the main source of dietary protein for the rural poor. The reproduction, breeding and spawning of fish in open inland waters is tuned and adjusted to the rhythm and amplitude of monsoon floods. The floodplains merge the rivers and streams into a single system, facilitating migration by broodstock and young. Our objective was to make an inventory of the seasonal floodplains, map their spatial distribution and classify their suitability for community-based aquaculture development to sustain the rural livelihoods. Rain is the main source of water in the Begumgonj Thana and the general availability of water remains high in most of the areas. Despite this fact, irrigated agriculture draws heavily on groundwater resources during the dry season. Begumgonj Thana has low elevation and water cannot drain out. The early rainfall fills the ponds, ditches and low lying areas and later rains overflow, keeping the area waterlogged for about six months from May to October. As a result, water stagnation is a common phenomenon during heavy rainfall. The highest rainfall occurs in June-August while the lowest occurs in November-January.



Suitability classification of seasonal floodplains of Begumgonj for prawn/fish farming.

Seasonal floodplain of Begumgonj, Noakhali, Bangladesh.

Satellite image (Landsat) and topographic maps were used for the present study, which were provided by the Bangladesh Space Research and Remote Sensing Organization and

Local Government and Engineering Department. The Thana map with union boundary was digitised using ArcView for Windows (version 3.2) developed by Environmental Systems Research Institute Inc, USA. Remote sensing image analysis used ENVI (version 3.4) developed by Research Systems, Inc, USA. Satellite image analysis identified 22,186 ha of seasonal floodplain spreading in 294 polygons that occupy about 52% of the total area. The suitable area for nursing fry was estimated at about 2,000 ha (class 1), with 16,000 ha was identified as suitable for rearing cultivable species to market size (class 2) and 4,000 ha for broodstock rearing and conservation (class 3). Participatory Rural Appraisal was carried out using field observations and community level group meetings with different stakeholder groups on the seasonal floodplain to gather primary information following the approaches of Pido[4], Pido *et al*.[5], Townsley[6], IIRR[7] and Hossain *et al*.[8] to learn about the available resources as well as their importance for community livelihoods. Direct observation prevents rapid appraisal from being misled by myth[9] and it often provides more valid and less costly information than other research methods[10]. Group meetings with local communities are the important way of learning about local conditions and resources[11].

Indigenous fishes, such as clupeids, snakehead, minnows and barbs, eels, and gobies are commonly available in the floodplain. Aquatic plants and water hyacinth grow in most of the seasonal floodplains and are used as cattle feed. The poor strata of the community, those who have no income generating option in the wet season, usually depend on the fisheries and other resources of the seasonal floodplains. They catch fishes from nearby waters for their own consumption and sell the surplus to the market (locally called *hat*), which help them to survive during the lean period. Different local gears are used to catch the indigenous fishes including cast nets, fixed nets, hooks, push nets, and bamboo basket traps (locally called *anta*). Each gear is used for operation in a specific water depth, for example *anta* are used in 20-30 cm depth to catch small indigenous fishes. It was reported by the people that the maximum fish catch occurs in the early morning and the peak time of buy/sell in local *hat* is between 7.00-9.00 am. A second catch occurs from noon to afternoon which is brought to local *hat* from 5.00-7.00 pm. It was reported that during heavy rain, most of the household ponds are flooded and cultured species (mainly carps) escape to the seasonal floodplain. Thus, rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*), grass carp (*Ctenopharyngodon idella*), common carp (*Cyprinus carpio*), and tilapia (*Oreochromis niloticus*) are additionally available during harvest in the seasonal floodplain. During field surveys we observed that some individuals and cooperatives have used bamboo fences to demarcate the seasonal floodplain into small bamboo pans for carp stocking, which never exceeds 2% of the total seasonal floodplain. The average yield is around 50-60 kg/ha in six months (June-November), lower than typical oxbow lake yields of 689 kg/ha/year[12]. No agricultural activities were reported in the seasonal floodplain during the rainy season due to high water depth and dense aquatic plants. When water depth decreases (October-November) the local communities drain or pump out the remaining water to catch the fishes and then prepare the land for paddy cultivation. Some *robi* crops (green chili, peanuts, radish, bean, arum, tomato, potato, etc) are also been cultivated in the elevated land.

The rainy season suspends most of the activities of poor communities and thus the poorer people face miserable conditions in their daily life. The rural communities usually eat chapatti (locally called *ruti*) at breakfast but sometimes they also eat watered-rice (cooked rice kept in water over night, locally called *hani bhat* or *panta bhat*) with green chili and onion. Rice is the main food during lunch and dinner. In the daily diet, the communities prefer fish than beef and try to arrange fish and beef on alternate days. In Bangladesh the per capita fish consumption has increased from 13.1 kg in 1997-98 to 14.4 kg in 2000-01[13]. On the other hand, the world average per caput fish consumption has been increasing over time, from 8.9 kg in 1961 to 15.8 kg in 1996[14]. The smell of potato and vegetable (either curry or fried) indicate the completion of dining arrangement, particularly in lunch and dinner. Communities reported that they eat seasonal vegetables and fruits almost every day, as these are easily available in their own homestead gardens.

The major activities of the inhabitants are agriculture, fishing, trading, either engaged as daily labourers or as owners of such enterprises. One person may be engaged in two or more different occupations i.e., one family may have agricultural land, a tractor for ploughing and a shop in the locality. Some occupations are seasonal, so a person can take up different activities in different seasons. The daily activities of men are connected with intensive labour for income generation of their family, while the women's activities are solely related to domestic affairs. Men usually pass their time in agricultural work and relaxing with tea breaks. Occasionally they are engaged in husbandry of cattle. During the rainy months they catch fish from the surrounding waters for domestic

Harvesting the last few fishes by hand.

consumption as well as for sale. Most mornings they visit village *hat* either to buy or sell fresh fish and vegetables. They spend their evening time trading, gossiping, purchasing household needs, meeting with friends and relatives at village hat or nearby shops. They also pass their leisure time with family members, neighbours and relatives. Women in rural communities do not participate directly in income generating activities. Usually they look after their families. These include the daily chores of childcare, collecting water, cooking, washing, chicken and duck rearing, homestead gardening, sewing cloths, making handicrafts, child education, and gossiping with neighbours. The dark, soundless village nights give them opportunity for sound sleep and relaxation.

The floodplains of Begumgonj remain relatively unutilised with no economic returns. About 22,000 ha of seasonal floodplains have been identified as suitable for nursing and culture of fish and prawns as well as indigenous brood fish rearing through the establishment of community-based fish sanctuaries for biodiversity conservation. Different types of integrated programs with special emphasis on prawn and fish culture may be undertaken for overall economic strengthening of the local communities by utilising the vast untapped floodplains in this region. Since wild stocks of different fish species including prawn are prevalent in floodplains, it is clear that community-based prawn and fish culture in the floodplains may be an excellent opportunity to stimulate income generation, employment and improve the nutritional status of the communities.

Rural communities need to be empowered economically, personally, educationally and politically to ensure their participation in planning and development process. Empowerment of the people through participation will help improve sustainable development in the floodplain areas. An excellent, comprehensive account of ways to improve fish and prawn farming may be provided in the framework that deals with some important processes involved in the floodplains of Begumgonj.

Women's activities in rural areas, making fuel & selling fish.

In the thrust for rapid aquaculture development, management of seasonal floodplains in the Begumgonj Thana has not been paid adequate attention in the planning process due to the lack of requisite data as well as resource shortages. Community-based aquaculture is a suitable activity for small-scale producers to augment their income and to promote ecologically sound farming in seasonal floodplains. The polyculture of silver carp, grass carp and prawn in seasonal floodplains can ensure sustainable utilisation of the available natural foods that ensure good production. Taking advantage of this situation it is easy to make use of this seasonal floodplain for community-based aquaculture.

References

1. Karim, M. 1989. Present status, scopes and constraints of *Macrobrachium rosenbergii* culture in the greater Noakhali district. Technical findings of a DANIDA-financed mission on identification of the socio-economic feasibility of freshwater shrimp culture in old Noakhali district, October-November 1989.
2. Alam, R. 2001. Feasibility study on freshwater prawn *(Macrobrachium rosenbergii)*. Prospect of fresh water prawn at GNAEP and PBAEP areas. The report of feasibility study prepared for GNAEP and PBAEP, Ministry of Fisheries and Livestock and DANIDA.
3. Chowdhury, A., Uddin K., Halder S., Colavito, L. and Collis, W. 2003. Environmental impact assessment of GNAEC freshwater prawn *(Macrobrachium rosenbergii)* farming promotion. GOB/DANIDA fisheries support unit, Winrock International, Dhaka, Bangladesh.
4. Pido, M.D. 1995. The Application of Rapid Rural Appraisal Techniques in Coastal Resources Planning: Experience in Malampaya Sound, Philippines. Ocean & Coastal Management 26 (1): 57-72.
5. Pido, M. D.; Pomeroy, R.S; Carlos, M.B. and Garces, L.R. 1996. A handbook for rapid appraisal of fisheries management systems (version 1). ICLARM. Manila, Philippines.
6. Townsley, P. 1996. Rapid Rural Appraisal, Participatory Rural Appraisal and Aquaculture. FAO Fisheries Technical Paper No. 358. Rome, Italy, 109pp.

Local fish market at Begumgonj.

7. IIRR., 1998. Participatory methods in community-based coastal resource management. 3 vols. International Institute of Rural Reconstruction, Silang, Cavite, Philippines.
8. Hossain, M.S; Khan, Y.S.A; Chowdhury, S.R; Saifullah, S.M; Kashem, M.B. and Jabbar, S.M.A. 2004. Environment and socio-economic aspects: A community based approach from Chittagong coast, Bangladesh. Jahangirnagar University Journal of Science 27: 155-176.
9. Chambers, R. 1980. Rapid rural appraisal: rationale and repertoire. Discussion paper. Institute of Development Studies, Sussex, UK.
10. KKU (Khon Kaen University), 1987. Rural Systems Research and Farming Systems Research Projects: Thailand. Proceedings of the 1985 International Conference on Rapid Rural Appraisal.
11. Pelto, P. and Pelto, G. 1978. Anthropological Research: The structure of Inquiry. Cambridge: Cambridge University Press.
12. Haque, A.K.M., Middendorp, H.A.J. and Hasan, M.R. 1999. Impact of carp stocking on the abundance and biodiversity of non-stocked indigenous fish species in culture based fisheries in oxbow lakes. In: Middendorp, H.A.J., Thompson, P.M., Pomeroy, R.S. (Eds.), Sustainable Inland Fisheries Management in Bangladesh. ICLARM Conference Proceedings, vol. 58: 141– 148. Manila, Philippines.
13. BBS (Bangladesh Bureau of Statistics), 2004. Statistical pocket book. Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh.
14. Ye, Y., 1999. Historical consumption and future demand for fish and fishery products: exploratory calculations for the years 2015/2030. FAO Fisheries Circular vol. 946. FAO, Rome, Italy. 32 pp.

Peter Edwards writes on

Rural Aquaculture

Promoting small-scale inland aquaculture in Papua New Guinea

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Papua New Guinea (PNG) comprises the eastern half of the world's largest tropical island with a total land area approaching 500,000 km^2 and is located to the north of Australia. Almost 90% of the population are subsistence farmers living in fertile highland valleys at altitudes between 1,500-2,500 m. Malnutrition is widespread with about 35% of children underweight. The isolation of communities caused by the mountainous terrain led to the evolution of more than 800 languages and some of the more remote human groups were only discovered in the 1930s. The mountainous landscape also severely hinders the development of infrastructure, including roads, and therefore constrains farmers attempting to grow fish from obtaining institutional support; seed, fertiliser and feed; and marketing fish surplus to household needs.

Small-scale fish ponds constructed in a valley with banana and sweet potato crops in the foreground.

While PNG does not have a tradition of fish farming, it has a unique indigenous system of agriculture based on root crops and not on cereal crops as in most other parts of the world, and on the exploitation of wild sago palm. New Guinea is also an early agricultural pioneer, one of only half a dozen places on Earth with independent development of agriculture. Recent dating of residues of taro and banana in soils and on stone tools indicates that they were planted, tethered in plots, and canals dug to control the flow of water about 10,000 years ago. However, it is uncertain how important agriculture was then relative to hunting, fishing and foraging and it may have only played a minor role as these indigenous plants are also distributed in the wild. Some of the other staples farmed today, root crops such as sweet potato and yam, vegetables and pigs were introduced into New Guinea much later.

I was delighted to be invited by the Australian Centre for International Agricultural Research (ACIAR) to join a team last October to review a project on the promotion of small-scale aquaculture in PNG. As I have spent most of my professional career on integrated aquaculture, I was most curious to see how small-scale aquaculture could be developed in PNG. Much of the traditional inland aquaculture in Asia is integrated with agriculture and animal husbandry using on-farm or locally available farm by-products as these were the only resources available to feed fish before the manufacture of inorganic fertilisers and formulated feed.

The development of aquaculture is a government priority in PNG to provide badly needed protein for a rapidly expanding population.

Young boys on a fish farm, potential future fish farmers.

Background

The severely denuded landscape in heavily populated areas is no longer rich in mammals and birds, and rivers and streams in most areas are too small to be important for fishing, so animal protein is in short supply. There are several types of traditional food production systems in PNG based on root crops, and mixed vegetable gardens with traditional crops such as sugar cane interplanted with introduced vegetables like cabbage and onion. Pigs store the energy of surplus root crops and provide an important source of animal fat and protein in the diet; but pig meat is perishable and once a pig is slaughtered it must be eaten without delay, usually at community-level feasts.

High population growth, currently over 2%, is having an adverse impact on the age old agricultural systems as well as the ability of families to raise sufficient numbers of pigs for food because of declining per caput availability of land. Ecological stability is threatened by a trend to reduce the fallow period required to regenerate soil fertility in the shifting cultivation or swidden method of farming in which crops are grown in cleared and burnt secondary forest; and there is a trend towards permanent cultivation of crops. Agricultural productivity is increasing, but also decreasing soil fertility and increasing erosion threaten sustainable crop production. Some communities

Seining a small-scale fish pond.

with better access to outside markets are replacing traditional polyculture of crops with monoculture of cash crops such as coconuts, cacao, coffee, peanuts or rubber which exacerbate these problems as well as increasing risks to natural disasters such as pests and economic risk due to falling produce prices.

Aquaculture is an important priority for the government for food security and poverty alleviation, especially to increase the protein consumption of people in the highlands, as well as a means to earn income. Fish is recognised as a source of high-quality protein, and fish can be eaten frequently as they are small compared to a large pig.

