VERSION 2

2009

Better Management Practices (BMPs) for Striped Catfish (tra catfish) Farming Practices in the Mekong Delta, Vietnam

This document is prepared under the AusAID Funded Project, "*Development of Better Management Practices for Catfish Aquaculture in the Mekong Delta, Vietnam* (001/07VIE)", by Project Partners

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- Network of Aquaculture Centres in Asia-Pacific
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This is the Second Draft- Version 2 of "*Development of Better Management Practices for Catfish Aquaculture in the Mekong Delta, Vietnam*", and the revisions are based on the feedback of the stakeholder meetings held in Dong Thap and Can Tho provinces on 6-7th and 9-10th of October, 2009, respectively.

Based on the feedback form stakeholder meetings in addition to the document separate BMPs for each of the farming stages, in simple language with suitable illustrations have been prepared for distribution to the farmers.

This revised document - Version 2 - is to form the basis for discussions with all stakeholders of catfish farming to be conducted in May-June 2010 at a national workshop to be held in An Giang Province, with a view to finalising Better Management Practices guidelines for implementation in the catfish farming sector, of the tra/striped catfish, scientifically referred to as *Pangasianodon hypophthalmus*.

This document is divided into parts. These include:

- Part A: General background to Better Management Practices (BMPs)
- Part B: BMPs for Grow-out
- Part C: BMPs for Hatcheries
- Part D: BMPs for Nurseries (=fry to fingerling rearing)
- Part E: General Aspects in Relation to BMPs
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PART A. GENERAL BACKGROUND TO BETTER MANAGEMENT PRACTICES

1 What are Better Management Practices (BMPs)

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

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

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

- Reducing and/or a minimising disease occurrence,
- Improving growth performance,
- Decreasing cost of farming,
- Improving environmental conditions, and consequently minimise impacts on the local environment,
- Attaining food quality standards,
- Consolidating good relationships with local communities through perception of industry’s commitment to good environmental performance,
- Improving marketability of the produce, and
- Facilitating sustainability amongst others.

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

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

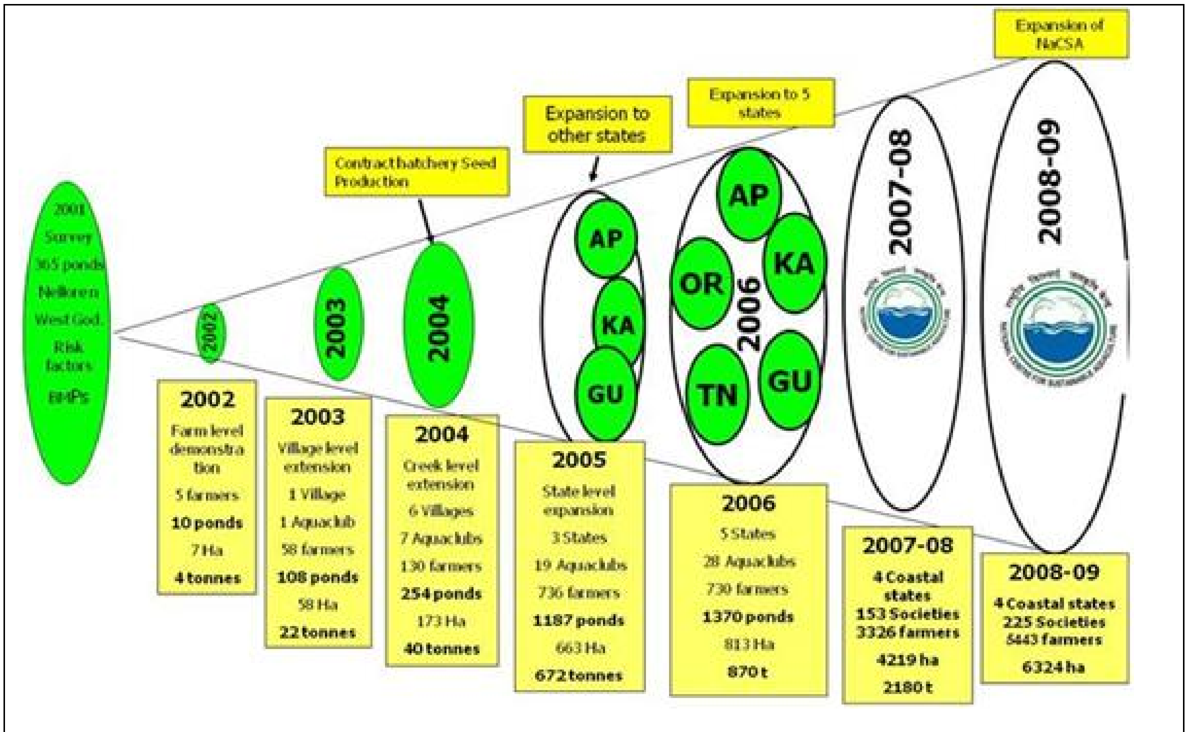

Figure 1. Figure depicting cluster/ society formations of shrimp farmers over the years (from Umesh *et al*., 2009)[1]

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

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

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

Good Aquaculture Practices (GAPs) are commonly used to address food safety issues in aquaculture. These tend to be farm management practices designed to minimise the potential for

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[1] Umesh NR, Mohan ABC, Ravibabu G, Padiyar PA *et al*.(2009)Shrimp farmers in India: Empowering small-scale farmers through a cluster-based approach. In: Success Stories in Asian Aquaculture (eds SS De Silva & FB Brian Davy), pp43-68. Springer, Dordrecht; NACA, Bangkok; IDRC, Ottawa.

farm-raised fishery products to be contaminated with pathogens, chemicals, or unapproved or misused veterinary drugs. GAPs can be defined as those practices necessary to address food safety concerns in isolation.

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

2 The term "better management practice"

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

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

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

3 Are BMPs needed for tra catfish farming?

3.1 Uniqueness of the catfish farming in the Mekong Delta[2]

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

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

3.2 The need for BMPs for tra catfish farming

This unique farming system has had its share of problems, particularly in respect of diseases and marketing, at various levels. Marketing problems are likely to intensify in the foreseeable future, and most of all the produce will have to meet the increasingly stringent food quality and production standards, resulting indirectly from globalisation and increasing demands of consumers. It is also noted that the tra catfish producers, especially small scale farmers at this juncture do not have the negotiating power to influence the market chain. Fish price is often

2 8°33'- 10°55'N; 104°30'- 106°50'E; $3.9x10^6$ ha; 17 million population as at 2007

determined by the buyers and so difficult to predict***. It is in the above context that tra catfish farming needs to develop and adopt, rather quickly, BMPs, which will ensure adoption of acceptable farming practices and most of all assist in achieving globally desired food quality standards,*** as has been achieved for other commodities. Adoption of BMPs, derived from science-based studies and agreed upon by all stakeholders, is a most logical way to meet the above challenges, and ensure long term sustainability of the sector and environmental integrity, the latter being almost consequential to the adoption of BMPs. Furthermore, ***experience elsewhere demonstrates that adoption of BMPs through farmer associations and aqua-clubs and or an equivalent organisational structure, is much more effective and enables better bargaining power to the group, in respect of purchases (e.g. feeds), marketing (e.g. negotiations with processors or importers), bringing about better environmental integrity and rational use of water resources, and most of all provides one voice to the group***; collective action is a much more powerful tool and enables access to government and policy makers also in much more effective and a coherent manner.

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

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

Stage 1:

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

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

- Planning meetings (HCMC and Can Tho) and technical workshop, Can Tho University(CTU), 3-4 Dec. & 8-11 Dec., 2008;

- Participation in ‘Catfish Aquaculture in Asia’ international symposium, CTU, 5-7 Dec., 2008;
- Design and test a questionnaire to understand the details of the existing farming systems;
- Survey 94 grow-out farms (89 owners), 45 hatcheries and 47 nursery farms between February to May 2009, through farm visits and discussion groups (**See** Annex 1 **for area surveyed**);
- Input the above data on farming practices using custom designed database and analyse using available statistical packages;
- The following subsidiary activities which had a bearing on the development of the draft BMPs were also undertaken:
    - A Risk Assessment Procedure for tra catfish farming in the Delta that incorporated the following elements:
        - Compile initial Risk Register (list of key risks) categorised according to generic BMP framework, based on the farm data collected;
        - Review score key risks in terms of ‘likelihood’ and ‘consequence’ of risks occurring to provide Risk Ratings;
        - Risk Ratings are ranked (= sum of likelihood + consequence scores) to provide the Risk Ranking;
        - Risk Ranking determines appropriate level of management response according to Risk Ranking Matrix and associated BMP outcome.
- Based on the above and numerous discussions with farmers and other stakeholders develop draft BMPs for catfish farming in the Delta;
- Ten selected catfish farmers and four Provincial/ District officials undertook a visit (June 2009) to witness and learn from the organisation, functioning and effectiveness of clusters/ associations of shrimp farmers in Andhra Pradesh, India.

The document before all is a culmination of the relevant information from all quarters which contributed to the development of the draft BMPs for tra catfish farming in the Delta.

Stage 2:

The preliminary document on the ”Development of Better Management Practices for tra catfish farming in the Mekong Delta, Vietnam” was translated into Vietnamese and distributed to many stakeholders for comments and formed the basis for discussions at two stakeholder meetings held in Dong Thap and Can Tho provinces on 6/7 and 9/10th of October 2009, respectively.

The stakeholder meetings were attended by catfish farmers of all the provinces, processors, provincial, district and central governmental officials, when each of the recommended BMPs were discussed in detail and feedback obtained.