Development of aquaculture

There is limited fish biodiversity in PNG so more than 25 exotic species were introduced into the country over the last 60 years in an attempt to increase fish stocks in rivers, some with value for aquaculture. Inland aquaculture began in PNG in the 1950s with the introduction of common carp (*Cyprinus carpio*) and rainbow trout (*Oncorhynchus mykiss*). Farming common carp as well as Mozambique tilapia (*Oreochromis mossambicus*) were promoted initially in the late 1960s/1970s as a means to alleviate chronic malnutrition in inland areas but they were abandoned due to lack of fingerlings and extension support, problems which are very much prevalent today. Aquaculture activities were reactivated in the 1990s with the assistance of the Japanese International Cooperation Agency (JICA). The Highlands Aquaculture Development Center (HAQDEC) at Ayuria in the Highlands Region was upgraded and the number of farmers building fish ponds grew rapidly through FAO as well as JICA funded programmes.

ACIAR has been providing assistance over the past decade to develop inland aquaculture in the country. Initially a survey was carried out from 2000-2004 to determine the level of pond aquaculture in PNG and to identify constraints (Smith, 2007). This was followed by the current project, commencing in 2005, to address the constraints to more productive small-scale aquaculture identified in the survey, especially through the GIFT strain of Nile tilapia *(O. niloticus)*. GIFT was introduced in 1998 and was quarantined until 2002 at HAQDEC, the largest hatchery in the country. It was introduced in part to lessen the reliance of small-scale farmers on centralised hatcheries for fingerlings as it breeds readily in farmers' ponds, unlike common carp, another species low down in the food chain that was previously promoted by the government.

The survey reported the presence of nineteen hatcheries, although only four had a substantial level of production and 11,000 fish farmers with a combined total of about 1,000 tonnes. Most farmers had two to three small ponds with a total area of 100-200 m^2, about half with flow-through water

One of the families of GIFT tilapia broodstock maintained at HAQDEC.

A pondside training programme.

Large sized GIFT tilapia harvested from Yonki Reservoir.

The seined fish indicating a poor yield of relatively small tilapia of various sizes.

A pelleted feed ingredient grinder (left) and an ingredient mixer (right) at a small-scale feed making centre.

from mountain streams. A majority of farmers did not use fertiliser as the main farmed animal, the pig, is free-ranging which makes it difficult to collect manure to fertilise ponds. The main feeds for fish were kitchen leftovers, waste vegetable leaves, termites and worms. Most farmers were inexperienced and lacked aquaculture training. Farmers reported difficulty in obtaining fingerlings and once stocked, uncontrolled breeding of tilapia and slow growth of fish in their ponds. Traditional experience with raising animals is with pigs which scavenge for much of their food so many farmers believe it is only necessary to stock fish in the pond and let them forage for their own feed in an extensive mode.

Field visit and project review

Overview

We flew north over the mountains from Port Moresby, the capital in Central Province, to Lae in Morobe Province, the lowland project area on the northern side of the island; and later drove up the mountains to Aiyura where HAQDEC is located and Goroka in Eastern Highlands Province. We visited several project collaborating farmers in both the lowland and upland areas, and fingerling distribution and small-scale feed making centres which have been established through the project. We also visited a provincial prison in Goroka where aquaculture is being used to help to rehabilitate low security risk prisoners. As the scheme has considered to be a success it was been introduced into five more provincial gaols.

Five to ten of the 20 collaborating farmers were reported to be successful but the farmers we visited did not appear to have productive ponds although some farmers expressed satisfaction with the 'palm' sized fish they were harvesting for domestic consumption and sale. Most of the farmers had been provided with tilapia fingerlings by the project 2-3 years ago and their ponds contained fairly small and stunted, freely breeding tilapia of various sizes.

GIFT

Visual observation of the five families of GIFT maintained at the HAQDEC indicated that some appear to be of high quality. Large-size tilapia were also observed for sale on the roadside adjacent to Yonki Reservoir, a 2,000 km^2 water body constructed for hydro power and stocked with GIFT, which supports the view that good quality tilapia still exist in the country. However, the founder stock of currently farmed Nile tilapia in PNG are derived from only a few individuals as the original fish introduced from the Philippines suffered from heavy mortality. Such an inbred stock with limited genetic variability may soon suffer from reduced performance so new stocks of GIFT should be reintroduced.

Seed

Decentralised production of tilapia seed, required in PNG because of the mountainous terrain, was taking place at some collaborating farms but was inefficient because of stunting and asynchronous spawning. The ability of tilapia to breed in the pond is considered a positive attribute by small-scale farmers as they can readily produce and sell seed but proper management is needed for good production of both seed and table fish. Introduction of improved tilapia hatchery technology is required for both central and decentralised farmer-level seed production.

Stunting, reduction in size of fish for their age through stress, and the timing of breeding in tilapia, are complex and poorly understood phenomena. In a sense all farmed tilapia may be regarded as stunted because natural populations of Nile tilapia in large African lakes may grow to more than 60 cm and mature when quite old, at least two years of age, while well-fed Nile tilapia in ponds reach a relatively small but acceptable size for small-scale farmers of only 250-350 g and in the relatively short time of only five to six

A fish pond being developed from a sago palm (background)swamp with taro and banana crops in the foreground..

months before they mature. In PNG the tilapia are also stressed even more than in well-managed ponds by poor nutrition, and subsequently breed when much smaller. Many of the 'fingerlings' collected by farmers for restocking their own ponds and for sale directly to neighbouring farmers or indirectly through the four seed distribution centres are likely to be relatively old as well as small, and therefore would breed relatively soon after stocking which would reduce their growth. There is evidence for compensatory growth of stunted fingerlings in some species of fish but this strategy may be counterproductive in tilapia, unless there is demand for out of season fingerlings, because it leads to the early onset of breeding.

Feed

There appeared to be very few materials on-farm that could be used to fertilise the pond or feed the fish as reported earlier in the survey. Feedlot chicken manure was being used by several farmers as raising poultry is a well-established business around Lae in the lowlands. Manure was applied in sacs suspended in the pond but it would be more efficient to fertilise the pond manually with a small amount of manure every few days to develop and maintain a satisfactory level of 'green water' without running the risk of overfertilisation. Not all farmers appreciated that allowing water to continuously flow through the pond would wash out phytoplankton. Farmers reported feeding cassava, papaya and sweet potato leaves but it would be difficult to feed a sufficient amount due to their high water content; also bananas, coconut meal and papaya fruit but these are worth more as human food; and termites but the supply would soon be exhausted. Since feed availability is clearly a major constraint, we recommended that grass carp be reintroduced to capitalise on abundant vegetation, especially underutilised wild grasses and other vegetation, although today the import of exotic species is restricted because of negative impacts of some introduced species. Efforts also being made to develop the culture of indigenous species.

The project was also manufacturing 'farm-made' pelleted fish feed at four feed-making centres as there are so few on-farm feed resources and farmers were asking for pelleted feed although there were problems in obtaining all the ingredients, especially fish meal. A brochure was produced through an ACIAR-funded mini-project on aquaculture feed formulation and how to make simple feeds, store them and feed them to fish (Gonzalez and Allan, 2007). Formulated feed is required for broodstock and nursing fingerlings as well as to demonstrate to farmers how to produce high yields of fish although it is likely to be beyond the limited resources of most small-scale farmers. However, according to Jacob Wani of the National Fisheries Authority, there is a need to develop a commercial tilapia industry in PNG similar to the well-established chicken industry and for this pelleted feed would be required. Small-scale feed production centres may be able to develop sufficient demand for feed to interest the commercial sector to produce and market aquaculture feeds. Small-scale farmers may be able to use the feed economically as a supplementary feed in chicken-manured green water ponds (chemical fertilisers are prohibitively expensive), and only to fatten fish towards the end of the growth cycle.

A holistic and comparative view of feeds is necessary as there are two groups of farmers: subsistence farmers with limited resources for rural food security; and potentially large scale commercial farmers with resources available to purchase inputs, and the capacity to supply urban markets. There is a spectrum between these two and the appropriate technology and its management will vary. A comprehensive assessment of the various types and levels of fertiliser use and feeds, alone and in combination, is required from the perspectives of both small-scale and potentially large-scale commercial farmers.

Credit

Farmers would require access to credit as well as to quality seed and feed and the development of markets to become more commercially oriented. Farmers currently have difficulties accessing micro-credit. NFA has attempted to make credit commercially available but banks lack an appreciation of the financial requirements of aquaculture. A proposed ACIAR micro-project on credit may help to solve this problem.

Conclusions and recommendations

The project has significantly raised awareness of the potential of inland aquaculture in PNG through training 1,500 farmers. Farm numbers are reported, albeit somewhat subjectively, to now exceed 15,000, and to be growing quickly. However, many farmers are inactive, having dug ponds at considerable effort while still waiting for technical advice, fingerlings and feed. There is a question regarding the impact of training on farmer practice as trainees returning to their villages to train others when the technology remains to be sufficiently verified; and that the trainees understand enough of a given technology to be able to implement it on their farms and to disseminate it correctly to others. There is a need to demonstrate that aquaculture can be productive, profitable and eventually sustainable as a private sector enterprise.

Ponds must be provided with adequate nutrition for fish to perform well in hatcheries and grow-out. Synchronous breeding should be used to obtain uniformly young and small-sized fingerlings. Recruitment should be controlled in grow-out ponds to obtain more growth and therefore higher production. The easiest way to achieve this is by stocking young fingerlings with potential for a longer period of growth of four to five months before they start to breed. Monosex culture is not necessary for small-scale aquaculture as fish of at least 250 g can be readily produced in well-managed mixed-sex culture before the onset of breeding. Fish pond biomass should be managed to optimise the use of pond volume and carrying capacity by multi-stage culture: early nursing of fry to produce 2-3 cm fingerlings, advanced nursing of the small fingerlings to produce 20-50 g large fingerlings, and final grow-out to 250-350 g table fish. Ponds must be drained between fish crops as it is not possible to harvest tilapia effectively by seining as they are adept at avoiding capture. Any recruitment may be controlled by polyculture with small numbers of carnivorous fish. Walking catfish (*Clarias batrachus*) and striped snakehead (*Channa striata*) have both been introduced into PNG but are considered to be invasive species. The native Asian seabass (*Lates calcarifer*) will grow in freshwater and could be considered if fingerlings

Many small-scale fish ponds have running water.

could be distributed in inland areas. A broad assessment of the feasibility of how best to integrate aquaculture into the diverse inland farming systems in PNG should be undertaken, although experience to date indicated rather few on-farm resources that can be used as fertilisers or feed. In both lowland and highland project areas, farmers are converting natural sago palm swamps to fish ponds, the economic and environmental impacts of which remain to be assessed. The assessment should cover socioeconomic-farm opportunities as well as potential environmental impacts, and possibly include GIS based technology. Evaluation of appropriate technology and its management for farmers requires consideration of the ability of current and potential farmers to farm fish within their available resource constraints. Future projects should adopt a farming systems research, development and extension framework which involves on-farm testing of technologies and their management, with feedback loops to the researchers who are providing the direction to the farmers.

Highland farmers are responsive to the promotion of aquaculture as their needs for food and income generating activities are great. However, there is greater potential for large-scale commercial aquaculture in the lowland Markham valley as it is flatter, more water is available and land is more readily accessible, and it is close to the major urban market of Lae with a reported significant and largely unmet demand for tilapia indicated by a high retail price of about US$5/kg.

References

1. Smith, P.T. 2007. Aquaculture in Papua New Guinea, Status of Freshwater Fish Farming. Australian Centre for International Agricultural Research, Canberra. 123 pp.
2. Gonzalez, C. and G. Allan. 2007. Preparing farm-made fish feed. ACIAR and New South Wales Department of Primary Industries. 21 pp.

Applying chicken manure in a sack suspended in the pond can lead to over-fertilisation.

Dried feedlot chicken manu pond fertiliser.

Group approach to shrimp farming: the key to sustainability

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In India shrimp aquaculture is being practiced mostly along the brackishwater creeks and canals in clusters of farms drawing and draining water from the same source. There are around 100,000 small scale shrimp farmers occupying about 140,000 hectares with an annual production of about 140,000 tonnes[1]. Indian shrimp culture has passed through three distinct phases:

- The 'rising phase-I' from the late eighties to 1995 wherein a sense of competitiveness prevailed among the farmers in a given locality. The farmers maintained 'at most secrecy' in all farm operations to produce more shrimp and make huge profits in just about four months of grow out.
- The 'falling phase-II' (1995-2001) witnessed the emergence of virulent viral diseases, particularly the 'White Spot Syndrome Virus' (WSSV), which reduced the shrimp aquaculture industry to chaos, mainly due to greed for high production, 'self pollution' due to poor farm management and lack of experience and cooperation among the shrimp farmers. Nevertheless, as a blessing in disguise this disaster made the shrimp farming a self mature and more responsible farming regime despite colossal losses and legal interventions at the time.
- The 'sustainable phase-III' (since 2002) facilitated with interventions from research and development institutions encouraged farmers to be open to their fellow farmers and to understand that one's success was dependent on his neighbour's success, also. This realisation led to the formation of cluster based farmer groups to enforce certain code of practices collectively adopted by the farmers. Further to this, market forces (price and food safety), anti-shrimp farming campaigns, legal and other socio-economic threats have also strongly contributed towards the development of group approach in shrimp farm clusters.

Experience has amply shown that farmer groups can ensure responsible and sustainable aquaculture development[2,3], empower farmers through collective decision making[4,5,6], offer opportunities to link with markets, improve social, environmental and food safety responsibility[6], facilitate delivery of farm extension services and contribute to the long-term sustainability of the shrimp farming[7,8,9,10].

Pamini river shrimp cluster - a success story of group approach

The primary advantage of group approach to shrimp farming is that it enables participating farmers to organise the schedule of farm operations, quality seed procurement, simultaneous stocking, water exchange and harvesting regimes contributing to substantial reduction in the vertical and intra cluster transmission of disease. In this context, the Pamini River Shrimp Farmers Association in Tiruvarur district of coastal Tamil Nadu (South India), a self initiated dynamic cluster-based association, was studied using case study methodology to determine its role in the sustainability of shrimp farming in the area. Popularly known as DCM cluster (land owned by M/s. DCM textile company and later sold to the local villagers), this association was formed by the farmers themselves in the year 2003, mainly to prevent and manage the disease outbreaks collectively by enforcing better management practices. The cluster started with just five farms (35 ponds) in 2003 and has now grown to 50 farms (320 ponds). One season of shrimp culture (February - July) was practiced in this cluster. The association oversaw the farm operations including pond preparation, stocking, farm management, harvesting and marketing to prevent the vertical and horizontal transmission of disease, promote optimum utilisation of resources and to help farmers get a better price for their shrimp their crop.

Reservoir pond and the culture pond in a farm.

Planning, seed procurement and stocking

The association planned shrimp farming activities through a General Body meeting in which the farming calendar and better management practices, including the bio-security measures to be followed (Table 1), were decided as a written document endorsed by all the farmers. The association monitored the farming operations in the cluster by appointing a technical person who facilitated proper pond preparation, initial water intake, double filtration and chlorination in the ponds. It constituted a seed team for seed procurement from one reputed hatchery and the team monitored the complete seed production process. Seed selection included screening of broodstock, nauplii, early and later stages of post larvae (PL 5 and PL 15 – 20) at the time of purchase in more than one diagnostic laboratory.

Seed were procured collectively or individually from the same hatchery. When seed were purchased by a group, the seed requirement of the individual members were calculated and packed separately. Even in the case of individual purchase, the hatchery was asked to furnish the details of seed taken by every individual farmer. This measure ensured that there was no variation in the stocking density among the member farms. It was mandatory to submit a copy of the report to the association that seeds have been subjected to the PCR screening. The association decided that the stocking was done in a period of 20 days and the stocking density was kept less than 6 PL/m^2. Collective seed procurement reduced the seed cost due to the nature of bulk order procurement and the low unit incidental and transport expenses. Moreover, there was a plan to raise 'seed money' from the common fund raised to supply 'free seed' to farmers for the next culture.

Pond management

It was mandatory that every pond was bird fenced and non-compliance attracted penalty of Rs. 2,000 per pond (US$ 40). It was reported that bird fencing had reduced the disease spread by 30-40%. Every farm had a reservoir wherein the source water was disinfected and used for water exchange. Every farm had a paid consultant who visited the farm once a week to monitor and advice. The following practices in farm management were strictly followed:

Farm with crab and bird fencing.

1. Feed rationing and scheduling based initially on feed off-take from the check tray up to 60 days and then based on check tray and weekly sampling till harvesting.

2. Soil and water quality management through application of probiotics, adequate aeration and continuous monitoring of animal behaviour.

The association permitted only a few well-known consultants to advise the farmers. The consultants were asked to appraise the association about the farm conditions of their clients. Movement of people were strictly restricted if there were disease incidences in the nearby areas. Consultants alone were permitted to move in the restricted areas after disinfection and as a precautionary measure, feed tray checking was not allowed during that time. Use of antibiotics was banned. However, use of probiotics and sanitizers were encouraged during the culture period.

Collective disease management

In spite of all precautions, if an outbreak of the disease occurred it was immediately informed to the association. The association convened an emergency meeting and decided the course of action. There were two courses of actions,
(i) either premature harvest was resorted to or (ii) the pond was bleached. Depending on the DOC (day of culture), nature and magnitude of problem, an appropriate decision was taken. Disease affected ponds were bleached if the culture was in less than 60 DOC. Bleaching of ponds was continued in a certain number of ponds to carry forward the culture in the other ponds to the maximum possible period. During such occasions the association assured the affected farmers' in writing that they would be compensated. The cost of bleaching was borne by the association. In 2007, when there was a disease attack in this cluster, the association bleached about 20 ponds and a sum of Rs. 20 lakh (approximately US$ 50,000) was paid as compensation to 20 ponds. Pre-mature or emergency harvesting was also allowed if the disease was other than WSSV. Even in the event of an outbreak of WSSV, if the size of the shrimp was above 15 g, with due precautionary measures the ponds were safely harvested using drag nets without letting out the pond water.

Compensation to the affected farmers through facilitated marketing

The association invited quotations from shrimp buyers for negotiating the best price for the shrimp produced in the cluster. However, the price was not binding on the members. Irrespective of the buyer, a stamped agreement (legally enforceable) was signed and given to the association by the farmers and the chosen buyers. This agreement stated that a given amount of the sale price per kg of shrimp sold was to be deducted at the buyer's end and handed over to the association to compensate the affected farmers and for maintaining the common facilities. It was the responsibility of the buyer to ensure this payment to the association. The same procedure was adopted to collect the common fund for the association to take up collective works even in normal culture seasons. This amount was deposited in the bank as a joint account operated by three executive members to ensure its safety and make certain that the agreed compensation was paid to the farmers who lost their crop due to the disease.

Group management of operation

All the farmers in the cluster were members of the association and they owned it. The association had written bylaws but was not a registered body. The association had a President, Secretary and a Treasurer. They were nominated unanimously and these positions were honorary. While the General Body meeting was the first one in which most of the members participated and the subsequent meetings were organised only whenever required during the culture period. In the first meeting prior to beginning of culture operations, the do's and don'ts were discussed, recorded as minutes and signed by all the farmers. The issues were discussed, sorted out collectively by consensus and the decisions were fully complied. The association had

Farmers of the Pamini River Shrimp Farmers Association with the author.

dynamic leaders to carry forward its activities taking the members together in confidence. The association was socially cohesive and successful since most of the members belonged to the same village and community. Mutual trust and commitment prevailed among the members as is evident from the consent given for crop bleaching on the event of full scale disease outbreaks and compensation agreed upon. The association adjudicated the conflicts if any between the members amicably. It had also kept proper financial records officially audited every year.

Interaction with key stakeholders and social responsibility

The Association was authorised to negotiate with hatcheries and shrimp buyers for quality seed and price respectively. Public institutions and private input traders considered the association as the representative of the farming community. It had closer interactions with the neighbouring farmers and shared information for mutual benefit. Since most of the farmers belonged to the same or nearby villages, cordial relations were maintained with everybody. The associations helped the village in developing and maintaining infrastructures, like roads, school buildings, temple renovation etc., for the benefit of the villages and fishers. Moreover, local villagers and fishers were given employment in shrimp farms. The group maintained close rapport and linkage with government departments and facilitated through the Department of Fisheries for availing farming approval from the Coastal Aquaculture Authority (CAA) which is mandatory for setting up aquaculture farms.

The factors behind the success of this group approach

Since formation of the Paminiriver Shrimp Farmers Association in 2003 all the crops were successful barring 2007. The association attributed its triumph to the factors indicated in the box.

Factors behind the success of this group approach	
Sustainability of group & shrimp farming ←	1. Complete membership of all farms 2. Economic deliverability through continued success 3. Compulsory technical consultancy 4. Community linked social cohesiveness 5. Conviction that group action is indispensable 6. Accountability – payment of compensation and auditing 7. Collective and compulsory compliance of BMPs 8. Dynamic leadership 9. Equality of all irrespective every factor

Conclusion

This association has been organising shrimp farming collectively contributing to the sustainability of the production system as well as farmers' welfare. Information sharing and close interactive approaches among farmers in shrimp farming cluster were the rules of the game. The compensation linked shrimp disease management is a unique mechanism to be emulated by other shrimp farming clusters. The association was contemplating to procure inputs like feed collectively by negotiating with the feed producer. However, this needs either credit support or a facilitating mechanism like contract farming from the institutional credit agencies. This group need to be facilitated to explore the possibility of "branding" the quality shrimps produced and obtaining geographical indication from appropriate agencies, like the "Mahagrapes" by grape farmers of Maharashtra in India. It is suggested that since the association controls every practice from seed to shrimp the CAA could consider this cluster as single farm and give one approval as a whole in the name of the association subject to the adherence of its regulations. Such recognition would help in availing certifications from the national and international aquaculture certifying agencies to certify the cluster as the producer of safe and quality shrimp.

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References

1. MPEDA. (2008). MPEDA Annual Report, available from: www.mpeda.org.

Scientists interacting with farmers association president at farm cluster.

2. Kumaran. M, Kalaimani. N, Ponnusamy. K, Chandrasekaran. V.S and Vimala, D.D. (2003). A case of informal shrimp farmers Association and its role in sustainable shrimp farming in Tamil Nadu, India', Aquaculture Asia, VIII (2): 10-12.
3. Kutty, M.N., Ravichandran, P., Krishnan, M., Kumaran, M. and Balasubramanian, C.P. (2003). Case Studies in India on the Role of Small Farmer Groups and Associations in Sustainable Shrimp Aquaculture Management. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment, 120 p.
4. Davis, K. (2006). Institutional Arrangements for Increasing the Dissemination Role of Farmer Groups in Agricultural Innovation Systems – journal of International Association of Extension Education, 152 – 162.
5. Marine Products Export Development Authority (2006). Action Plan for Development of export oriented aquaculture in maritime states of India. Prepared and published by the MPEDA, Cochin, India 72 pp.
6. Umesh, N.R. (2008). Sustainable aquaculture through empowerment of farmers. Paper presented in the Aqua India-2008, February, 2009, Organized by Society of Aquaculture professionals, Chennai, India.
7. Krishna. S, Sridhar., M, Kartha, P.N.R and Mohanan, A.N. (2000). Group farming for Sustainable Aquaculture, Ocean and Coastal Management, 43(2000):557-571.
8. Franzel, S., Wambugu, C. and Tuwei, P. (2003). The adoption and dissemination of fodder shrubs in central Kenya. AgREN Network Paper No. 131. London, UK: The Overseas Development Institute.
9. Omoyeni, B.A. and Yisa, J. (2005). Enhancement of fish production in Borno State with extension services: In Araoye, P.A. (ed.,) Proceedings of the Annual Conference of the Fisheries Society of Nigeria (FISON). pp. 658-662.
10. Kumaran. M. (2007). Participatory Technology Transfer Model for Sustainable Coastal Aquaculture, Final Report of the AP Cess funded project, Social Sciences Division, CIBA, Chennai, Report, 136 pp.

Table 1. Better management practices adopted by the group

Prevention of vertical transmission of diseases	Prevention of horizontal transmission of diseases: Pathogen transfer	Prevention of stress to shrimp	Ensuring food safety	Ensuring environmental safety	Ensuring economic sustainability
1. Screening of brooders 2. Selection of seed from single spawning 3. Selection of seeds from single mother shrimp 4. Quality seed - colour, activity, uniform size, muscle-gut ratio, length, MBV & PCR tests 5. Optimum seed packing density 6. On-farm nursery	1. Initial chlorination of pond water 2. Filtration of inlet water to prevent vectors 3. Reservoir-chlorination-water exchange to prevent vector 4. Crop scheduling 5. Synchronized stocking 6. Restriction of movement of people, equipments, etc. 7. Disinfection of people, equipments and vehicle 8. Bird scaring & crab fencing 9. Remove and bury moribund/dead shrimps 10. Non-draining of disease affected pond water 11. Emergency harvest and bleaching of the disease affected pond 12. Disease attack - Information to nearby farmers	1. Removal of bottom black soil, drying, ploughing, etc. 2. Drying and ploughing to remove bottom algae and gastropods 3. Acclimatization of seed before stocking 4. Maintenance of optimum soil and water quality parameters (pH, salinity, temp, bloom, oxygen, bottom soil) 5. Feeding and feed management-type of feed, rationing, scheduling, method of feeding, place of feeding 6. Aerators position and orientation 7. Maintenance of optimal blooming and optimum water depth in the pond 8. Removal of floating algae and weeds 9. Appropriate water exchange - using reservoir 10. Chain dragging of pond 11. Prevention of development of benthic algae 12. Monitoring for soil and water quality, animal behaviour 13. Avoidance of feeding shrimps with the by-catch crustaceans	1. Sites free from industrial pollution – preventing residual heavy metals 2. Non-use of harmful/ banned drugs, pesticides, antibiotics 3. Appropriate harvesting time & method 4. Avoidance of feeding shrimps 6 hours prior to harvest to keep the gut empty to improve shelf life 5. Thoroughly wash the hand picked shrimps in clean water and pack them separately to maintain quality. 6. Ice dipping of harvested shrimps in freshwater ice slurry for freshness & additional weight 7. Avoidance of use of any chemicals while washing & chilling the harvested shrimps 8. Packing the harvested shrimps in transport tubs with ice 1:1 ratio for better preservation 9. Maintaining cleanliness while packing and stacking 10. Separating any dead, discoloured shrimps from the quality shrimps	1. Proper site selection-guidelines 2. Shrimp farm-minimum distance from human settlements 3. Farming does not affect other traditional activities 4. WSA 60:40 area for other purposes 5. Separate inlet & outlet on each farm 6. Mangrove plantations in the bunds to prevent erosion 7. Non-use of bore well water	1. Written agreement 2. Loss compensation 3. Risk coverage 4. Quality assurance to buyers

Native catfish culture - a technology package for fish farmers

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Freshwater aquaculture makes an important contribution to the national economy of India, as well as contributing to improved livelihoods and nutrition of rural people. Among freshwater fish species, murrels (snakehead) and catfish are favoured species in South East Asia and are amongst the most economically significant species. Worldwide there are about 2,500 catfish species belonging to 30 families, most of which are freshwater. In India catfishes form a significant component of capture fisheries.

Indian fish farmers often prefer the exotic catfish viz: the African catfish *(Clarius gariepinus)* and the Thai catfish *Pangasius sutchi* due to continuous supply of seed, their wider feeding spectrum, cheap dietary requirements, fast growth and short culture period[1]. These exotic catfish pose a heavy threat to native fish biodiversity and hence the Government of India put a ban on them, although farmers are still producing them due to favourable short term profits. It has become imperative to promote native catfish culture among fish farmers as an alternative to exotic fish culture for income generation and ultimately to conserve fish biodiversity.

Approach

The Indian subcontinent harbours 142 species of catfishes belonging 13 families and 43 genera[2]. Native catfishes that are larger in size (e.g. *Heteropenustus fossilis* (singhi), *Clarius batrachus* (magur), *Ompak bimaculatus, O. malabarichus*, *Mystus gulio, M. montanus, M. cavasius, Horobrachus brachysoma* and *Spiratus seenghala)* are widely preferred by consumers all over India. Among the freshwater catfish *Mystus* occupies a major role due to the greater numbers of species available in Indian rivers, reservoirs and brackish waters (Table 1). Moreover they play a major role in nutrition of socially weaker sections in India since they are both cheap and tasty.

The Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar has succeeded in breeding and hatchery management of singhi *(H. fossilis)* as well as magur *(C. batracus)*. CIFA has also promoted culture of *Mystus vitatus* and *Ompak pabo* in Bhubaneshwar. However, fish farmers throughout India are not very familiar with commercial native catfish culture due to want of breeding, feeding and culture techniques. Hence, Dr. M.A. Haniffa, Director of the Centre for Aquaculture Research and Extension (CARE) of St. Xavier's College and his research team have developed a technology package for native catfish culture with the financial assistance received from DBT. The technology package developed addresses the full cycle of culture from brood fish nutrition, seed production, larval rearing and commercial grow out.