The current document is a revised version in which the feedback from the two stakeholder meetings are incorporated, and provided the base material for the preparation of dissemination of BMPs to the grass roots, in a simple and a comprehensible language.

The farm survey (grow-out phase) findings have published in a peer-reviewed journal bringing into public and scientific domain detailed aspects of the tra catfish grow-out sector. The details of the publication are:

“Lam PT, Tam BM, Nguyen TTT, Gooley G, Ingram B, Hao NV, Phuong NT, De Silva SS (2009). Current status of farming practices of striped catfish, *Pangasianodon hypophthalmus* in the Mekong Delta, Vietnam. **Aquaculture** 296: 227-236”

PART B. BMPS FOR GROW-OUT

1 General aspects

BMPs are applied to single farms. However, experience shows that the clustering of farms as units in the management of common resource uses greatly enhances the results of application BMPs, leading to beneficial impacts on the individual farms, which could not have been achieved if functioned individually. In this context the guidelines take into account the advantages of clustering and recommendations are made with this principle underpinning the adoption of BMPs for the tra catfish farming sector in the Delta.

It is recommended that a group of farms that are located in the same geographical area or an administration unit, or share a common water supply source and outlet should form a cluster and implement the same set of BMPs.

For example, as illustrated in Figure 2 farms within the frame could function as a cluster.

Figure 2. An impression of the concentration of catfish farms in the Mekong Delta. Note the relatively uniform pond size.

The second most important aspect of the application of BMPs is accurate record keeping on all aspects of the farming practices, including water quality criteria. Record keeping though a cumbersome process and its use and application is not immediately evident, is the key to finding answers and solutions when calamities occur. Here again uniformity of record keeping in a cluster ensures that records become comparable between farms. Note that an adversary in one farm could impact on others, with time, and hence the importance of uniform record keeping through a cluster.

Figure 3. An example of the books used in record keeping in shrimp farms, India**.**

Record keeping also permits and facilitate traceability, ensure to demonstrate to the buyers that the farms have adhered to food safety guidelines and so forth.

For example, throughout India where BMPS have been adopted and a cluster approach is functional all records are maintained in a uniform manner, and as a consequence the whole cluster could be and has been certified by some certifying bodies.

It is expected that with the adoption of BMPs for the catfish farming sector in the Delta a uniform record keeping process will be developed in consultation with all the stakeholders.

2 Pond sitting and size

Catfish farming has taken route along the river and its branches in the Mekong Delta region. In essence, siting of farms is no longer an issue as the farms are already functional and it is unlikely in view of real-estate prices that any of the farms of substantial nature would be developed. In this context this document does not endeavour to make recommendations on future farm siting. A Google map (Figure 2) clearly indicates the intensity of farm locations which provides a fairly general impression for all of the major catfish farming provinces in the Delta. Already inlet and outlet aspects are incorporated into this farming system and very little change is possible. However, what should be endeavoured is to improve upon the existing system rather than attempt to make changes.

The extensive survey conducted gave an insight into the farm size distribution in the Delta. In general, the pond size was relatively uniform throughout the Delta (also see Figure 2). The farm size and the water surface area ranged from 0.2 to 30 ha (mean: 4.09 ha ± 0.48 se) and 0.12 to 20 ha (mean: 2.67 ha ± 0.33), respectively. The number of ponds per farm and pond size ranged from one to 17 (mean: 4) and 0.08 to 2.2 ha (mean of mean: 0.61 ± 0.03 se), respectively. Approximately 72% farms were less than 5 ha, and only 9 % were 10 ha or greater in size. Large scale operations that are few in number and belong to companies were not included in this survey. **Therefore, catfish farm size in the Mekong Delta can be categorised as being primarily small scale.**

Moreover, the concentration of the farms in given localities, and the fact that a great majority of the farms are owned, managed and operated by families, make it feasible to introduce BMPs and the form clusters/ Associations for tra catfish farming in the Delta.

3 Pond preparation

Pond preparation is essential to reduce risks of disease outbreaks, obtain a conducive environment for the growth of the stock, and therefore attaining better productivity.

All surveyed farms treated pond bottom before a new culture cycle. The fallow period varied between farms (2-45 days). However, majority of farms have a fallow period of either 7 days, 10 days, 15 days or 30 days. But in exceptional years the farmers may have to wait longer until seed becomes available.

Almost all farms removed the sludge during the fallow period, which was followed by the application of lime. Some farms dried the ponds. Other treatments included application of salt or filling water then treating with chlorine before draining. Some farms use other products for pond bottom treatment as listed in Annex 2.

All farms did not screen the supply water. In fact this is necessary to minimise the introduction of unwanted materials and organisms. Farms also did not have water sedimentation before supplying water into the ponds – this is although ideal but considering the amount of water use every day, it is difficult to comply. All farms treated the pond water before stocking and the list of chemicals/products used for treatment is given in Annex 3.

The following factors/steps are recommended to significantly improve pond environment. It also takes into consideration the fact that the location of some tra catfish farms are such that the possibilities of providing a provision for a sedimentation pond and or even achieving complete drainage of the pond water between cycles are very limited if not zero.

Step 1. Removal of the bottom sludge between culture cycles

Removal of bottom sludge ensures better water quality when the pond is refilled and stocked for the next cycle. The sludge contains organic matter which will get transformed in to harmful gases such H_2S (also NH_3, NO_2^-, CH_4). Aerobic bacterial decomposition of organic matter is also an important drain on dissolved oxygen in the pond.

Removal of bottom sludge should preferably be undertaken after every harvest but compulsory after every second harvest. The sludge must be disposed away from the pond site, so that it does not seep back into waterways, ponds, or cause other environmental problems.

The catfish farming system in the Delta has to, in due course, evolve strategies, as groups or clusters, to use the sludge as a fertilizer for the vast acreage of crops (e.g. grass as fodder for animals, rice and fruit) in the Delta.

BMP 1. 1. Pond bottom treatment

• Removal of bottom sludge
  o If a pond can be completely drained, bottom sludge should be removed and used as fertilizer to gardens or put into a storage pond
  o The drained pond should be limed and dried for 1 week before filling up water and stocking of fingerling commenced after a two week pond preparation.
  o If water cannot be drained completely (as in the case of some farms), the bottom sludge can be siphoned into the canals in the gardens or storage ponds. Applly lime and repeatedly wash the pond several times within 2-3 weeks before stocking of fingerlings.
  o If the bottom sludge cannot be removed (as in some farms), the pond should be treated by applying lime and salt.
• Consolidate the pond dikes, sluice gates.
• Pond dike should be completely cleaned.
• Develop strategies for using the sludge as an income generator, e.g. as fertiliser for gardens or landfill for planting grass for animal husbandry.

Step 2: Ploughing

Ponds located inland and or on high ground may dry easily. On removal of the sludge, light ploughing of the soil when wet, is desired. This step is generally lacking in the current practice. The main purpose of ploughing is to expose the black soil layer(s) underneath to sunlight and atmospheric oxygen, which assist the breakdown and oxidation of the organic waste (sludge) into less harmful substances.

Presence of moisture in soil (*i.e.*, under wet soil conditions) during ploughing allows bacteria to work better in breaking down the black organic matter, thus making the ploughing process more effective. After ploughing, dry the pond bottom for 5 to 7 days.

Ploughing the pond bottom may lead to turbid water conditions during the culture period. Therefore, compaction of the bottom using heavy rollers after the whole process of pond preparation, *i.e.*, before water intake, can avoid the turbid water condition. This step is not applicable to ponds located on the river bank or those that can not be drained completely.

Step 3: Liming

Liming during pond preparation, a common and low cost practice, is useful for optimising the pH and alkalinity conditions of soil and water**.**

The type and amount of lime to be added depends mainly on the soil pH and also on pond water pH, which ideally should be checked before lime application.

Where a disinfectant such as bleach (calcium hypochlorite) is used apply lime only 3-4 days after the application of the disinfectant. If lime is used earlier to disinfect, then the effectiveness of the disinfectant is reduced.

BMP 1. 2. Liming
• Applying lime as recommended o If water is completely drained, applying lime CaO at 10-15 kg/100m2 in both pond and dike. o If water cannot be completely drained, applying lime CaO at 10-15 kg/m2 mainly on the pond dikes and a part for treating pond water depending on pH of pond water.

Step 4: Pond filling

When ponds are filled/ or water is added care needs to be taken to filter the water using small mesh at the inlet pipe to prevent undesirable organisms entering the pond. Admittedly, this will not stop all organisms entering the pond this practice at least offers some control.

BMP 1. 3. Intake water
• **Water should be screened using small mesh device at the inlet pipe before entering the ponds**

4 Stocking

Stocking involves a number of crucial steps, from the time of procurement of the seed stock/ fingerlings until the seed stock are introduced into the grow-out ponds, prepared as described in the earlier section.

The process of seedstock selection (hatchery visit, transportation and screening) should be done at least 2 – 3 days prior to stocking.

Step 1: Procurement of seed stock

Procurement of seed stock is one of the crucial steps in any form of farming. Often farmers tend to procure the required seed stock from the same hatchery, year after year, based on a number of perceptions that the seed stock are of good quality, reliability in supplies, easy accessibility reduced transportation costs, affordable price, and the long-established business partnership, which even perhaps permit credit.

Catfish seed stock, unlike in the case of shrimp for example, until now do not need to be tested for any specific pathogens. However, it is advisable to evaluate the performance of the seed stock on a yearly basis, for growth, yield and percent mortality not only in your farm but also that of the adjacent farms. In this manner an evidence based judgement can be made as to whether, there had been a deterioration of the seed stock over the years and if so steps to seek alternative supplies of seedstock can be taken.