Native catfishes like *Mystus* are increasingly becoming threatened (Table 1). Under the DBT sponsorship the CARE research team is providing catfish culture training for disadvantaged youth to assist them with income generation. Ten trainees have already implemented the techniques in their home localities and succeeded in the culture practices of catfishes especially *H. fossilis, M. montanus* and *M. gulio*.

Advantages of catfish culture

Catfish have several beneficial characteristics that make them advantageous for culture[3]. These include:

- Air breathing. They can survive in oxygen depleted waters by coming to the surface to gulp air.
- Thrive in all kinds of shallow freshwater habitats (marshes, rice fields, swamps, streams, lakes and irrigation canals).
- Tolerant of crowding and can be reared at extremely high stocking density.
- Accept pelleted diets.
- Fetch high market price due to tender flesh and delicious taste.
- Preferred all over South East Asia and have export potential.

Brood fish nutrition

The quality and quantity of feed as well as feeding regime are important for spawning as well as egg quality. The research team of CARE recommended chicken intestine (70% protein), fish waste (56% protein) or any artificial feed with 60% protein to be fed to *H. fossilis, M. gulio, O. malabaricus,* and *O. bimaculates* for a maximum spawning of 6,000-10,000 eggs with 90% fertilisation and hatching. A rectangular pond of 6m x 4m x 1m is suitable for brood stock rearing as well as for netting operations. A minimum depth of 1m is recommended since catfishes are air breathing.

Induced breeding and seed production

Most of the catfish show sexual dimorphism. Males show serrated pectoral fin and genital projections but may not ooze milt in most cases. Whereas females have soft and swollen bellies and a genital pressure on the belly will result in oozing of eggs. Catfish could be induced to spawn by injecting natural (pituitary, human chorionic gonadotrophin) or synthetic (ovaprim, ovatide) hormones intramuscularly (0.3-0.5 mg/kg). Among the different hormones tested at CARE ovaprim was recommended for *H. fossilis* and ovatide *M. gulio* and *O. malabaricus*[4].

Table1: *Mystus* species and categories of threat in Indian rivers and reservoirs (IUCN 1996).

Mystus Species	IUCN status	Ornamental / Food fish	Place
Mystus armatus	LRIc	Food fish	Bharathaipuzha (Reservoir), Kabbini (River), Chalakkudy(River)
Mystus cavasius	LRnt	Food fish	Bhavani sagar (Reservoir)
Mystus gulio	LRIc	Food fish	Periyar (Reservoir), Bharathaipuzha (Reservoir), Kabbini (River), Chalakkudy (Reservoir), Tambirabarani (River)
Mystus keletius	DD	Food fish	Travancore (Reservoir), Bhavani Sagar(Reservoir)
Mystus menoda	DD	Food fish	Achenkoil (River)
Mystus oculatus	LRIc	Ornamental	Kabbini (River)
Mystus bleekeri	VU	Food fish	Mahanadi headwaters and West Bengal, Kerala, Maharashtra Ombatta swamp, Moyar, Bhavani River, Godavari estuary
Mystus malabaricus	EN	Food fish	Western Ghats of Kerala, Karnataka and Maharashtra in India.
Mystus montanus	VU	Food fish	Tambirabarani (River)
Mystus punctatus	EN	Food fish	Kerala, Tamil Nadu and Karnataka in Western Ghats, Cauvery river drainage in southern India
Mystus vittatus	VU	Food fish	Eastern Punjab, Bihar, Uttar Pradesh, Assam, West Bengal, Orissa Bhavani River, Tamil Nadu
Sphereta seenghala		Food fish	Bhavani Sagar (Reservoir)

LRIc – Lower risk least concern, LRnt – Lower risk near threatened, VU – Vulnerable, EN – Endangered, DD – Data deficient

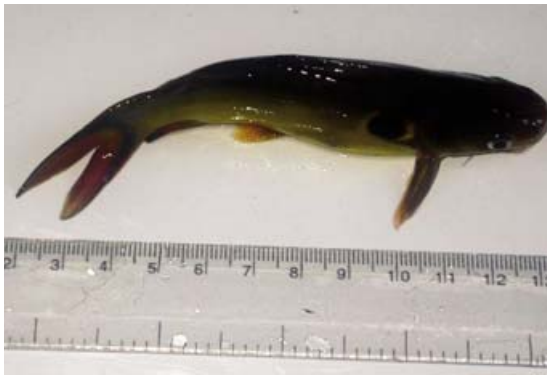
Each breeding set consisted of one female and two males irrespectively of species. Immediately after intramuscular injection of the hormone, the breeding set was introduced into breeding tank (3m x 3m x 2m) containing well aerated water (DO 5.0± 0.5 mg/l; pH 7.2±0.3; temperature 27°C). Aquatic macrophyte *Hydrilla verticillata* was introduced into to the tank for the purpose of providing cover. After 6-12 hrs of injection, breeding behaviour could be noticed in most of the catfish species. Mating will be preceded by courtship by the active male chasing the female until spawning[5]. It is better to remove the parents after spawning, since the young ones do not require any parental care in the case of catfish, contrary to murrels.

The eggs of *H. fossilis* were submerged on the floor of the breeding tank whereas they were adhesive and attached to the aquatic macrophyte in the case of *M. montanus* and *M. gulio*. The eggs usually hatch within 24 hrs in most of the catfish species. The hatchlings were acclimatised in the breeding tank by providing aeration with least disturbance. Water quality parameters were recorded and everyday freshwater was supplied by changing at least 50% of water from the tank. Yolk sac absorption will take three days and the major constraint will be the larviculture since post larvae will succumb heavy mortality unless otherwise water quality is monitored, nutritionally adequate food and pathogen and predator free environment is provided. Even then mortality may be a common occurrence during larval rearing. It is better to feed the post larvae with plankton (*Daphnia*, *Cyclops* and *Moina*) for a period of one week and after that suitable supplementary diets like minced chicken liver, macerated yellow yolk and fish waste powder until they reach the fry stage, when they will be capable of taking pelleted feed and survival will be greater[6]. A flow through system will always be preferred for better survival of the post larvae. The fry could be reared in large cement tank (3m x 1m x 1m) up to the fingerling stage. Once they reach the fingerling stage they are suitable for commercial culture.

Fingerlings of Mystus gulio.

Commercial culture

To popularise commercial catfish culture among fish farmers, earthen ponds (15m x 5m x 1m) available at the CARE Aquafarm were used. One of our trainees attempted singhi culture in an open well (12m x 7m); cow dung, thumbai plant, indigo plant and tapioca leaves were cut into pieces and placed in a sack, introduced into the well and allowed to decay. After a few days the decomposed materials had completely mixed with the soil at the bottom. In addition waste water from adjacent household was allowed to enter the well. Once per month fish waste was chopped into pieces and mixed with waste rice collected from nearby marriage halls and put into the well. During a seven month culture period the farmer harvested about 125 kg singhi (each 75 – 250 g) translating to a yield of around 800 kg/ha[1].



Horobragus brachysoma

Heteropenustus fossilis.

Another fish farmer excavated two culture ponds (30m x 20m x 1.5m) and introduced 2,000 fingerlings of *M. montanus* (length: 1.5-2.5 cm and weight: 1.3-1.5 g) into each culture pond. He mixed chicken manure with rice bran, corn flour and ragi malt in the ratio of 19:2:2:2 and the mixer was taken in a tray and water was added little by little. After six hours the feed paste was made into balls and were kept in a tray and slowly immersed into the pond. The tray was kept undisturbed for two hours till the fingerlings got a good meal and after that they were removed from the pond. The fingerlings were fed twice (9.30am and 4.30pm) every day. After 4 months the entire pond was drained and *M. montanus* were harvested. The weight of the harvested catfish ranged between 150-250 g and the total weight of the fish harvested was around 300 kg/pond translating to a yield of 5,000 kg/ha over a culture period of four months. They were sold to the nearby market at the rate of Rs 130/kg (= Rs 40,000/ pond or Rs 70,000/ha) (Table 2).

With regard to feeding of catfish fingerlings, the fish farmers can supply chicken intestine/fish waste or any formulated feed according to the availability of the ingredients with protein content of at least 50%. From our past experience it is possible to suggest that minimum six months culture period may be adequate for singhi and *Mystus* farming. An unemployed youth can earn a sum of more than Rs. 100,000/year according to availability of area for commercial catfish culture. If they do not have land and water resources they can utilise the neglected water bodies of their area by establishing cooperative groups.

Commercial culture of M. montanus.

Conclusion

The striking feature of this technology package is that breeding; larval rearing and culture can be practiced independently by fish farmers. Those who have undertaken catfish culture training at CARE have already succeeded in seed production and larviculture independently. Unemployed youth and fish farmers can practice commercial catfish culture for income generation. A minimum area of at least 50 m^2 is essential for catfish culture. Water can be supplied from bore well or any other sources nearby. Biowastes like chicken intestine/ fish waste or commercial feed can be supplied. Women folk may be encouraged to start catfish culture in a minimum area of 50m^2 (12m x 5m x 1m) in their backyards.

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Table 2: Estimated costs and returns of *M. montanus* culture.

Costs	For two ponds
Capital cost	
1. Construction of ponds (2 ponds of 30m X 30m X 1.5m each) Rs.10,000 per pond	Rs. 20,000/-
2. Fingerlings 2,500 / Pond	Rs. 5,000/-
Operational Cost	
1. Labour 1,500 per month	Rs. 6,000/4 months
2. Fish Feed 1,500 per month	Rs. 6,000/4 months
3. Fertilisers and Manures	Rs. 3,000/4 months
	Rs. 40,000/-
Income after 4 months	
Fish harvested: 350 kg/pond	700 kg/2 ponds
Fish sale price Rs.130/kg	Rs. 91,000/-
Net income after 4 months (Rs. 91,000-Rs. 40,000)	Rs. 51,000/-
Net income per year (Rs. 51,000 x 3)	Rs. 153,000/-
Net income for every subsequent year (Rs. 91,000-Rs. 20,000 x 3)	Rs. 213,000/-

References

1. Haniffa, M.A. (2004). Native catfish culture – a boon to Indian fish farmers. Aquaculture Asia, IX (3): 21-22.
2. Jayaram,K.C. (1989). The freshwater fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka: A handbook, Zoological Survey of India, Calcutta.
3. Haniffa, M.A., Ananth Kumar, Y., Dhanaraj, M., Muthu Ramakrishnan, C., Sethuramalingam,T.A. and Narayanan, M (2007 a). Seed production of the threatened catfish *Mystus gulio* by artificial fertilization Fishing Chimes 27 (9): 54-57.
4. Haniffa, M.A., (2005). Chapter – 10. Induced Breeding Techniques for Aquaculture. In Chakraborthy, C.C. (ed.) Advances in Biochemistry and Biotechnology Volume I. Daya Publishing House, Delhi , pp 214-224.
5. Haniffa, M.A., Sethuramalingam, T.A., Dhanaraj, M., Muthu Ramakrishnan,C., Ananth Kumar,Y., and Arun Singh,S.V. (2007 b). Breeding and larval rearing of the native Indian catfish *Heteropneustes fossilis*. Infofish International 6: 16-19.
6. IUCN 1996. The conservation of biological diversity: An explanatory guide. International Union for Conservation of Nature. Environmental Law Center of the World Conservation Union.

An assessment on the influence of salinity in the growth of black clam *(Villorita cyprinoides)* in cage in Cochin estuary with a special emphasis on the impact of Thennermukkom salinity barrier

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The growth and survival of molluscs are affected by a wide variety of environmental factors including the seasons, salinity, temperature and sediment. An analysis of the growth of an organism with respect to its environment is important not only for interpreting its adaptation to environmental changes but also to understand the impact of environmental changes on the species.

Longevity and rate of growth are helpful in describing the present status and the past history of a population and to estimate the future course of the fishery. In recent years, considerable emphasis has been given in India to culture edible bivalve molluscs such as oysters, mussels and clams, since they form a subsidiary fishery in most of the coastal and estuarine regions. Though many species of commercially important bivalves occur along the Indian coast, little attention was paid by past researchers on various aspects of growth despite the fact that this field offers a large number of unanswered questions.

Thanneermukkom Bund was constructed in 1974 to prevent salt-water incursion and to permit two crops of paddy in about 50,000 ha of low lying fields in the Kuttanadu area[3]. The bund has been functional since 1976 and remains closed from January to May every year. This has resulted in drastic ecological changes in the lake, particularly south of the bund, affecting the distribution, survival and abundance of the living resources in the estuary, and causing depletion of the black clam in several localities. Dredging conducted in several parts of the estuary has aggravated this problem.

The responses of an aquatic organism to environmental change may vary with the physiological state of the organism. Alterations in growth patterns occur during definite stages of growth and different seasons, because the proportion of energy utilised by the mollusc for different activities may change with time. Hence a thorough knowledge on the growth of bivalve mollusc along with its different life stages and seasons is of interest in the successful exploitation of its fishery potential. Due to the paucity of this information in molluscs in general, and in *Villorita cyprinoides* in particular, an investigation on the influence of salinity on the growth of the black clam was conducted in cages in Cochin estuary, with particular emphasis on the impact of the Thanneermukkom salinity barrier.

Study area

Three sites were selected for cage culture experiments; one on south of Thannermukkom Bund (station II), one on north of the bund (station IV) and another in front of Cochin University Boat Jetty (station V). Regular fortnightly sampling for hydrographical parameters was carried out from stations II, IV and V for one year.

Hydrographic parameters

Among different parameters temperature was measured by ordinary thermometer, salinity by Mohr's titration method[13] and sediment texture by the method proposed by Carver [4].

Cage culture experiments

Age and growth were studied by growing clams of varying length (1-3 cm) for one year in plastic boxes (9.6 x 15 x 5 cm). Four class ranges were selected for this study (1-1.5 cm, 1.5-2 cm, 2-2.5 cm and 2.5-3 cm). Cages in triplicates were arranged at three locations (Station II, IV and V). Each cage was filled with sediment obtained from the location of each clam bed, clams of fixed length were introduced in to each cage and the cages were covered by nylon mesh of 5 mm and placed in the clam bed. Monthly measurements of the clams were taken over the course of one year.

Results

Temperature

Significant variation in temperature at different stations during different seasons was observed in this study. Being a tropical estuarine environment the variation in bottom temperature was similar in trend to that of other tropical estuaries. While comparing stations on either side of bund, the station situated south of the bund (station II) showed frequent fluctuation in temperature. At station II it was between 27°C and 33.5°C and at IV the variation of temperature was between 26°C and 32°C, whereas at station V it was between 28°C and 32°C (Figure 1). At all the stations the minimum temperature was noted during June and maximum during March except at station V. Among three stations, station II showed the highest annual average followed by station V and IV.

Salinity

The first two stations (Station II, IV) had a freshwater dominated environment with measurable salinity occurring only during pre–monsoon. At station V, the ambient salinity

was high except during monsoon (Figure 2). Annual average salinity at stations II, IV and V were 0.29, 1.96 and 17.67 ppt respectively.

Sediment texture

At station II the substratum was always silty sand except in March, April and May. During March it was sandy silt but in April and May it was clayey silt (Figure 3). At station IV the dominant sediment texture was sand and at station V it was clayey silt (Figures 3, 4 and 5). At station IV the annual average value for sand was 97 %, whereas at station V the annual average value for silt and clay was 61 % and 30 % respectively.

Growth of clams in cage

At station II the annual average growth was 8.48 mm (Figure 6). It was noticed that as the size of the clams increased the growth rate decreased. Among different class ranges(1-1.5 cm, 1.5-2 cm, 2-2.5 cm and 2.5-3 cm) of clams introduced in the cage, class range 1-1.5 cm (10.2 mm) showed higher growth rate and class range 2.5-3 cm (7.3 mm) showed lower growth rate. There was a gradual decrease in the growth of clams from February to May in all class ranges.

At station IV the growth rate was comparatively higher, annual average growth rate observed was 15.15 cm (Figure 7). Here also, as the size of clams increased the growth rate decreased. The maximum growth rate observed was for 1-1.5 cm class (16.25 mm) and minimum was for 2.5-3 cm class (13.82 cm). At this station growth was more or less constant during the study period. At station V the growth of clams were low during most of the months with higher ambient salinity (Figure 8). Here the annual average growth of clams were 9.64 mm. Minimum growth was observed for larger clams ie. the 2.5-3 cm class (8.26 mm) and the maximum was for smaller clams ie., 1-1.5 cm (11.19 mm). As in the case of station II, at station V also the growth of the clams were very low during February to May. At stations IV and V, there was a significant difference in annual average growth rate between difference classes, whereas at station II the difference was negligible.

Discussion

Cage culture growth studies revealed that smaller clams grow faster than larger ones. Among the four class ranges (1-1.5 cm, 1.5 – 2 cm, 2 – 2.5 cm and 2.5 – 3 cm) selected for studies at all the stations, class range 1-1.5 cm showed the highest growth rate and class range 2.5 – 3 cm showed the lowest growth rate. Similar observations were made by Rao[9] in *Katelysia opima*, Abraham[1] in *Meretrix casta*, Nayar[7] in *Donax cuneatus*, Alagarswami[2] in *Donax fabe*, Mane[6] in *Katelysia opima* and Rao[10] and Thippeswamy and Joseph[15] in D*onax incarnatus*. Spear and Glud[11] have reported that environment and not heredity that is important in determining the growth of the soft clam *Mya arenaria*. Comparing station II and IV it was observed that the highest growth rate was at station IV rather than station II, and besides that, station II showed a decrease in growth rate from January to May in all class ranges. This may be due to the accumulation of silt and clay at station II during the closure of the bund (December to May). Swan[12] and Pratt[8] reported that linear growth of clams *Mya arenaria* and *Mercenaria mercenaria* was higher in sediment with a sandy texture than a muddy one. Another reason for better growth at station IV compared to station II may be the prevalent typical estuarine environment (saline mixed water) at station IV when compared to that at station II (freshwater). Abraham[1] compared two clam beds at Adyar and concluded that growth of clams is much more rapid in the backwater than in the river. At station IV there was a sharp decrease in the growth of clam from January to May and then it gradually increased. This was due to the higher saline condition that prevailed at that station. According to Talikhedkar *et.,al.*[14], in tropical waters, changes in temperature are relatively small and the importance of salinity as an important influence the growth of bivalves is greater. Durve[5] reported that the retardation of growth may perhaps be attributed in some way to the increase in salinity in the ambient environment especially during summer months.

In conclusion, the existence and periodical opening and closure of Thanneermukkom bund has a significant impact on the ecology of black clam beds and may threaten the very existence of clams in the estuary. The bund management should give appropriate consideration to the impact of the bund to maintain the ecology of clam beds and clam fishery of this estuary.

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References

1. Abraham, K.C. (1953). Observations on the biology of Meretrix casta (Chemnitz). Journal of Zoological Society of. India, 5:163-190.
2. Alagarswami, K. (1966). Studies on some aspects of the biology of the wedge clam Donax faba (Gmelin) from the Mandapam coast in the gulf of Mannar. Joural of Marine Biological Association of India 8: 56-75.
3. Arun, A.U. (2005). Impact of artificial structures on biodiversity of Estuaries: A case study from Cochin Estuary with emphasis on clam beds. Applied Ecology and Environmental Research 4(1): 99-110.
4. Carver, R.E. (1971). Procedure in Sedimentary petrology. Willey, New York, 653pp.
5. Durve, V.S. (1970). On the growth of the clam *Meretrix casta* (Chemnitz) from the marine fish farm. Journal of Marine Biological Association of India 12 (1&2): 125-135.
6. Mane, U.H. (1974). Growth and breeding habits of the clam *Katelysia opima* in the Kalbadevi estuary at Ratnagiri. Indian Journal of Fisheries 21: 386-398.
7. Nayar, K.N. (1955). Studies on the growth of the wedge clam, *Donax (Lantona) cuneatus* Linnaeus. Indian Journal of Fisheries 2: 325–348.
8. Pratt, D.M. (1953). Abundance and growth of *Venus mercenaria* and *Callocardia morrhuana* in relation to the character of bottom sediments. Journal of Marine Research 2: 60-74.
9. Rao, K.V. (1951). Studies on the growth of *Katelysia opima* (Gemlin). Proceedings Indo-Pacific Fisheries Council Sec. II: 94-102.
10. Rao, G.S. (1988). Biology of *Meretrix casta* (Chemnitz) and *Paphia malabarica* from Mulky Estuary, Dakshina Kannada. Proceedings of the National seminar on Shellfish Resources and Farming, Tuticorin, India. Bulletin of the Central Marine Fisheries Research Institute 42: 148-153.
11. Spear, H.S. and Glude, J.B. (1957). Effects of environment and heredity on growth of the soft clam (*Mya arenaria*). Fishery Bulletin of United States 57(114): 279-292.

12. Strickland, J.D.H. and Parsons, T.R. (1968). A manual of seawater analysis. Bulletin No. 167 (Fishery Research Board Canada).
12. Swan, E.F. (1953). The effect of substratum on the growth rate, shell-weight and shape of *Mya arenaria*. Fourth annual conference on clam research, U. S. Fish and Wildlife Serv. Boothbay Harbour. Marine: 43-46.
14. Thalikedkar, P.M., Mane, U.H. and Nagabhushanam, R. (1976). Growth rate of the wedge clam, *Donax cuneatus*, at Mirgabay, Ratnagiri. Indian Journal of Fisheries 23(1-2): 183-193.
15. Thippeswamy, S. and Joseph Mohan, M. (1991). Population selection strategies in the wedge clam, *Donax incarnates* (Gmelin) from Panambar Beach, Mangalore. Indian journal Marine Sciences 20: 147-151.

Figure 1. Variation in temperature in station II, IV and V

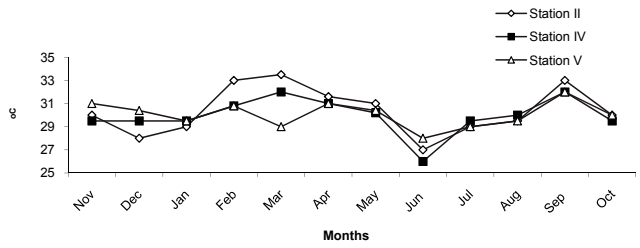


Figure 2. Variation in salinity in station II, IV and IV

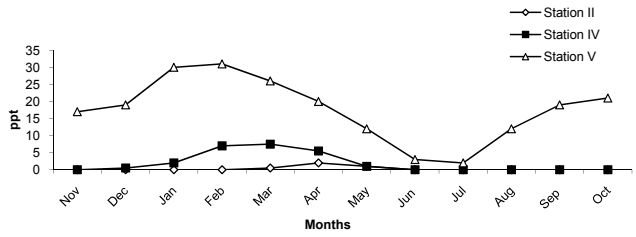


Figure 3. Variation in percentage of sand in station II, IV and V.

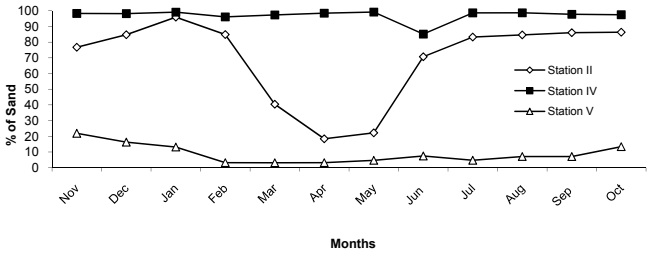


Figure 4. Variation in percentage of silt in station II, IV and V

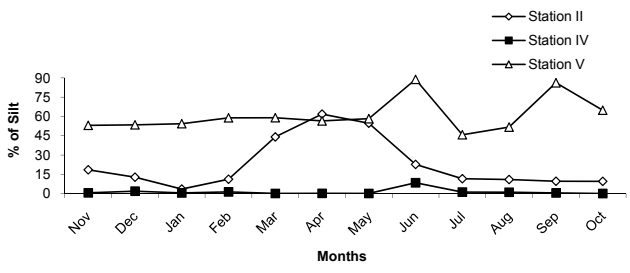


Figure 5. Variation in percentage of clay in station II, IV and V

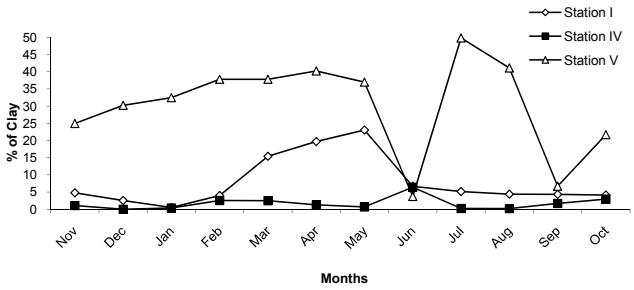


Figure 6. Growth in cage at station II

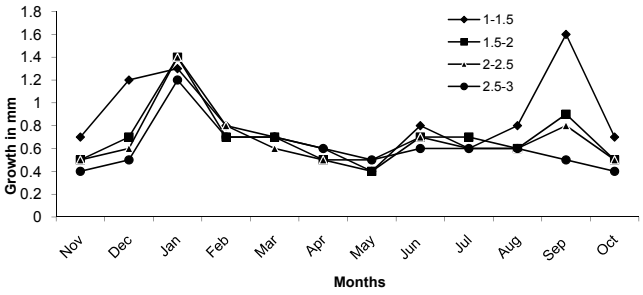


Figure 7. Growth in cage at station IV

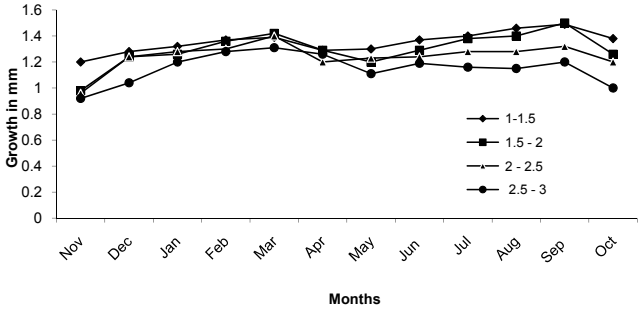
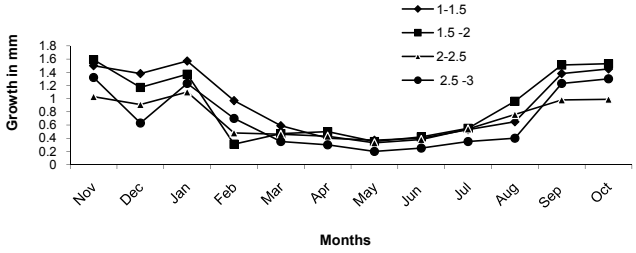


Figure 8. Growth in cage at station V



EUS in Asia and Africa: stimulus for regional initiatives!!!

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Trans-boundary movement of live aquatic animals (international trade) always carries a risk of transferring aquatic animal pathogens. Responsible introductions, compliance to regional and international standards and codes and informed decision making based on scientific risk analysis are some of the tools available to minimise the risks of pathogen introductions associated with the international trade in live aquatic animals.

Since 1970, an epizootic condition of wild and farmed fishes, characterised by ulceration, invasive fungal infections and high mortality has been reported from different parts of the world. These epizootics caused heavy losses when they first occurred and spread rapidly often across long distances. In Japan, the epizootic ulcerative condition was found for the first time in cultured ayu, *Plecoglossus altivelis* in 1971 and the disease was named as mycotic granulomatosis (MG). In Australia, the cutaneous ulcerative condition called red spot disease (RSD) affected estuarine fish, grey mullet in 1972 and later progressed to affect freshwater and other estuarine fish in coastal waters. In 1979, Malaysia became the first country in Peninsular south east Asia to report a serious ulcerative condition. This same disease first appeared in 1981 in the southern part of Thailand and later spread to central part in 1982 and became most significant epizootic in Thailand. Between 1981 and 1988, the disease spread to most of the countries in south east and south Asia. In Asia the disease was named epizootic ulcerative syndrome (EUS). The country to be affected most recently in Asia by EUS was Pakistan where EUS was confirmed in snakeheads from the Punjab province in 1996 and in *mrigal Cirrhinus mrigala* from Sindh province in January 1998. In the United States, similar ulcerative lesions, designated as ulcerative mycosis (UM) have occurred in estuarine fishes along the east coast since 1978. The disease has been given various colloquial names but is most commonly known as mycotic granulomatosis (MG) in Japan, red spot disease (RSD) in Australia, epizootic ulcerative syndrome (EUS) in south east Asia and ulcerative mycosis (UM) in USA. It is now generally accepted that EUS is the same disease as MG, RSD and UM. EUS is caused by an infection of a primary fungal pathogen, *Aphanomyces invadans (= A.piscicida)*.