The above on-going evaluation should be undertaken by the District/ Provincial administrations and the relevant information updated on a yearly basis and made available to farmers. This will be an essential element in the BMPs for catfish farming in the Delta.

Step 2: Choosing seed stock

At each procurement it is essential that the farmer visits the hatchery/ nursery operation and obtain a full history of the potential procurement. The details to be obtained are:

- **How many female and male broodstock were used in the spawning and the approximate ages of these animals**
- **The number of times the female broodstock have been used in the current spawning season, and if more than once, which spawning the current seedstock originate from (for example first in the year or the third in the season)**
- **Ideally, the farmers should procure seedstock from females that are 3-5 years old spawn no more than twice a year.**
- **Spawnings that have resulted in average or above average fry to fingerling survival**
- **The seedstock are active, and show no signs of any abnormal behaviour nor any signs of disease or physical damage**
- **The seedstock are properly weaned**
- **The seed stock are of uniform size.**

BMP 1. 4. Selection of seedstock for stocking
• **Seed from certified hatcheries, which could supply in sufficient quantity at once, should only be used. Test the seed quality before buying at nurseries and investigate the history of the seed such as chemicals used, nursing period, fish size etc.** • **Criteria for seed selection:** o **To obtain a fairly uniform size at harvest, seed should be of uniform size and is one of the key requirements.** o **Seed should be healthy, and have no signs of external physical damage.**

- **30-40 fingerlings should be randomly selected and left in a water bowl for 3-4 min and observed closely, If some fish do not school with the rest, it is recommended that the stock be not purchased.**
- **The best seed size is 1.7-2.2 cm in body depth 75-80 and 30-35 fish/kg, respectively.**
- **Seed should be uniform in size, of brilliant colour, with no signs of deformity and swim actively.**
- **If possible, seed can be sampled for testing common diseases (parasite, bacteria) before purchasing.**

Step 3: Transportation of seed stock (fingerling)

The science of seed stock transportation is well developed, for many species, and lessons can be taken from these experiences for the catfish farming sector.

The selected seedstock, should be starved the day before being packed for transportation. In the Mekong Delta, catfish seedstock are mostly transported by boats in which water is continuously pumped through the transport tanks. The transportation of fingerlings should be done in the early hours of the morning and away from direct sunlight. In addition, land transportation may be used (very rarely in the Delta) for seed transportation, particularly for short distances from farm locations.

The total duration of the transportation time from the nursery to the grow-out farm should be, ideally less than 6 hours duration, and during transportation, care should be taken to minimise direct exposure of the containers to sunlight - to avoid sudden increases in temperature.

BMP 1. 5. Seedstock transportation

- **It is a requirement that hatcheries/nurseries starve the seed destined for sale for 24 hrs before transportation .**
- **Transportation time should be less than 10 hrs.**
- **All seed stock transportation should be by special boats (permitting constant exchange of water) or trucks.**
- **Transportation densities should not exceed 5% of boat loading capacities.**
- **Seed health management during transportation**
  - **Siphon and exchange water.**
  - **If the transportation time is more than 6 hrs, exchange water, siphon waste and apply salt at 5ppt (5 kg/m^3 of water) every 6 hrs.**

- Step 4: Seedstock treatment and stocking

On arrival of seed stock at the farm site the containers should be placed in the grow-out ponds (or special large tanks that could be used for this purpose), unopened, so that the water temperature in the pond and the containers are balanced. Sudden and immediate release of seedstock to the pond should be avoided.

The pH and the temperature of the containers are the same as that of the pond- water the seedstock can be slowly released into the ponds, in batches. Here again care should be taken that these operation are not carried out in direct sunlight, and preferably done during the period when the sun is setting. At the place of release of seed stock, salt can be used as a disinfectant.

Do not feed the released seedstock on the day of stocking; so as to permit time for the seed stock to acclimatise to the pond environment.

Feeding should initially carried out at a very low level, approximately 1 % of the body weight per day of the stocked fish, for three to four days, and then raised gradually to 3 to 5 % of the body weight per day.

BMP 1. 6. Seedstock treatment and stocking
• **Stock fingerlings when the water level reaches approximately 2 m (reduce expenses for other unnecessary treatments).** • **Stock fingerlings after filling water for 5-7 days (when water colour is slightly green as in young banana leaves).** • **Seed can be stocked in a hapa in a corner of the pond and treated with salt for 10-15 min, prior to the release to the pond** • **Feed mildly for the first 3-4 days after release, at a rate that is 30-50% of common requirement.**

- Step 5: Stocking densities

The catfish farming sector in the Delta is one of the most intensive aquaculture practices in the world. The deep ponds, regular water exchange and the ability of the catfish to breath air permits this intensity of stocking.

The stocking sizes range widely: 1.0 to 8.5 cm (mean 4.5 cm) as fry or 1.2 to 20 cm (mean 8.6 cm) as fingerlings, depending on the nature of the practices. The survey results also indicated that the stocking densities used (SD) ranged widely:

- **18-125 fish/m^2 (mean 48 ± 2.1 se) and 5-31 fish/m^3 (mean 12 ± 0.5 se), depending on the size and availability of seedstock and the financial capacity of farmers to purchase seedstock.**

The survey results show that the yieldin the farms increased linearly in relation to SD. However, it is suggested that the SD should not exceed 80-100 fish/ m^2 and/or 18-22 fish m^3.

BMP 1. 7. Stocking density (SD)
• **Stocking density should not exceed 60 fish/m^2 or 15 fish/m^3.** • **Stocking size: 1.7-2.2 cm in body depth.** • **Stocking should be carried out in the early hours of the morning and or late afternoon and ensure that you do not stock when the sun is up** • **Stocking season can be year round.**

5 Day to day pond/ stock management

Although good and careful monitoring of all steps and all stages of a farming system are crucial to the well being of the stock, in grow-out operation this requirement is doubly so, especially in view of the fact that vigilance has to be maintained for the whole growth cycle, which could extend from 6 to 8 months, and is totally the farmer's responsibility.

There are number of important elements that are crucial to the above, none less important than the others, and these collectively contribute to better management.

The crucial elements of daily management are:

- Personal observations on the behavioural aspects of the stock
- Water management; intake and discharge
- Record keeping of water quality parameters
- Feeding and feed management
- Monitoring the health of the stock and mortalities Presence of predators, e.g. birds

5.1 Personal observations on the behavioural aspects of the stock

The farmer should train all technicians working on the farm to make observations on the stock and recognise what is not normal behaviour.. Observations should be done on a daily basis, at least three times a day, especially at feeding times. The elements to be noticed are:

- Are the fish feeding normally

- Is most of the stock coming to the feed
- Are there groups of fish not behaving normally, such as being huddled / congregated together in a corner of the pond without much movement, and not responding to feed or to any other stimuli, such as making the water move
- Are groups of fish surfacing more than average
- Are there areas of the ponds with algal masses, or slicks of oil (can originate from feed)

If any of the above abnormalities are noticed then remedial action needs to be taken. The specific actions are dealt with in each of the following relevant sections.

5.2 *Water management; intake and discharge*

In a manner the catfish farming sector is generally blessed with an abundant and unlimited supply of water and free access to this invaluable resource, a blessing that most other farming sectors in the world would envy. A further blessing is that the farms are located at a relatively close distance to the sea mouth of the river which has the 10^{th} highest discharge rate of the world rivers. Nevertheless, the catfish farming sector has an obligation to ensure that minimal environmental damage is done to this resource, through excessive nutrient discharge that could result in long term adverse impacts to all users, and the environment, now and in the future.

The farm survey results gave a clear indication that on average 30% of water is replenished daily at least during the last two months of the production cycle, and that ***the pond productivity was not related to either the amount of or frequency of exchange water***. This observation is somewhat surprising, in a way, and perhaps more scientific investigation is needed prior to making firm conclusions on the optimal water exchange rate and frequency. However, in the interim it is suggested that the exchange rate per week be reduced by 5%, enabling the farmers to make a saving on electricity/ fuel and reduce water usage, without a loss in productivity.

The intake water should go through a set of screens or filters before entering the ponds.

Equally, where possible the discharge should not be discharged directly to the river but to a reservoir tank or pond where the water is allowed to settle for at least for 24 hrs before being discharged to the river. It is recognised that not all farms can afford the facility of a reservoir tank or pond, but every endeavour should be made to incorporate such a facility. Water exchange As water exchange during the early stage of the culture cycle is less frequent compared to late in the cycle, farmers within a cluster can organise a production calendar so that the facility for water sedimentation could be done on rotation.

As pointed out earlier the water management of the farms adopting BMPs is done best collectively, in clusters/ groups.

Water intake and discharge should not be done on an individual farm basis. The BMP water intake should be based on a pre-determined schedule that covers clusters of farms divided into stretches of 2 km of the river. A calendar/ schedule will determine the discharge and intake of each farm that would minimise contamination between farms and also provide for a relatively good quality water for intake.

Furthermore, all the farmers along a stretch of 2 km, will SMS intake/discharge activities to all the other farmers in the cluster consolidating the nature of the collective activity.

BMP 1. 8. Water exchange
• **Introduce a water intake and discharge schedule/calendar for all farms in each 2 km stretch of the river.** • **In order to achieve this the farms in a stretch should organise into a group.** • **The group should evolve a simple communication strategy, such as by SMS, to inform all farmers of the group of discharge and intakes, on a regular basis.** • **In the above manner contamination from one farm toanother could be minimised and all farms could ensure that the intake is fresh.** • **Endeavour to have a reservoir tank/canal to store waste water before discharge.** • **Exchange water:** o **Filter/screen the intake water.** o **First month: limited water exchange (twice a month).** o **Following months: exchange water daily.** ▪ **In dry season: effluent can be moved to the fruit gardens or storage ponds** ▪ **In rainy season: flood coming with a huge amount of water, when part of the effluent could be drained directly into rivers** • **In case of disease outbreak: limited water exchange or completely stop exchanging water, and inform all farms of the groups of the disease incidence**

BMP 1. 9. Sludge management
• **From the third month on, the bottom sludge should be siphoned into gardens or storage ponds. During the culture period, siphoning can be done 2-3 times depending on the amount of feed supplied.**

Catfish, in addition to extracting oxygen from the water, are capable of breathing air, and this enables very high stocking densities to be maintained. In heavily stocked catfish ponds there is accumulation of metabolites excreted by fish, such as ammonia, and the decomposition of accumulated uneaten feed and fish faeces by bacteria which contributes to reduced oxygen concentrations in the water and build-up of ammonia and highly toxic hydrogen sulphide. The impacts of these may necessarily cause mortality but stress the catfish leading to increased susceptibility to disease and reduced growth. Farmers have noticed that the stock tends to gather in the corners ofa pond, appearing to be stressed and feeding rates reduced; in all probability as a reaction to poor water quality. Also, these impacts can become more intense when the oxygen levels in the water are relatively low, particularly at night.

In BMP it is be desirable to have some form of aeration device (a powerful airline for example) at the pond bottom that is operated for a few hours in the night to maintain oxygen levels and facilitate the oxidation of toxic metabolites and circulate the water.

This will involve an initial investment and an on-going operating cost. However, this cost is likely to be offset by enhanced growth and the improved well-being of the cultured stock.

BMP 1. 10. Improvement of pond water quality
• **Introduce and operate an airline at the pond bottomand operate for a few hours at night, especially into the second half of the growth cycle when a large quantity of feed is provided to the growing stock.**

5.3 Record keeping of water quality parameters

A very small number of farms test the quality of water before supplying into ponds. Also majority of farms did not or seldom (2-3 times a month, or only when farmers felt that water quality was deteriorating) monitor water quality during a culture cycle. For farms that test water quality, the two most often tested parameters are pH and ammonia. Water quality in ponds is crucial as good water quality provides for a conducive environment for fish to grow, whereas poor water quality will stress fish leading poor health and reduced growth.

Monitoring water quality should be undertaken at a regular time each day and preferably twice a day, once early in the morning (e.g. between 0700 and 0800 hrs) and once late in the day (e.g. 1700 to 1800 hrs). Measurements should preferably be taken near the centre of the pond and at two other random points, at 1 m below the surface and near the pond bottom.

The daily measurements to be taken are:

- Temperature
- pH,

- salinity, and
- ammonia
- records of mortalities, and general appearance of dead and or moribund fish

For the above purpose commercially available probes can be used.

BMP 1. 11.Monitor pond water quality and record keeping for water quality
• **Measure/monitor pH and ammonia weekly. In saline affected areas, salinity should also be recorded weekly.** • **Regular and uniform record keeping of water quality parameters and other important, unusual behavioural patterns of the stock should be done .** • **For the above purpose use the record keeping booklets provided.**

5.4 Feeding and feed management

Feeds, feeding and feed management are crucial elements in aquaculture. The industry survey results of 94 farms indicated that most farmers purchase commercial feed on credit and generally continue a binding relationship with the supplier, who may not necessarily be the feed manufacturer.

Currently the grow-out feeds available for tra catfish in the Delta are of three basic types:

- feeds for 14-150 g range stock
- feeds for 20-200 g range stock
- feed for over 500g stock

Table 2 shows the specifications given on the bags of 12 randomly selected commercial feeds and Table 3 provides the results of laboratory analyses conducted on randomly selected commercial feeds, of each type, and farm-made feeds.

Table 1. The proximate composition of a random selection of 12 commercial feeds, as specified on the bags, used in catfish grow-out operations in the Mekong Delta. The names of the producers are withheld for ethical reasons (na - not available).	
Parameter	Range (mean)
Maximum Moisture (%)	10-11 (10.9),
Minimum Protein (%)	22-30 (25.8)
Minimum Total lipid (%)	3-5 (4.3)
Maximum Ash (%)	10-14 (11.3)
Maximum Fibre (%)	6-8 (6.9)

Table 2. Results of laboratory analysis on the proximate composition of randomly selected commercial feeds and farm-made feeds (FMF). The numbers in parentheses indicate the number of feeds sampled				
	14-150 g (5)	**20-200 g (5)**	**>500 g (2)**	**FMF (4)**
Moisture (%)	8.78	7.50	8.22	9.15
Protein (%)	27.07	27.21	20.42	19.65
Lipid (%)	2.10	2.26	2.52	10.45
Ash (%)	8.33	9.32	11.27	20.18
Phosphorous (mg/ g)	9.32	9.49	9.53	11.87
Energy (Kcal/g)	4.49	4.48	4.25	4.19

The bulk of the stock is generally given feeds with a protein content of 25-27% and a low lipid content, except in the case of stock over 500 g in weight when the protein content is significantly reduced. On the other hand, farm-made feeds tend to have a significantly higher lipid and ash content.

The proximate composition is one thing but the utilisability of feed is another. There is no scientific data available on the digestibility of the different feed types used in catfish farming and it is recommended that this should be urgently addressed.

Knowing the proximate composition of catfish feeds (Table 3), it is likely that some of the feed used in this sector is nutritionally inadequate, resulting in poor condition of stock, poor growth and even mortality through what is popularly designated as “whole body yellow symptom”, swollen and pale liver; yellowing in the belly and the fin bases and so on. The demand for tra catfish is because it provides a suitable alternative to the traditional ‘white fish’ varieties. As such it is imperative that the stock does not acquire a yellow flesh colour, which is commonly know as the ‘jaundiced’ condition, and is thought to be brought about by nutritional deficiencies.

When the above signs are observed the following BMPs should be adopted.

BMP 1. 12. Feed management when fish show a symptom of whole body yellow colour
• **Reduce feeding and test the fish in the ponds.** • **Dissect a few fish and make observations (e.g. swollen liver; excess fat in the body cavity etc.) and send a few for investigation to a certified laboratory.** • **Retest the feed on date of use and or rancidity, if yes, change the new feed.** • **Consider changing the feed if desired results are not obtained** **(Please note that the available evidence suggests that yellow body colour commonly referred to a "jaundiced condition" is caused by nutritional deficiencies and not due to any bacterial and or viral infection. As such treating the stock with antibiotics and or other form of chemicals will not be effective)**

5.5 Feed procurement and storage

The time lag between *the date of manufacture and the date of use of the feed should not exceed two weeks,* and particularly so at the high temperatures and humidity prevalent in the Delta region. Under these conditions the feed tends to oxidise (especially the lipids) and become rancid, which makes it unattractive/ unpalatable to the stock and will cause deleterious effects if eaten.

Feed should be stored in such a way as to permit air circulation at least 20 cm above the ground on a dry wooden platform, and protected from rain, sunshine and wind. At feeding the contents of each bag should be smelled for signs of rancidity, and if found to be rancid the feed must be discarded (not into the pond).

BMP 1. 13. Feed procurement and storage
• **Use feed that have not expired the use by day as indicated in the specifications of the manufacturer (fed bag) Feed should be stored to permit air circulation, at least 20 cm above from the ground on a wooden platform, protected from direct sunlight, rain and wind.** • **Each feed bag should be smelled before being used for rancidity.** • **Rancid feed bags should be discarded.** • **Once a feed bag is opened ensure that all feed in the bag is completely used within two days.**

5.6 Feeding

Currently in catfish farming in the Delta the feeding intensity is relatively high, ranging from 1-18%/day and 1-10%/day for commercial feeds and farm-made feeds, respectively, and feed rates are greatest at the beginning of the production cycle when fish are small. Fish are typically fed twice per day, but some farms fed up to six times per day. The food conversion ratio (FCR= Amount of feed used ÷ Increase in wet biomass) for commercial pellets and farm-made feed ranged from 1.0 to 3.0 (mean 1.69), and 1.3 to 3.0 (mean 2.25), respectively.

The perception that excess feeding makes the stock grow better and faster is erroneous. Even though the stock may ingest the feed, when fed in excess, the great bulk of it will not be digested adequately and will not be used for growth, but rather be voided as faecal matter. Scientific data available suggest that no fish species at the grow out stage (> 10 g or so in weight) requires more than 5 % of the body weight per day of a good quality feed, the amount decreasing in proportionate to the body size. In stock of 200 g weight 2-3% of body weight per day of a good quality feed will be more than adequate to obtain optimal growth and well being of the stock. Feeding in excess of three times is unnecessary and costly as it is a waste of feed and human resources, and can lead to water quality deterioration.

Proper feed usage and management will lead to a reduction in FCR and thereby greater profitability, better quality stock and significantly reduced impacts on water quality. The following BMP guidelines are provided for feeding and feed management.