Since late 2006, fish with clinical signs similar to that of EUS were found in several locations of Zambezi river system, in Africa. Following a request from the Government of Botswana to FAO, a joint mission involving scientists from FAO, AAHRI (Aquatic Animal Health Research Institute of Thailand) and NACA was undertaken during May 2007 to provide emergency technical assistance to assess the present situation and advise on future preventative and control measures. The team made field visits in Kasane, Botswana and specimens and tissue samples were collected from fish in Chobe-Zambezi river system. The preliminary histopathological investigations of the tissue samples from infected fish collected in Chobe River, Kasane, Botswana confirmed that the disease in question is EUS, caused by an infection of a primary fungal pathogen. Histopathology of muscle tissues from dashtail barb (*Barbus poechii*)

showed clear mycotic granulomas penetrating from the skin (epidermis and dermis) to the muscle layer, typical of fish infected with EUS. Confirmation of mycotic granulomas in histological sections of affected tissues and organs, using special stains such as Grocott's silver stain for fungal hyphae, is one of three OIE recommended EUS confirmatory methods. The confirmation by internationally accepted diagnostic procedures of EUS in the Chobe-Zambezi river system is the first confirmed case of this serious fish disease in the African region which has grave implications for the fisheries of the Chobe-Zambezi river system and the livelihoods of many people dependant on these fisheries. The risks to other fisheries through wider spread beyond the Chobe-Zambezi river system are also significant.

EUS in Asia was largely responsible for stimulating national, regional and international efforts aimed at developing and implementing national and regional aquatic animal health strategies. In 1998, the Food and Agriculture Organization of the United Nations (FAO) launched a Technical Cooperation Programme (TCP) Project "Assistance for the Responsible Movement of Live Aquatic Animals". This project addressed issues concerning trans-boundary pathogen transfer, with the view to build capacity in the Asia region on responsible movement of live aquatic animals. It was implemented by NACA with the participation of 21 countries in Asia. Under the project, 21 governments in the Asian Region adopted the guiding principles in the FAO/NACA *"Asia Regional Technical Guidelines on Health Management and the Responsible Movement of Live Aquatic Animals"* (or the "Technical Guidelines") and their associated implementation plan, "the Beijing Consensus and Implementation Strategy".

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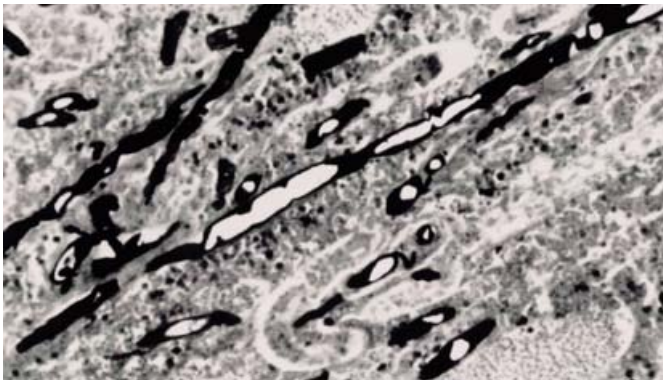

MARINE FINFISH AQUACULTURE NETWORK

Offshore opportunities for artisanal aquaculture

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Traditional cage aquaculture utilising basic floating net structures in protected coastal environments has long been a fundamental means of raising fish for the Asia-Pacific region. While this approach has provided success, it is also due for reassessment and improvement as near shore production sites become crowded and polluted and new technologies emerge that stand to benefit both the environment and fish farmers.

Development of open ocean aquaculture has created opportunities to transfer and apply new technologies to established production methods. While commercial scale open ocean aquaculture operations are capital intensive and not realistic for the average family farmer, a strong argument can be made for the feasibility of using small submersible net pens designed for exposed conditions in artisanal applications by apply in low volume high density (LVHD) production methods. Two such examples of this equipment are the OCAT pen designed by the United Soy Board and Micropods engineered and produced by Ocean Farm Technologies, Inc.

With large scale aquaculture applications it is a common assumption that bigger net pens are better based on the decreasing cost per unit of volume of larger net pens. Yet this assumption can only be validated when stocking densities remain fixed regardless of the size of the net pen. Upon further analysis one can conclude that smaller net pens suitable for artisanal production are capable of higher stocking densities under appropriate conditions.

The concept of LVHD aquaculture is well established and based on the fact that in open water production systems, smaller pens maximise the exchange of water per unit of volume when compared with larger pens. Essentially smaller pens have more surface area in relation to their production space than big pens. This means that the number of fish metabolising between the clean water source and interior space is minimised. Under these circumstances environmental conditions in the pen are optimised and allow for higher stocking densities than might be reasonable in larger cages which have slower water exchange rates. This improves the economic feasibility of small scale operations for artisanal farmers.

Yet this concept can only be fully realised when smaller net pens are placed in exposed sites with ample current and depths. Until recently this has not been feasible because traditional pens are not designed for this environment. By utilising small scale versions of fixed volume offshore pens such as those previously mentioned, one can address many of the challenges faced by traditional surface pens situated in protected bays and waterways.

Three Micropods of various sizes waiting to be positioned in Puerto Lindo, Panama.

First and foremost environmental impacts can be reduced when pens are placed in water with both reasonable depths and currents. These conditions improve the distribution of pen effluent and allow the surrounding environment to better assimilate it. Naturally a reduction in concentrated waste accumulation benefits the local ecosystem and minimises the likelihood for disease outbreaks at the farm site. In turn the high water exchange rate at exposed sites provides ideal dissolved oxygen levels inside the cage and rapidly flushes away metabolic wastes benefiting the crop.

Relocating operations further from shore eliminates common use conflicts in crowded regions where demand for water space can be high. In addition to providing a better natural environment for the culture of crops, moving offshore reduces exposure to coastal pollution sources. Contact with runoff and direct contamination from land can be minimised with exposed site conditions.

Storm damage and subsequent crop loss is also an issue in near shore production areas where typhoons can devastate surface pens. Available OOA equipment offers solutions to these challenges. This is because wave energy decreases substantially with increasing depth. Submersion of pens prior to storms reduces the energy levels and the associated risks which the equipment is exposed to. Moorings can also be designed to provide self-submersion in storm surges.

Predators are another consistent challenge faced in all types of aquaculture operations and typical netting materials are often inadequate at preventing persistent intrusion attempts.

The application of vinyl coated steel wire mesh to the rigid frame of Micropods eliminates the threat of crop damage or loss posed by predators whether it is at or below the surface.

One must also consider the distribution of risk when working with smaller pens. The opportunity for total crop loss is diversified when multiple pens are used. The total risk posed by disease, damage to equipment and subsequent escape opportunities are all reduced when an entire crop is distributed in multiple pens.

Of course the requirements for any new equipment must not exceed the reasonable capacities of current farmers if such a transition is to occur. First the pens must be of a reasonable size that makes management by an individual or small crew easy. Existing boats should be sufficient to service them and if necessary tow them from one location to another. Routine operations also must require minimal equipment so that a barrier for entry is not created.

In the case of Micropods which have diameters of 10m or less, raising and lowering of the pen from the surface can be accomplished with a hand operated winch and all feeding, harvesting and repairs can be conducted near the surface by rotating the pen. This permits users to work almost exclusively from the surface. Diving requirements on pens of this size are mostly restricted to mooring inspection and maintenance and a simple hookah apparatus should be sufficient for most applications. The OCAT pen design also facilitates work from the surface.

Micropods are easily cleaned by rotating portions of the pen at the surface for drying. If appropriate, cleaning with a portable pressure washer can greatly accelerate the speed and ease at which fouling can be removed. According to the Soybean Industry's engineering manual the application of antifouling paint to the OCAT pen proved valuable in minimising the cleaning required.

Assembly of Micropods is relatively simple, can be accomplished in less than a day by a small crew and once completed can be rolled from a beach into the water, eliminating the need for docks or other major infrastructure elements that may be difficult or expensive to come by in some regions.

Local residents roll a Micropod off the beach.

Most submersible pens can be moored with a simple single point mooring system. In this configuration the pens swing freely in a watch circle with the prevailing current. These are the simplest systems to deploy as well as the most economical. Additionally, the larger site footprint created by a single point mooring further reduces the potential for concentrated waste deposition.

The benefits to moving production away from protected waterways to exposed ocean sites are clear and the time has arrived where such a move is not only feasible but it is reasonable. Adaptation and acceptance by established entities will take time and the initial steps may require the assistance and collaboration of government or NGO organisations to realise this. This new platform may also provide a means for artisanal fishermen to convert to aquaculture, especially because they are adapt at working at sea. Just as commercial scale aquaculture begins to accept the advantages and necessities of placing production in exposed open ocean sites, small scale artisanal farmers will likely draw the same conclusions. Until this transition begins the best interests of both the fish farmer and the environment cannot be realised.

Reference

Cremer, M.C., Lan, H.P., Chappell, J. (2008). Engineering Manual: Soybean Industry OCAT Offshore Ocean Fish Culture Cage.

EUS...from page 28.

The project created a strong Regional Aquatic Animal Health Programme in Asia. Within Asia, the Technical Guidelines provide the basic Biosecurity framework and guidance for national and regional efforts in reducing the risks of diseases due to trans-boundary movement of live aquatic animals. Since 2000, supporting the implementation of the key elements of the technical guidelines has remained the focus of NACA's regional aquatic animal health programme. EUS in Africa has succeeded in focusing the attention of policy makers and researchers on issues of risks associated with movement of live aquatic animals and the need for effective national and regional aquatic animal health management strategies. Recognising the serious consequences of EUS, several southern African countries have now come together and taken preliminary steps to address the issue of aquatic animal disease management. In response to requests of FAO member governments for technical assistance, a regional Technical Cooperation Project *Emergency assistance to combat EUS in the Chobe-Zambezi River* has recently been approved by FAO for implementation. This regional project in operation since October 2007 is being participated by seven southern African countries (Angola, Botswana, Malawi, Mozambique, Namibia, Zambia and Zimbabwe). Several activities including capacity building, surveillance and disease reporting are being held as part of this project with the long term objective of developing and implementing an effective aquatic animal health management programme for southern Africa. NACA's regional aquatic animal health program executed in close partnership with FAO of the United Nations and the Office International des Epizooties (World Organisation for Animal Health), could serve as useful model for development and implementation of a possible future regional aquatic animal health programme in Southern Africa.

Grouper culture in Brazil

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In Brazil, mariculture is a well developed activity, with farming focused largely on shrimp, clams, oysters and mussel culture. Brazilian shrimp culture is represented by *Penaeus vannamei* farming in more than 16,000 hectares and malacoculture by *Perna perna, Crassostrea gigas, Crassostrea rizophorae* and *Nodipecten nodosus* farming.

Dusky grouper (Epinephelus marginatus).

The first investigations on marine fishes in Brazil were conducted in the middle 1970s by researchers from Universidade Federal de Pernambuco studying mullets *(Mugil liza)*[1]. Investigations on the dusky grouper *(Epinephelus marginatus)* began in 1980, by Eduardo Fagundes Netto and Daniel Benetti, researchers from the Instituto de Pesquisas da Marinha, in Arraial do Cabo[2]. Nowadays, many institutions maintain research groups studying marine fish species suitable for farming, including the Instituto de Pesca, Universidade Federal de Santa Catarina, Fundação Universidade do Rio Grande and the Universidade Federal do Ceará.

The most studied species in Brazil are the snook *(Centropomus parallelus* and *C. undecimalis)*, the flounder *(Paralichthys orbigyanus),* the groupers *(Epinephelus marginatus* and *Mycteroperca microlepis)* and the snappers *(Lutjanus synagris* and *L. analis)*. For many reasons, the activity had a low profile for many years, but at present marine fish farming is facing a big expansion, particularly with enterprises dedicated to cobia *(Rachycentron canadum)* farming.

Many grouper species are considered to have a high potential for farming and are threatened in the wild due to overfishing and destruction of coastal environments. The most commonly encountered species that occur in Brazil[3] are: *Epinephelus marginatus* (Lowe, 1834), *Epinephelus morio* (Valencciennes, 1828), *Ephinephelus niveatus* (Valenciennes, 1828), *Epinephelus flavolimbatus* (Poey, 1865), *Ephinephelus itajara* (Lichtenstein, 1822), *Epinephelus adscensionis* (Osbeck, 1765), *Epinephelus striatus* (Bloch, 1792), *Epinephelus nigritus* (Holbrook, 1855), *Epinephelus mystacinus* (Poey, 1852), *Epinephelus guttatus* (Linnaeus, 1758), *Epinephelus drummondhayi* (Goode & Bean, 1879), *Mycteroperca acutirostris* (Valenciennes, 1828), *Mycteroperca microlepis* (Goode & Bean, 1880), *Mycteroperca interstitialis* (Poey, 1860), *Mycteroperca tigris* (Valenciennes, 1833), *Mycteroperca bonaci* (Poey, 1860) and *Mycteroperca venenosa* (Linnaeus, 1758).

Giant grouper (Epinephelus itajara).

Among these, outstanding species include the dusky grouper *(Epinephelus marginatus)*, printed on the Brazilian one hundred reais bill, black grouper *(Mycteroperca bonaci)*, gag grouper *(Mycteroperca microlepis)* and the giant grouper *(Epinephelus itajara)*, the largest species in the genus, reaching more than three hundred kilograms.

Conservation

The reduction of some of Brazilian grouper populations reinforces the concept of developing economically feasible, environmentally sustainable and socially responsible options to reduce the extractive pressure on the fishing stocks. In that sense, the development of marine fish culture of these endangered species may represent a strategic implement for conservation, reducing wild capture as cultivated fish is offered, making restocking possible. One measure that may contribute to this is the implementation of a semen bank for such species.

Considering the occurrence of many species of serranids in Brazil and the situation of their stocks, their economic importance and the possibility of generating rearing technology for these species, the Instituto de Pesca has conducted studies upon the culture of these fishes since 2005. This work, known as Serranidae Project, is conducted in Ubatuba, Brazil, and has brought important advances in serranid culture. The employed system is “near shore” in 8 m³ net cages and fishes are fed with trash fish. After twelve months rearing dusky grouper present a mean weight of 1.0 to 1.2 kg and giant grouper after only ninety days presented a mean weight of 1.3 kg.

The project has demonstrated that grouper farming in net cages has an internal rate of return of 15.05% to 36.74% for two selling prices (US$ 7 and US$ 9), is economically feasible and possible to be conducted by small scale undertakings and artisanal fishermen.

Reproduction of dusky grouper.