BMP 1. 14. Feeding

• **Start feeding after 2-3 days of release sufficiently to satisfy the requirement of the stock.**
• **Pelleted feed are recommended (commercial or homemade).**
• **Feed should not be rancid.**
• **Feed quantity and frequency:**
    o **Twice a day.**
    o **Feed early morning (before sunrise) and late afternoon (after sun set).**
    o **Feeding regime: a maximum of 5% of body weight per day from the early stages to about 50-80 g/fish, and reduce the feeding rate as, to about 2-3% body weight per day.**
• **Endeavour to manage the farm to obtain a FCR of 1.3 to 1.5 and always be on the look out to reduce ways and means of reducing the FCR further such as through:**
    o **Feeding on alternate days**
    o **Using “mixed feeding schedules’ where feeds of high level of protein are alternated with feeds of lower protein levels**
    o **Use of the above may delay the harvesting time by two to three weeks at most, but the economic gains in feed cost savings will far outweigh this delayed harvesting.**

It was reported by one tra catfish farmer (Mr. Nguyen Ngoc Hai from Can Tho) that he introduced the use of a mixed-feeding trial, as a result of the discussion he had with the project personnel during his travel to India as a component of the project in June 2009. He alternated a day of feeding at a slightly higher rate (normal rate + 7-10% of that), with a day of non-feeding. He observed that the use of this schedule though extended the harvest time by four weeks enabled him to save 100 g of feed per kg of fish produced (equivalent to the reduction of the FCR from1.6 to 1.5), which at feed prices amounted to VND 800 per kg of produce. The total saving was VND 360 million per ha per crop (~US$ 20,200).

Mr. Hai is the Chief of the Thoi An Cooperative of tra catfish farmers that includes 36 members farming 30 ha (60 ponds) of water. The Cooperative has now extended mixed feeding schedule to 20 ponds (~20 ha) and found that the results obtained provided the farmers an increased saving as in his case. The Cooperative expects to extend the adoption of mixed-feeding schedule to all ponds and also disseminate this finding in general to other catfish farmers. Importantly all the farmers observed that the adoption of mixed-feeding schedule also resulted in a reduction in the frequency of disease occurrence from 6-7 times per cycle to 3-4 times per cycle and consequently, an overall reduction of mortality by approximately 50%.

5.7 Mortalities

Levels of mortality vary from one farm to the next as well as throughout the production cycle. Mortality of fish in the first week following stocking ranged from 0-30% (mean 7%). The industry survey indicated that the level of mortality was typically up to 30% during the early to mid months of the production cycle and <10% in latter months. Three farms only reported a level of mortality > 30%. Diseases and poor weather conditions were the most common reasons given by farmers for mortality events.

Farmers reported 15 different symptoms and/or diseases, with Bacillary Necrosis of *Pangasius* spp (BNP) (Edwardsiellosis) (98% of farms), parasites (88%), redspot in flesh (61%), spot disease (58%), white gills (30%) and slimy disease (28%) being the more common diseases, and BNP, parasites and white gills being the more severe diseases. BNP is a recognised as an economically significant pathogen of catfish in the Mekong Delta, which can cause 50-90% mortality when it occurs. The occurrence of symptoms/ diseases was greatest in June and July which corresponded with the onset of the wet season and increased rainfall (**Figure 4**). Clearly, this is an area that warrants more systematic pathological and epidemiological investigations.

Management of the health of catfish on farms mainly involves chemical treatment, often with antibiotics, use of feed additives (vitamin C) and increased water exchange. Farmers mainly bury or sell dead fish and disturbingly, 30% of farms sell dead fish to other fish farmers ,which represents a significant pathway for disease transfer in the Delta. ***Selling dead fish to other farmers may spread pathogens to other fish and regions in the Delta.***

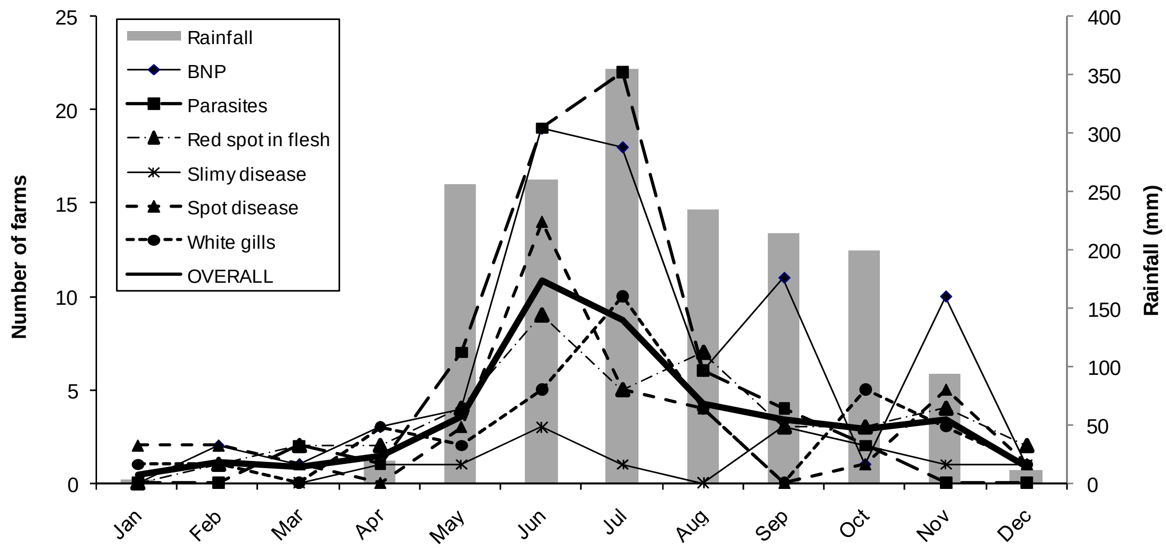


Figure 4. Common diseases found in catfish in the production cycle. Rainfall (mm) are average values obtained from nine provinces of the Mekong Delta.

Mortality of stock could occur due to number of reasons, among which are:

- Disease from infectious pathogens (normally parasitic, bacterial, fungal or viral) when the level of mortality could be high depending on the virulence of the pathogen.
- Nutritional deficiencies, when the mortalities are low at any one time but continues to occur on a regular basis.
- Very poor water quality. In the case of catfish farming the latter is unlikely to be due to oxygen deficiency but could be due to high levels of metabolic wastes (eg. ammonia) and or hydrogen sulphide.

Daily careful observations of the stock will enable farmers to pick up early signs of disease. ***Some of the important symptoms to look for are: changes in behaviour, fish congregating near inlets and outlets, not feeding normally or loss of appetite, jumping out of the water, discoloration of flesh (yellow), ulcers and haemorrhages on body, pale gills, torn fins, fish floating on the surface and loss of balance***. Every attempt should be made to collect sick fish and do a preliminary examination either at the pond side or preferably by sending to a nearby disease diagnostic laboratory for testing. In the event of noticing mortality, gather the following information assist in diagnosis:

- A description of the symptoms observed.
- The number of live fish showing symptoms and the severity of symptoms (very low/high).
- The number of ponds on the farm affected (is it in one pond or several ponds in the area?).
- Size and number of fish that die each day (is it a one-time event or a continuous event?).

If dead fish are noticed, they should be removed and properly disposed of. Dead fish should never be left in the pond as other fish could eat them and become infected.

Many of the pathogens responsible for causing disease may already be present in the pond water. Only when the water quality is poor and fish are stressed, they cause disease in fish. By improving water quality and minimising stress, many of the infectious diseases can be controlled/minimised.

Use of chemicals and drugs to treat diseases may not be useful unless a proper diagnosis is obtained. Only approved chemicals and veterinary drugs should be used. Indiscriminate use of drugs could lead to food safety issues and market rejection of stock.

BMP 1. 15. Fish health management; pay attention at all times to the factors given below and take appropriate action as suggested

- **External factors cause negative impact on fish health**
  - **Weather changes (temperature drop, too much rain …).**
  - **Hight fluctuation of water conditions (water colour changes).**
- **Abnormal fish behaviour:**
  - **Loss of appetite (reduce eating).**
  - **Suddenly jump up.**
  - **Congregation of groups of fish in corners of the pond**
- **Common diseases:**
  - **Bacillary Necrosis of *Pangasius* spp. (BNP):**
    - **Symptoms: glassy swim, jump out of the water pond, rotated swim down to the bottom, loss of appetite.**
    - **Treatment: stop feeding and drug/chemical treatments.**

- White livers and gills:
  - **Symptoms: Gills and livers are whitish colour.**
  - **Treatment: Reduce feeding rate and treat water.**
- **Haemorrhage:**
  - **Symptoms: red anus, red mouth, goggle eyes, red fins. Dark red liver, haemorrhage in intestinal tracts and inside abdomen walls.**
  - **Treatment: treat water and mix appropriate antibiotic with feed.**

- **Disease prevention:**
  - **Ensure that feed of proper nutritional quality is used**
  - **Monitor water quality on a regular basis.**
  - **When the weather changes, treat water with salt and lime.**
- **It is equally important that the disease in one farm is not transmitted to the adjoining ones, if the sector as a whole is to become sustainable. Therefore when a disease occurs in the farm:**
  - **Immediately inform adjoing/ sorounding farms**
  - **Do not discharge water in to a common source**

Disease/dead fish management

Diseased and concurrent dead fish management is cruicial to better management. Adoption of timely actions in this regard helps the spred of disease in the farm and to other farms and makes it also easier to treat the disease. Proper actions in respect of the disposal of dead and diseased fish also helps to minimise the attraction of scavengers terrestrial, arboreal and aquatic, this itself impacting on minimisation of the spread of the disease and also acting as 'reservoirs/ for further bacterial and or viral contamination.

BMP 1. 16. Disease/dead fish management/ disposal

- **Regularly observe fish for abnormal clinical signs and behaviour.**
- **Record carefully all clinical signs and progression of development and size of the affected stock.**
  - **Bury the dead fish with lime in a fixed place in the farm.**
  - **Do not sell diseased/dead fish to other grow out farms.**
  - **Send the moribund fish samples to the nearest laboratory for disease diagnosis.**
- **Do not use chemicals without understanding the primary aetiology of the disease.**

- **Use treatments very judiciously based on diagnosis results.**
- **When discharging water from diseased ponds, inform other farmers in the area.**

5.8 Harvesting

Harvesting represents the culmination of a period from stocking to careful husbandry and the final reaping of the rewards of hard labour and financial inputs. In tra catfish farming in the Mekong Delta harvesting is a relatively difficult process compared to most aquaculture practices as the stock is retained in a pond of average 4.5 m deep and a potential harvest up to 800 t/ ha/ cycle averaging 400-450 t/ ha/ cycle (see Figure 5).

In catfish farming in the Mekong Delta, when the stock is ready for harvesting the farmer will explore the market prices, from the processors, and will enter in to a deal that suits him/her best. The processor in turn will test the stock for quality, uniformity in size and chemical residues, when a final deal is struck and the harvesting date(s) fixed. Harvesting is rarely carried out by the farmer. In the Delta specialised harvesting and transportation (boat) crews operate and these crews are often contracted to do the needful.

Harvesting is conducted by these specialised crews over a few days, up to 7 days, and is done so in batches as the water level in the pond is depleted. The day's harvest is kept in pens, batch weighed, and often hand carried to an anchored boat with facilities for transportation of live fish.

BMP 1. 17. Harvesting

- **Stop feeding fish 2-3 days before harvest.**
- **The average survival rate: >80%.**
- **The average fish size should be around 900 g/fish for a culture period of 6 months which would be the most economical operational cost**
- **Total harvest time should not more than 7 days.**
- **It is best to complete the harvesting within 4 days.**

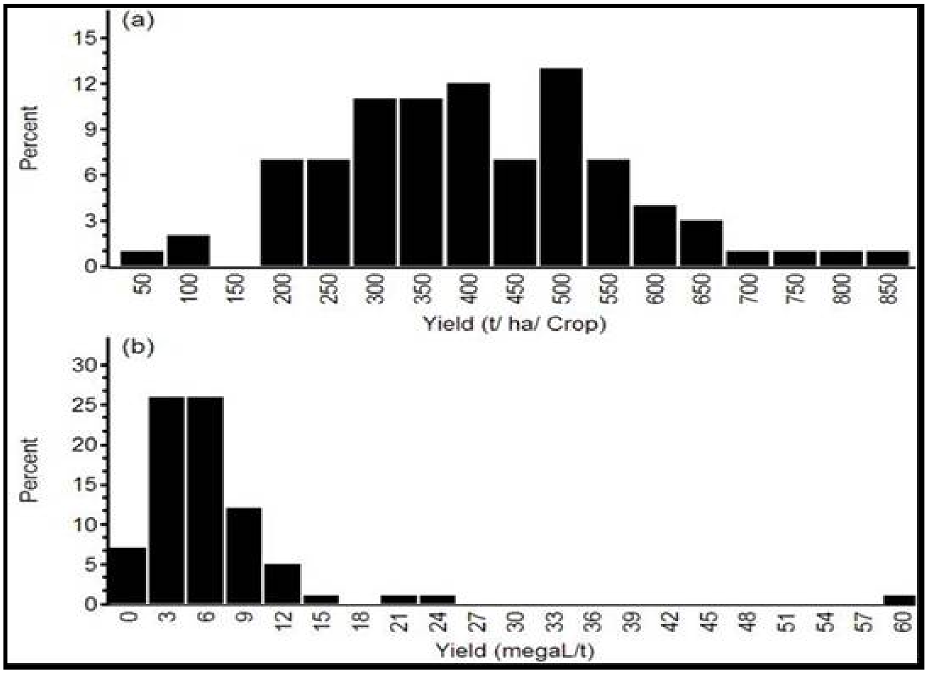


Figure 5. The percent of with different average tonnages at harvesting in relation to area and the amount of water (from Phan et al., 2009[3])

Pictures showing a day's harvest being weighed and taken to the boat for transport to the processor

3 Lam PT, Tam MT, Nguyen TTT, Gooley GJ, Ingram BA, Hao NV, Phuong NT, De Silva SS, 2009. Current status of farming practices of striped catfish, *Pangasianodon hypophthalmus* in the Mekong Delta, Vietnam. *Aquaculture*, 296, 227-236.

PART C. BMPs FOR HATCHERIES

The Mekong Delta catfish farming sector has hundreds of hatcheries in operation, located mainly in An Giang and Dong Thap provinces. These hatcheries are estimated to have produced 11,807 million fry in 2007, which is 25 fold of that in 2000. Needless to say this is a very important sector and special attention is needed to ensure the supply of good quality seedstock and in turn the sustainability of catfish farming in the Delta as a whole.

Quality of seedstock depends on a number of factors. These include physical status of the broodstock such as size, age, level of maturity, number of spawns per year, appearance and health condition which are largely dependent on broodstock conditioning practices. In addition, genetic quality of the broodstock also impacts significantly on the quality of the seedstock.

From an aquaculture perspective, hatcheries in the long-term should aim at continuingly providing good quality seed (i.e. fry) to the nursery/grow-out sectors:

- **Through proper husbandry practices; and**
- **Ensuring long-term genetic quality of the broodstock with a sound genetic management plan.**

1 Husbandry practices

1.1 Broodstock ponds

We surveyed 30 and 15 hatcheries in Dong Thap and An Giang, respectively. Ponds used to hold broodstocks ranged from 0.02 to 3 ha with water depth from 1.2 - 4.0 m. *Ponds over 1 ha in size are probably too large to collect broodstock when needed.*

The majority of hatcheries clean the broodstock ponds yearly by removing the sludge, though some hatcheries do so every three, four to six or eight months. Pond bottom treatment duration ranged from 1-15 days and the treatments include the application of lime (in a large number of hatcheries) and others such as charcoal, BKC, Zeolite, Yucca and Virkon A. There is no scientific information on the effects of the latter and therefore *it is recommended to use lime for pond bottom treatment* (see BMP 1.1 and 1.2 for bottom treatment for grow-out ponds).

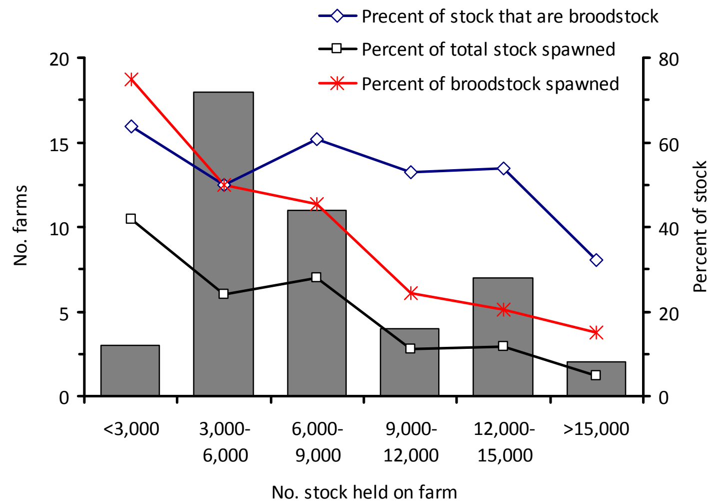
Because broodstock is one of the major resources of a hatchery, it is important to have a well protected pond area with strong dikes to avoid ponds from being flooded. Broodstock ponds should also be clear from any obstructions for easy netting and transportation during breeding seasons.

BMP 2. 1. Broodstock ponds; recommendations
• **Minimum farm size: 2 ha.** • **Minimum number of broodstock: 300 fishes.** • **Broodstock ponds should not be larger than 1 ha in size.** • **The most suitable pond sizes are 500-2,000 m^2 with 2 m depth.** • **Pond dike should be strong and higher than the maximum flood level in the past 5-10 years to prevent broodstock from escaping during floods.** • **Remove all obstructs from the pond bank for easy netting and transportation of brood fish.** • **See BMP 1.1 and 1.2 for suggestion on pond bottom treatment.**

1.2 Broodstock conditioning

The tra catfish farming sector in the Mekong Delta is some what unique in maintaining a vary variable, and often an excessive number of fish as potential broodstock, by hatchery operators (Figure 6). Potential broodstock numbers retained by hatcheries range from from 240 ->15,000 tails/ha. Broodstock should be maintained under less crowded conditions than in grow-out. *Ideally, no more than 1 fish per m^2, males and females, should be held in pond of 1 ha*. In addition, the number of broodstock held should be in accordance with the capacity of the hatchery. ***Holding excessively large number of broodstock fish does not make sense as only a fraction will be used for spawning, and therefore unnecessary expenditure is incurred by maintaining large numbers.*** However, some farmers of the view that the cost involved is maintaining a large number of potential broodstock is secondary to the "insurance" the large number provide in the case of some degree of lost of stock. The farmers are of also of the view that the large number provides them of a greater choice for spawning purposes.

Figure 6. Number or broodstock held on 45 striped catfish hatcheries in the Mekong Delta, and precent of these stock that are broodstock, and percent of broodstock that are spawned in 2008.



The survey results suggest that there are no special broodstock diets available for catfish. Some farms (38%) use only farm-made feed to reduce cost and improve quality of the diet, some farms (49%) used both commercials diet for grow-out in combination with farm-made feed and some (13%) used only commercial feed. Farm-made feed ingredients include fish meal, blood meal, "trash" fish, rice bran, broken rice, cotton seed flour, soybean cake, milk, egg and vegetables (e.g. water spinach and green pea). Feeds are also supplemented with vitamins (C, E), prebiotics (glucan), premix, probiotics and digestive enzymes before feeding.