Although showing aptitude for farming, the reproduction of serranids has a great complexity due to a curious characteristic. The members of the sub-family Epinephelinae are protoginic hermaphrodites, what means that they initially mature as females and in a given moment of their growth have a definitive sexual reversion, becoming males. With that complex reproductive strategy, to obtain males for the reproduction in captivity is a problem. To

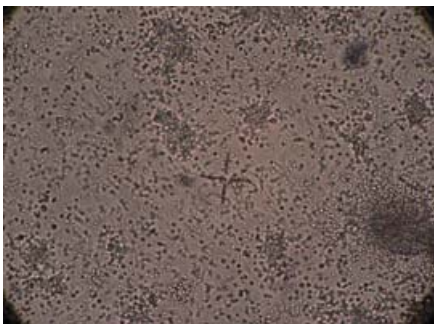
Semen collection from dusky grouper.

get males in the natural environment is very difficult for many reasons: they are rare (serranids form harems with few males and many females), they are big fishes (difficult to manage) and normally occur in depths of more than 30 meters, making capture difficult and with a low survival rate.

An alternative for this question, already shown by many authors, is the sex inversion in captivity, using masculine hormones. This treatment provokes the development of testes, but six months after interrupting the administration of androgens, the fishes return to their initial condition of females, making the process laborious and expensive. Even being an interesting strategy, few studies have focused on the importance of semen cryopreservation of this fishes. Cryopreservation and stockage of the semen of fishes submitted to sexual reversion may reduce the complexity of the process, lowering difficulties and costs to obtain males for reproduction of serranids.

Recently, the researchers of Serranidae Project succeeded, for the first time in Brazil, to obtain and cryopreserved semen of the dusky grouper, defining a protocol of cryopreservation and formation of a bank of semen, which resulted of the first fishes gotten from stocked semen. Cryopreservation also made unnecessary the constant processes of sexual reversion to obtain males. The creation of a bank of semen of many serranid species may also provide an important implement for conservation and commercial production of these species, contributing to conservation of these fishes for the future generations.

Considering the history of Brazilian marine fish culture, the bank of semen contributed decisively for the success of the reproduction of the dusky grouper in captivity, making possible the first commercial production of juveniles from these species in Brazil. Presently, the reproduction of other serranids such as gag grouper, black grouper and jewfish is already in course.



Dusky grouper semen (400 X).

The process of semen cryopreservation

The process begins with the sex inversion of females. As soon as that is completed the collection of semen starts. It is extracted individually from each specimen, after a soft pressure on the abdomen, being collected with the help of a plastic syringe, which aids to avoid the accidental contamination with blood and urine. The semen is then analysed in its qualitative aspects, determining parameters of sperm mobility (percentage of cells with movement in the sample), time of sperm mobility (durability of cell movement, in seconds) and sperm concentration (number of cells/ml of semen).

Only semen with sperm mobility higher than 90% is utilised for freezing. The semen is mixed with an extender

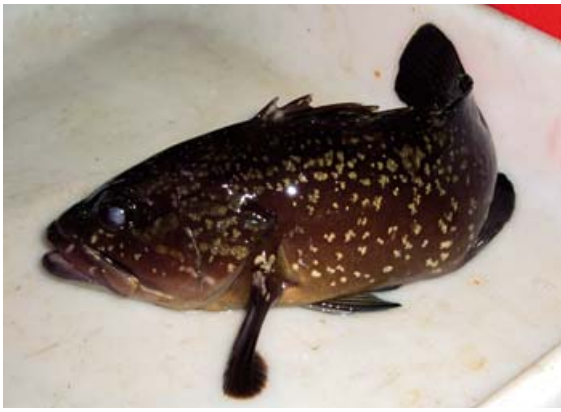
Dusky grouper fingerlings.

and a cryoprotector and is frozen in nitrogen vapor using cryogenic slats, and subsequently transferred to liquid nitrogen for long term storage (-196°C).

When it is intended to use the semen in the reproductive process, the cryogenic slats are thawed in water (26°C) for 2-3 minutes, sperm mobility and time of mobility are checked and then the sperm are used utilised in the fertilisation of the ovocites.

References

1. Brugger, A. Piscicultura marinha. Panorama da Aqüicultura, v.5, n.28, p. 6-11, 1995.
2. Fagundes Netto, E.B.; Benetti, D.D. Noções sobre o crescimento e perspectivas de cultivo da garoupa-verdadeira (*Epinephelus guaza*, Linnaeus, 1758) Pisces, Serranidae. Anais Simpósio Brasileiro Aqüicultura III. São Carlos/SP, p.453, 1984.
3. Rocha, L.O.F.; Costa, P.A.S. Manual de identificação de peixes marinhos para a costa central. REVIZEE. UNE-RIO. Rio de Janeiro. 1999. 230p.
4. Sanches, E.G.; Henriques, M.B.; Fagundes, L. Viabilidade econômica do cultivo da garoupa verdadeira *(Epinephelus marginatus)* em tanques-rede, região Sudeste do Brasil. Informações Econômicas, n. 36, v. 8, p. 15-25, 2006.



Dusky grouper juvenile.

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Lao PDR becomes the 18th member of NACA at the 20th GCM

Participants in the 20th NACA Governing Council Meeting.

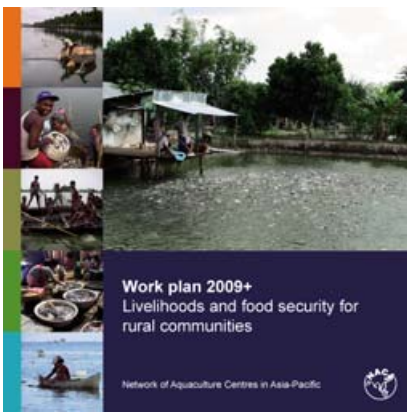
We are pleased to announce that the government of Lao PDR became the 18th member government of NACA, following the endorsement of its application by the NACA Governing Council at its 20th meeting, held 13-16 May 2009 in Xiamen, Fujiang Province, PR China.

Member governments and the Secretariat welcomed Lao PDR to the network and expressed a desire to work closely with Lao PDR in its development efforts on sustainable aquaculture, and to contribute to the food security and livelihoods of its people through sustainable aquaculture development.

Lao PDR has a long history of collaborating with NACA and is presently host to an ACIAR-funded project on *Culture-based fisheries in Lao PDR*. The primary objective of the project is to develop applied production models to optimise yields from culture based fisheries practices in flood plain depressions and reservoir coves, implemented through village community participation in two provinces. More information about this project is available from the project webpage, http://www.enaca.org/modules/inlandprojects/index.php?content_id=2.

The Governing Council also endorsed the new NACA Workplan for 2009 onwards, entitled "Livelihoods and food security for rural communities". The workplan contains several new programmes to address the changing priorities and emerging issues in the region. These include: Emerging Global Issues, which will address climate change and other international concerns; Food Safety and Quality, which will help farmers address increasingly stringent food safety and trade regulations, and Coastal Aquaculture, which will incorporate both the Asia-Pacific Marine Finfish Aquaculture Network and the Shrimp Farming and the Environment Programme.

You can view the new NACA workplan on the website or download a copy in PDF format from: http://www.enaca.org/content.php?page=workplan_2009.



Vietnamese catfish farmers visit Andhra Pradesh, India

International farmer to farmer interactions for the exchange of technical information don't happen often due to the substantial cultural, language and geographic impediments that are usually involved. However, there can be considerable value in bringing farmers together to share their experience and solutions to common problems.

NACA recently facilitated a visit to India by a group of Vietnamese catfish farmers, so that they might observe the operation of collaborative shrimp farmer societies. The small-scale shrimp farmers of Andhra Pradesh have set a world example in their adoption of better farm management practices and coordination of cropping activities, based on clusters of nearby farms. Through mutual support and leveraging the market power of the group, small-scale farmers have been able to significantly improve crop outcomes, profitability and their livelihoods in an increasingly competitive international environment. The visit took place from 27 May to 3 June.

Cultural differences were no barrier to sharing experience.

The Vietnamese farmers were drawn from the four main provinces of catfish farming in the Mekong Delta, also joined by four provincial extension officers, and researchers from Can Tho University and the Research Institute of Aquaculture No. 2, Ho Chi Minh University, and two representatives from NACA, totalling 16 people. The exchange was undertaken under the auspices of the project Development of Better Management Practices for Catfish Aquaculture in the Mekong Delta, Vietnam, funded by the AusAID CARD Programme.

The shrimp farmer associations in Andhra Pradesh began as part of an initiative to reduce the impact of shrimp disease through the implementation of better management practices in small-scale farming clusters. The initiative was established under a cooperative program between the Marine Products Export Development Authority of India and NACA. As participating farmers began to realise greatly improved crop outcomes, market power and profitability the word spread, with farmers from adjacent clusters and villages forming their own associations and adopting better management practices. Over the last few years this has brought about a revival of small scale tiger shrimp farming in Andhra Pradesh and other coastal states of India. It has also lead to policy and institutional change within India, culminating in the formation of the National Centre for Sustainable Aquaculture (NaCSA).

The Vietnamese farmers visited the Chinavasala Aqua Famers Welfare Society (consisting of five Aqua Farmer Welfare Societies with a total of 84 farmers), the Venketawara Aqua Farmers Welfare Society (a well knit unit with 25 farmers), a contract hatchery (certified by NaCSA from which the BMP farmers purchase certified seed stocks) and participated at the field day of the Lakshmi Narasima Aquafarmers Welfare Society, which was attended by over 500 small scale shrimp farmers who are adopting BMPs, and the Nellore Shrimp Farmers Association. The Vietnamese farmers discussed the operation, management and benefits of the associations, including:

- The uniform manner in which farm records are kept.
- How the information is gathered on a collective basis.
- The advantages of forming associations in gaining higher productivity, reducing cost of operations, improving accessibility to lucrative niche markets, accessibility to government, banks and other interested agencies that wish to contribute to rural development, and in helping to generate synergies within the community, and most of all attain sustainability.

The Vietnamese farmers continued to compare and contrast their own situation with the way farmers were collaborating in Andhra Pradesh. By the end of the visit they had concluded that working in collective units offered great advantages to small scale farmers compared to working alone, and were convinced of the need to establish similar cluster-based management approaches for farmers in Vietnam. They were also convinced of the importance of developing better management practices for the Vietnamese catfish industry, which will improve the dialogue to finalise draft practices being developed under the project, in early October.

Vietnamese farmers presenting a gift to their Indian counterparts.

Vietnamese delegation and Indian counterparts together with NaCSA and NACA staff.

It was also very evident that cultural differences do not have to be a barrier to communication between small scale farmers; it was done very effectively in this instance with three way translation (Vietnamese into English into Telugu and vice versa), and the effectiveness was always evident from the hundreds of questions that the Vietnamese farmers had.

All in all this was a major step forward which NACA will try to emulate under similar circumstances. Logistically it was not an easy matter to handle but NACA was fortunate to enjoy excellent cooperation from the Indian farmers and authorities, who took care of every detail. NACA would like to express thanks to the NaCSA CEO and his staff for their excellent arrangements.

Further reading

Umesh, N.R. (2007). Development and adoption of BMPs by self-help farmer groups. Aquaculture Asia XII, 8-10.

Umesh, R.N., Chandra Mohan, A.B., Ravibabu, G., Padiyar, P.A., Phillips, M.J., Mohan, C.V., Vishnu Bhat, B. (in press). Implementation of better management practices by empowering small-scale farmers through a cluster-based approach: the case of shrimp farmers in India. In: De Silva, S.S., Davy, F.B. (Eds.), Success Stories in Asian Aquaculture. Springer and IDRC, Canada, pp. 43-65.

The Success Stories in Asian Aquaculture book will be available for free download from the NACA website in the near future.

Global Conference on Aquaculture 2010

9-12 June, Bangkok, Thailand

In 1976, FAO held the first ever global conference on aquaculture, the Kyoto Conference, which explored opportunities for aquaculture development and triggered the recognition of aquaculture as a significant food production sector. Ten years after the millennium conference, with aquaculture now providing nearly 50% of global food fish supplies, FAO in partnership with NACA and the Thai Department of Fisheries, are organising the Global Conference on Aquaculture 2010, to evaluate where the sector stands today and face the challenges and opportunities ahead.

Plenary lectures together with six regional reviews and one global synthesis will set the scene for six thematic sessions and associated expert panel discussions on key aspects of aquaculture development and management in the coming decades. The conference will provide a global forum to build consensus to advance sustainable aquaculture development and contribute to the Millennium Development Goals. Have your say on the future of aquaculture development: Join us in Bangkok from 9-12 June 2010. For more information, visit:

http://www.aqua-conference2010.org/

Expert Meeting on the Use & Exchange of Aquatic Genetic Resources

Until late in the last century, genetic resources had largely been considered the common heritage of mankind, available to all. This view began to change in the latter half of the 20th century as issues surrounding intellectual property rights as well as access and benefit sharing arrangements have gained prominence, beginning with the establishment of the *Convention for the Protection of New Varieties of Plants in 1961*.

Participations in the expert consultation

An international framework for regulation of genetic resources has gradually evolved since. Major milestones include the establishment of the FAO Commission on Genetic Resources (CGRFA) in 1983, initially as the Commission on Plant Genetic Resources; the *Convention on Biological Diversity* in 1992; the *WTO Agreement on Trade-Related Aspects of Intellectual Property* (TRIPS) in 1994 and the *International Treaty on Plant Genetic Resources for Food and Agriculture* in 2004. All of these agreements have had significant impacts on the use and exchange of genetic resources for agriculture, and consequently have important implications for food security, poverty alleviation and agricultural research. The international framework for regulating genetic resources is still evolving rapidly, with many issues still under discussion, particularly with regards to access and benefit sharing arrangements.

While the international framework for regulation of plant genetic resources is well developed, at least for agricultural plants, arrangements for aquaculture are in their infancy, the latter sector being included in the portfolio of the CGRFA only in 2007. The heavy dependence of aquaculture on wild genetic resources distinguishes it from other agricultural sectors that are mainly reliant on domesticated strains. However, the *Convention for Biological Diversity* has firmly drawn wild genetic resources into the international debate and there is now a need to develop arrangements for the aquaculture sector as well.

To address these issues the CGRFA through the Aquaculture Management and Conservation Service (FIMA) of the FAO Fisheries and Aquaculture Department and NACA convened an Expert Meeting on the Use and Exchange of Genetic Resources Relevant for Food and Agriculture in Chonburi, Thailand, 31 March – 2 April 2009. The preparatory work for the meeting was coordinated by Dr. Thuy Nguyen, Coordinator, Genetics and Biodiversity Work Program of NACA in conjunction with Dr. Matthias Halwart, FIMA, FAO. The workshop was attended by 17 persons including scientists and government officers with a broad range of expertise in different areas of aquatic genetic resources including finfish, molluscs and crustaceans, as well as law and public policy. The purpose was to:

- Review the state of the use and patterns of exchange of genetic resources of important aquaculture commodities, including penaeid shrimps, Nile tilapia, oysters, common carp, salmon, Clarias catfish, and newly emerging aquaculture species.