Broodstock conditioning, under the current prevalent practices, is divided into two stages: the gonad developmental stage and the maturation stage. In the former, the majority of farms (up to 60%) feed very high protein diets and at the latter stage some farms reduced the protein content. ***In fact there is no need to feed broodstock with special diet throughout the year but use a special diet during the 2-3 months before breeding***.

The broodstock generally requires a diet that is used for grow out, supplemented with some essential ingredients 2-3months prior to spawning. It is noted that attempts were made to improve protein content in the diet for broodstock. However, 40% protein in catfish broodstock diet seems ***too high and it is necessary*** *to* ***improve the fatty acid levels*** *which is equally important to oocyte development. Broodstock need is a normal diet- the fish have grown by this stage- that maintains its health and condition, and a diet that enhances oocyte formation, and yolk deposition, which is not necessarily dependent on the very high protein content diets. However, two to three months prior to spawning is crucial, and during this period changing the diet on a weekly basis is more advantageous than a single diet.* BMP 2.2. **Requirement for prebroodstock management**: the following are recommendations to be followed for all potential broodstock maintained on farms.

BMP 2. 2. Broodstock conditioning/ management requirements
• **Pond conditions: Size: 500-2,000 m^2, depth: 2.0-2.5 m.** • **Fish : body weight >3.0 kg/fish; good shape, no deformity; stocking density: 2-3 kg/m^2.** • **Management:** o **Culture period:** ▪ **If the first spawning, the culture period is 12 months (9 months for intensive conditioning and 3 months for maturation).** ▪ **If the fish has spawned, the culture period is 2-4 months (1-2 months for intensive conditioning and 1-2 months for maturation).** o **Stock male and female separately.** o **Pelleted feed: about30% protein, suppliment with unsaturate faty acid at 0.1%, Vitamin C and E at 1%. Feeding rate is 1% of body weight or Four to six weeks prior to be used for spawning supplement the diet with minced oxliver, fresh trash fish to about 1% of the body weight every other day.** o **Check the feed quality before use.** o **Water exchange: every 10 days at 30% of water volume.**

1.3 Spawning

Catfish spawning season is between February to October. Fish are often selected for spawning based mainly on level of maturity and health condition (uniform size and colour of eggs for females and running milt for males).

Often catfish reach maturity at about 3-3.5 years old (~3-3.5 kg). However, it was observed that some farms use very young (2.0-2.5 years old) or too old (7-10 years old) broodstock which would lead to poor quality of seed.

All hatcheries use human chorionic gonadotrophin (HCG) to induce spawning followed by artificial fertilisation. No anaesthetics are applied during hormone injection and stripping.

The sex ratio of male: female in matings ranges from 1:9 to 1:1. *Although the sex ratio does not directly affect the quality of one batch of seedstock for grow-out, care must be taken in case seedstock are selected to become potential broodstock. See Section 2 below for more information on effect of sex ratio on genetic diversity.*

Based on the mean weight of females used by each hatchery, and mean fertilisation and hatch rates, spawning females produced 0.003-1.28 mil. eggs/kg (0.127 ± 0.036 mil. eggs/kg) and 0.0012-0.8 mil. larvae/kg (0.087 ± 0.024 mil. larvae/kg). Further, egg and larval production was significantly negatively corrected with female weight. These relationships are described by the following regression equations;

Eggs/kg (mil.) = 0.151 - 0.015 x female wt (kg) (P=0.006, Adj. R2=0.179).

Larvae/kg (mil.) = 0.108 - 0.012 x female wt (kg) (P=0.006, Adj. R2=0.182).

Fertilised eggs are treated with a tannin solution to remove their stickiness, which facilitates incubation.

BMP 2. 3. Spawning

• **Do not spawn an individual fish more than twice ina 12 month period, and ideally spawn once only**
• **The best spawning age: 3-6+**
• **Broodstock quality checking:**
    o **Female:**
        ▪ **Egg quality: diameter: >1.1 mm, eggs translucent to transparent, uniform size and brilliant colour.**
        ▪ **Average fecundity: 500 g of eggs for 5 kg of female.**
    o **Male:**
        ▪ **Sperm quality: > 1 ml of fluid, milk while colour and fairly thick.**
• **Fertilisation: 2-5ml sperm for 1 kg of eggs.**

1.4 Hatching/ Care of the hatchlings

The rate of metabolism per unit weight is at a maximum during larval development. Consequently, many metabolic products, such as ammonia, are excreted by larvae in significant quantities, and also at this stage the sensitivity of larvae to chemicals is also at a maximum. As such it is important to ensure that there is continuous exchange of water and the developing eggs are kept in constant motion to prevent any clumping.

It is also important to maintain a proper record on performance of each of the broodstock.

BMP 2. 4. Egg incubation/ Hatching/ care of hatchlings

• **Ensure that the fertilized eggs are kept in constant motion, in good quality water, with regular monitoring of water quality.**
• **If fecundity is below average (egg mass is <5% of body weight), do not use the eggs from this particular broodfish.**
• **Do not use any chemicals.**
• **Requirements for egg incubation:**
    o **If plan to use the offspring as further broodstock, incubate separately the eggs from each broodstock at spawning.**
    o **If use the offspring for growing out, incubate all eggs at a spawning together.**
    o **Record the spawning performances (hatching rates, mortalities, deformities); cross check with the past performance of the female.**

2 Maintaining genetic diversity of broodstock

Genetic quality of the broodstock plays an important role in ensuring the quality of seedstock produced. Hatcheries, apart from day-to-day duty of producing good quality seedstock to support the grow-out sector, have also to develop their broodstock by eliminating poorly performing fish and at the same time recruit new ones. This has to be undertaken strategically in order to avoid selecting closely related animals, maximising genetic diversity in the broodstock and as such can avoid inbreeding and associated effects (see Figure 7).

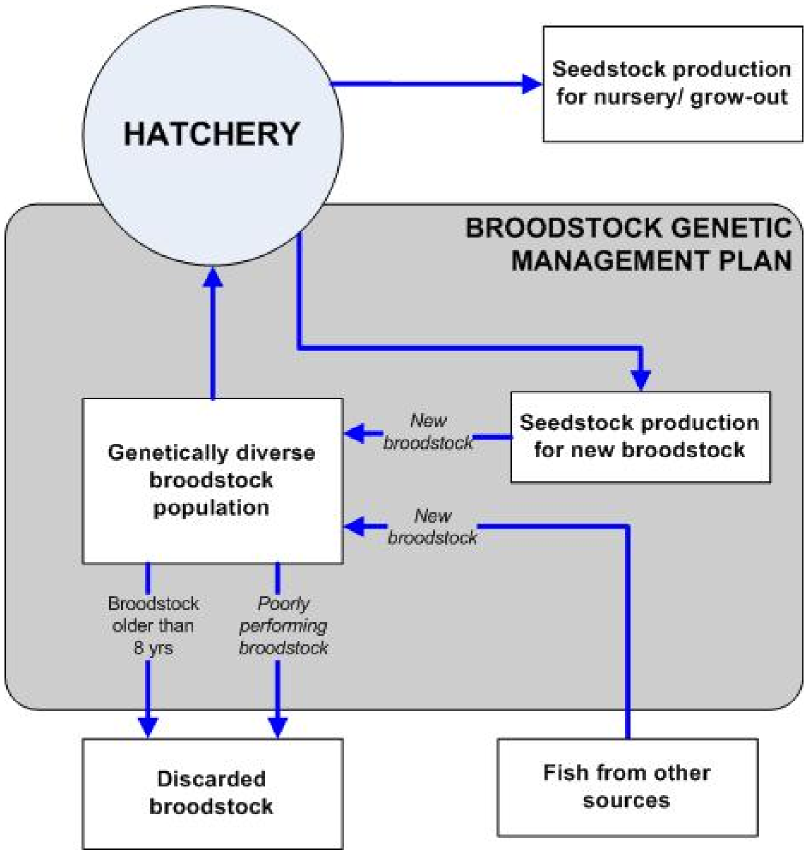


Figure 7.Schematic diagram showing major activities of a catfish hatchery

One of the major problems of poor genetic management of broodstock is "inbreeding", which is the mating of siblings or relatives, for example between brother and sister, cousins, parents and their offspring etc. In some cases, well planned and directed inbreeding can be beneficial, unintentional and unplanned inbreeding will cause problems.

When inbreeding occurs, performance of fish declines over subsequent generations due to a number of factors including low growth rate, reduced viability and fecundity, increase in incidence of abnormalities and increased susceptibility to diseases.

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

However, please note that inbreeding is not always the major reason behind many of the production problems. *Many catfish farmers believe that seedstock quality is decreasing because inbreeding has occurred.* ***This could be erroneous because low seedstock quality (deformities and decrease in growth rate) can be the result of a range of factors other than genetic factors, such as developmental errors****,* ***toxins, nutritional deficiencies or water quality****.*

To avoid inbreeding, it is ideal to provide a unique tag and to have a full pedigree record for each of the brood fish. However, proper tagging could be expensive. If tagging is not affordable, hatcheries must manage the broodstock population as a whole to minimise the accumulation of inbreeding.

To minimise inbreeding means to maximise “effective breeding number” (EBN), which is determined by number of females and males that reproduce viable offspring which in turn can reproduce and contribute genetic material to the next generation, and the sex ratio. EBN can be maximised by:

- Increasing the number of spawning females and males, and
- Bringing the sex ratio spawning broodstock as close to 1:1 as possible.