- Develop a framework for a synthesis document on the use and patterns of exchange of aquatic genetic resources, to be submitted to the next Regular Session of the CGRFA scheduled for October 2009.

- Discuss and develop strategic plans including suggested future directions with regard to issues of access and benefit sharing (ABS) in aquatic genetic resources.

The consultation was conducted in a 'write shop' format. Selected participants prepared review papers on the use and exchange of the major aquaculture commodities highlighted above, which were presented for critique and further development. The final papers will be published in a forthcoming issue of the new peer-reviewed journal Reviews in Aquaculture.

The consultation also began work on a synthesis document, drawing together the patterns of use and exchange of aquatic genetic resources and the role of these processes in aquaculture development globally. The synthesis will be presented to the Twelfth Regular Session of CGRFA in Rome, October 2009. FAO has also commissioned background studies on use and exchange of genetic resources in other sectors related to food and agriculture. Together these studies will facilitate the Commission's consideration of how systems for access and benefit sharing in genetic resources could work, and planning for the inclusion of aquatic genetic resources in the Commission's Multi-year Programme of Work.

It was of interest to note that the common carp was most probably the most domesticated species in aquaculture with many hybrids and strains produced across the world and it still continues to be one of the major cultured species. In fact, its origin is difficult to trace with a suggestion of an Asian origin in the Amur River and Lake Biwa (Japan) and an Eastern European origin. In most ways common carp can be equated to rice which makes it the "rice of water". NACA and its partners will continue to develop various follow up strategies and readers should stay tuned to the NACA website for more information on this important topic.

Training course in the application of business management skills in small-scale farming

NACA has taken the initiative to develop and deliver a short course in business management principles and practices for small scale aquaculture in partnership with the United Nations University, Fisheries Training program (UNU-FTP) and the Faculty of Aquaculture, Nha Trang University, Vietnam.

The importance of small scale aquaculture in Asia has grown rapidly and it now accounts for more than 90 percent of the world production. This has happened without the explicit application of principles of business management and planning. With increasing demand on the primary resources used and increasing prices of the inputs such as feed in aquaculture, there is a need for small scale farmers to be trained in business management if they are to remain economically viable and sustainable. Formal training and extension activities in aquaculture tend to focus on biological and technological aspects as skills and knowledge in the establishment and management of businesses are rarely included in tertiary curricula of regional fisheries and aquaculture teaching institutions.

In the context of globalisation and breaking down of barriers between small - and large scale enterprises, as well as cultured low valued species gaining increasing export market share, such as in the case of the striped catfish *(Pangasianodon hypophthalmus)* from Vietnam and rohu *(Labeo rohita)* from Myanmar there is an urgent need for business management skills to be developed in aquaculture, amongst small scale practitioners and trainers.

The United Nations University - Fisheries Training program (UNU-FTP) has thus far concentrated on fisheries management. Recognising the importance of aquaculture as an important contributor to food fish production and livelihoods, particularly in developing countries, the program has begun to address these aspects. In this regard the UNU-FTP expertise on business management and its fisheries related experiences could be harmonised and utilised to meet the needs of the small scale aquaculture farming systems in developing countries, and the first steps in this direction were undertaken through discussions with NACA.

A course development workshop was held at the Faculty of Aquaculture, University of Nha Trang, Vietnam, 15th to 22nd of October 2008 discuss the target group and design of the course, outline the content, budget and implementation schedule. Based on the recommendations of the above workshop (workshop report available elsewhere) and further deliberations between NACA, UNU-FTP and NU it has been decided:

- To develop a two week course utilising Icelandic and regional expertise in business management and aquaculture.
- That the target group should be personnel involved in aquaculture planning and development in relevant government departments, government agencies and/or the private sector in Vietnam and the region.
- To integrate the material developed for the course into the regular degree programmes offered by the Faculty of Aquaculture, Nha Trang University, Vietnam with a view to adapting and extending it to other fisheries and aquaculture academic institutions in Asia.
- A secondary and a relatively medium term objective will be to adopt this training material for delivery adapting and extending it to farmer groups and selected farming communities.

Course contents

The course contents is expected to be approximately of 60 hours of teaching material, including lectures and practical exercises initially targeting undergraduate and postgraduate students, who are likely to move into aquaculture practices on their own, particularly in Vietnam, and personnel involved in aquaculture development and business management in national governments, and indeed capable farmers. Draft contents of the proposed course will be finalized by September 2009 and posted on the NACA website for comments from all interested parties.

Activities

The proposed activities until the end of 2010 are:

- Preparation of course materials for delivery to an international group involved in aquaculture business management and development, as well as for delivery in the under-graduate curriculum of the Faculty of Aquaculture, Nha Trang University.
- To deliver the prepared material through an International Workshop, that will include participants from developing countries who are currently engaged in aquaculture development activities.
- To deliver and pilot test the prepared material as a part of the Nha Trang University under-graduate curriculum.
- Obtain feedback from all of the above, improve the course content for further dissemination, and possible adoption, with suitable modifications, for delivery to selected farmer communities.

New email newsletter service

Want to receive the latest network news and publications as they happen? Sign up for the NACA email newsletter service and you will receive personal updates delivered to your your mailbox once a month. To subscribe, submit your email address using the form at:

http://www.enaca.org/modules/newsletter/

Culture, capture conflicts: sustaining fish production and livelihoods in Indonesian reservoirs

Stakeholder groups have made much progress in the development and implementation of co-management strategies in the Jatilnuihur, Cirata and Saguling reservoirs of the Ciratum watershed in West Java. These strategies will ensure the long term sustainability of the cage culture activities and improve the livelihoods of capture fishers of the three reservoirs, which collectively account for the production of nearly 700,000 tonnes of food fish annually.

Governor Pak Ahmad, provincial officials and the project team.

The strategies are being developed based on three years of scientific and socio-economic investigations funded by the Australian Centre for International Agricultural Research (ACIAR) in a cooperative effort between NACA and the Directorate General of Aquaculture, Ministry of Ocean Affairs and Fisheries, Government of Indonesia. They include the regular stocking of herbivorous/ omnivorous fish, such as milkfish to enhance capture fishery yields and a reduction in the stocking density and a corresponding reduction in feeding to reduce eutrophication from cage farming activities. The former has already been put into practice and there had been a significant increase in catch per unit effort from 8.7 to 11.4 kg/ fisher/ day in the fisheries in 2008. Negotiations are ongoing with fishers and the dealers with regard to introducing a levy on the landings to sustain the stocking program on a regular basis.

With regard to cage culture activities a number of farmer groups have been formed and these will form the nuclei to test the effectiveness of adoption of co-management strategies aimed at reducing the nutrient loading and reducing the incidence of fish kills, which are a source of conflict between fishers and cage farmers. The trial adoption of the co-management strategies will be monitored closely by the researchers with suitable modifications introduced and disseminated throughout the farming communities of the reservoirs.

An important advance in the adoption of strategies developed through the first phase of the project is the increasing involvement of the West Java Provincial Government in embracing the options and taking an active part in the dissemination of the co-management strategies, including adoption of a regular stocking program to enhance the capture fishery yield and indirectly contributing to reduced nutrient loading and eutrophication in the reservoirs.

The Governor of West Java, Pak Ahmad Heryawan, together with the reservoir management authorities, have shown a keen interest to continue implementing the strategies developed through the Provincial Administration. The support of the authorities will ensure the sustainability of the fishery related activities in the reservoirs and improve the water quality of these water bodies so that fish kills and conflicts between fishers and cage farmers will hopefully become a thing of the past. The Governor's commitment to the cause was best exemplified when he met with the researchers and the relevant Provincial administrative authorities at his residence, late in the night on 15 April and discussed the details of the co-management plans and their dissemination and implementation. This commitment will help bring about a lasting solution to this rather intricate problem of the management of the reservoirs of the Ciratum watershed and in resurrecting these to an environmentally and economically sustainable status. It is pleasing to note that the silver lining in the clouds is beginning to get brighter and brighter.

Reservoir fisheries and cage culture are important source of livelihoods.

Regional Grouper Hatchery Training Course, 11 - 31 October 2009

NACA in collaboration with the Main Centre for Mariculture Development, Lampung, Indonesia, is pleased to announce that the 7th Regional Grouper Hatchery Production Training Course is now open for applications. The course is tentatively scheduled from 11 to 31 October 2009 and will be conducted in the Main Centre for Mariculture Development, Lampung, Indonesia. The training course only accepts a maximum number of twenty participants and it is operated on a first-come-first-served basis. If you would like more information, please email your request to Mr Yuan Derun (yuan@enaca.org) or download the course flyer for more information and application / payment details:

http://library.enaca.org/announcements/grouper-hatchery-flyer.pdf

Sri Lankan group trained in cage culture in Thailand

Fixing floats to cage frames.

Just finished making fish feed.

Ten fish farmers, four government officers and one project officer from Sri Lanka completed a ten-day training and study tour on cage-based aquaculture in Thailand from 20-30 May 2009.

The training program was structured with a couple of class room lectures to provide participants with some background theory on cage aquaculture systems, hands-on sessions to practice feed making and cage construction and field visits to government fisheries centers and cage aquaculture sites. Despite the very short time for preparation and language constraints, participants expressed their satisfaction to the program and felt that the training is useful for cage aquaculture development in Sri Lanka.

NACA would like to thank AIDA, the Spanish NGO, for sponsoring the program and the Department of Fisheries, Thailand, for their cooperation and support which made the program possible.

Discussion with Mr Somwang, the Director of the Freshwater Fisheries Research and Development Bureau, Department of Fisheries, Thailand.

First step towards the creation of a network of aquaculture centres in the Americas

A meeting for the initiative to create an Aquaculture Network of the Americas or Red de Acuicultura de las Americas was held in Guayaquil, Ecuador, 10-12 June 2009. The meeting was held in response to the request made by delegates of countries of the Americas that attended the IV Session of the Sub-committee of Aquaculture of the Committee on Fisheries of FAO in Puerto Varas, Chile in October last year. Delegates representing 13 countries (Argentina, Brazil, Chile, Columbia, Costa-Rica, Ecuador, Guatemala, Mexico, Nicaragua, Panama, Paraguay, Uruguay, USA) and two aquaculture-related intergovernmental organisations attended.

As an invited key-note speaker, Dr Sena De Silva, Director General of NACA, apprised the group of the successful evolution of the network. This presentation, along with a global and a regional synthesis of the aquaculture sector presented by FAO, provided the context for the discussions of the country representatives, who formulated and agreed upon the network's mission and vision statements. The delegates also designed and agreed upon the basic organisational structure of the proposed network and identified the priority areas that such a cooperation mechanism should address in its initial stages.

Delegates signed a letter of intent that ratified the interest of their governments to create an inter-governmental aquaculture network, an important step towards creating this long-aspired mechanism for cooperation in the sustainable development of the sector in the Americas.

The delegates chose Brazil as the host country for the network in its initial stage, which is expected to be approximately two years. This involves the provision of an office and the Secretariat for the network. The Secretariat will coordinate the formulation of the statutes and the processes that lead to its formal constitution through the signing of an inter-governmental agreement by the national aquaculture authorities of participating countries.

As an initial step the delegates recommended the creation of a Directive Council to coordinate with the Executive Secretary. The Council will be formed by the delegates of Mexico (representing North America); the Fisheries and Aquaculture Organization of the Centro America isthmus (OSPESCA) who will represent Central American countries; Ecuador (representing Andean countries) and Chile (representing southern cone of South America). A Caribbean representation is expected to join soon.

The meeting was organized by the FAO´s Deputy Representative for Latin America and the Caribbean and the Coordinator of the Multidisciplinary Team for South America and the Aquaculture Service, of the Fisheries and Aquaculture Department of FAO in Rome.

Network of Aquaculture Centres in Asia-Pacific

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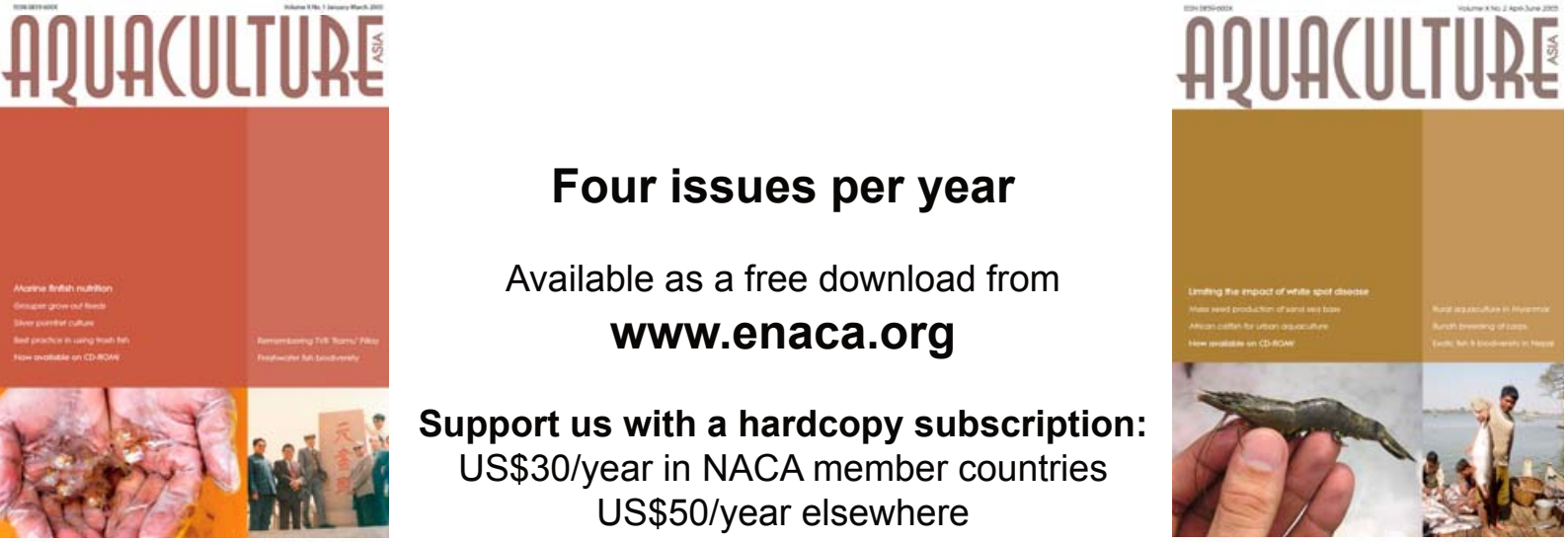
NACA is a network composed of 18 member governments in the Asia-Pacific Region.

Participants in the meeting to discuss formation of a NACA - like organisation for the Americas



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