There is no rule of thumb of how large the value of EBN should be. This depends on the goal of the hatchery, i.e. what level of inbreeding is acceptable and for how many generations. For example, if a hatchery would like to maintain levels of inbreeding of less than 5% for 50 generations (i.e. 150 years for catfish), ***EBN should be kept at least at 500. This is in fact an achievable goal for catfish hatcheries in the Mekong Delta.***

It is noted from the survey that numbers of broodstock held at the hatcheries are highly variable, ranging from 240 to 11,000. Of these, male: female ratio also varied, from a balanced ratio of 1:1 to a highly skewed ratio of 1:9. A l***arge broodstock number does not necessarily reduce inbreeding – as what is important is that they can contribute their genetic material to the next generation (i.e. EBN)***. Hatcheries often keep only a small portion of the offspring for broodstock (about 4%) and it is likely that this small portion is only confined to a few families which may perform well at one spawning but this is not good in the long run as inbreeding can be accumulated quickly when there are few families contributing to the next generation. *The more skewed a sex ratio, the least EBN becomes.*

Keeping excessively large number of broodstock is not necessary and it will increase the costs of maintenance. Based on the average number of broodstock used at each spawning and the number of spawning conducted per year, we found that a majority of hatcheries are maintaining excessive number of broodstock from 800 to 9,000 fish.

It was also clear that all hatcheries did not have a strategic plan for broodstock management and in general there is a lack of understanding on genetic aspect of broodstock management. Some hatcheries for example procured adult fish from grow-out farms or from Cambodia. The following BMP should be applied when fish are selected to become potential broodstock.

BMP 2. 5. Genetic management

Note that this BMP is only applied for spawning batches that produce potential broodstock.

- **Parents should not be relatives.**
- **Efforts should be made to achieve EBN of at least 500.**
- **One or more of the following should be applied to maximise EBN:**
  - **The more number of parents the better, and parent male: female ratio should be 1:1.**
  - **Keeping a small portion of each family of many families.**
  - **Equalise the number of offspring from each family: This requires each family to be raised in a separate unit until family size can be equalised.**
  - **Apply pedigreed mating: i.e. each female leaves one daughter and each male leaves one son as broodstock for the following generation (can be more than one as long as all leave the same number of individuals). This also requires each family be raised in a separate unit to ensure each parent leaves an offspring of the correct sex.**
  - **Milt should not be pooled or added in a sequential manner. These practices cause gametic competition and one male can fertilise most of the eggs, producing EBN smaller than expected.**
  - **Hatcheries can maintain two separate broodstock populations and produce hybrids between them. If more lines are maintained, rotation mating program can be used to prevent inbreeding for a number of generations.**
  - **Procure broodstock from the wild or grow out farms (know the history) to replace 10-25% of new brood fish every year.**
  - **Exchange of broodstock among hatcheries is recommended.**

PART D. BMPs FOR NURSERIES

Background

The tra catfish farming sector in the Mekong Delta, in view of the specialisation in the activities undertaken in relation to the different components of the life cycle, as expected the nursery activities are a stand alone component. The interrelationship between the different sectors is schematically represented in Figure 8.

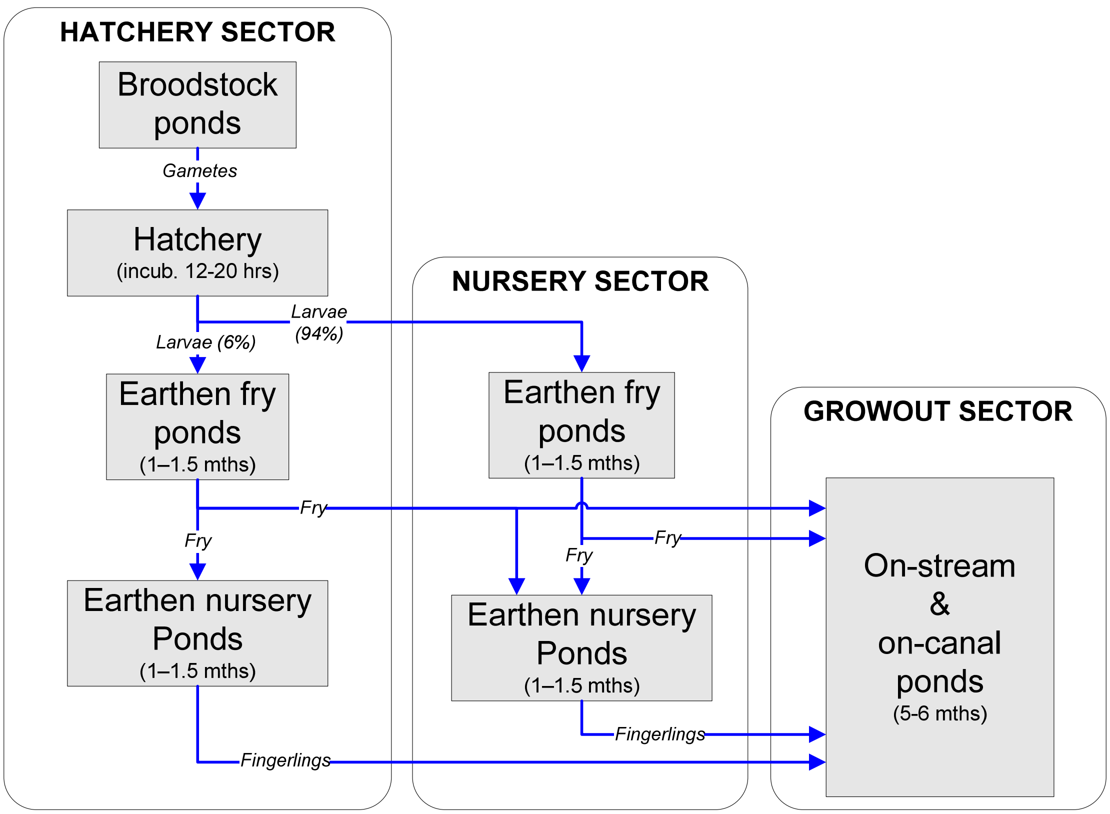


Figure 8. Schematic representation of the interrelationship among hatchery, nursery and grow out sectors of the striped catfish industry of the Mekong delta and movement of stock between each sector.

As evident from the above diagram in some instances the hatcheries themselves will carry out nursing to fingerling stage, albeit to a smaller degree, the great bulk of nursing being conducted as a specialised activity in farms dedicated for fry to fingerling rearing. Hatcheries produced larvae which were mostly sold to nursery farms. However, both the hatchery and nursery sectors grow fry and fingerlings for sale to the grow-out sector.

Hatchery farm size ranged from 0.2-15 ha (2.5 ± 0.5 ha), with 0.05-10 ha (1.59 ± 0.3 ha) under water.   Most farmers (96 %) operate one farm only. Hatchery buildings cover 12-500 m^2 (122 ± 16 m^2). Hatcheries have 1-25 (mean 8) outdoor broodstock ponds ranging in size from 0.02-3.0 ha (0.16 ± 0.05 ha) which are up to 4 m deep, and 1-10 (mean 4) outdoor nursery ponds ranging in size from 0.03-0.8 ha (1.3 ± 0.1 ha) which are up to 3.7 m deep. All hatcheries clean the broodstock ponds at some stage.

Nursery farm size ranged from 0.09-11 ha (mean 1.9 ha), with 0.01-10 ha (mean 1.3 ha) under water. Nursery farms have 1-10 (mean 3) ponds for rearing striped catfish. Ponds used for the larvae-to-fry rearing stage were generally smaller and shallower (0.0025-2 ha, mean 0.44 ha, mean depth 1.8 m) and than those used for the fry-to-fingerling rearing stage (0.016-4 ha, mean 0.48 ha, mean depth 2.2 m).

Most hatcheries and nursery farms used the river as the main water source. Ponds are treated before use, mainly by removing sludge, applying lime and salting. Less than 50% of farms screen the inlet, but most farms will treat the water once ponds are filled. Farms mostly dispose of water to a rice field or a garden.

Table 3. Fertilisation rates, hatch rates, larvae to fry survival rates and fry to fingerling survival rates during the peak and off-season production periods. Values (in percentages) represent range with mean and s.e. (±) in parentheses.

Survival rate (%)	Peak season	Off-season
Fertilisation	10-99 (86 ± 2.2)	28-95 (71 ± 3.3)
Hatch	60-100 (88 ± 1.2)	50-100 (77 ± 2.7)
Larvae-to-fry	15-80 (34 ± 3.9)	5-80 (32 ± 5.8)
Fry-to-fingerling	10-90 (44 ± 8.3)	7-90 (32 ± 8.7)

In essence BMPs for nurseries have many facets; some common to all operations and some specific to the type of operation. Equally, larval to fry and fry to fingerling rearing will each have its own characteristics, and therefore a need for BMPs for each type of operation.

BMP 3.1. Pond preparation

3.1.1. Primary Pond preparation: see BMP 1.1 and 1.2.

- **Ensure that ponds are surrounded by nets.**
- **Consolidate the pond dikes, pipes.**
- **Clean up the pond dikes.**
- **Pond size should range from 5,000-10,000 m^2.**
- **Water depth should be 1.5-2.0 m.**
- **Apply lime CaO for the pond and dike at 10 kg/100 m^2 for the first time.**
- **Dry the ponds for 1-3 days depending on seasons and soil characteristics. Do not dry acidy soil.**

3.1.3. Water screen and treatment
• **Screen water before filling up the rearing ponds to eliminate trash/predator fish.** • **Prepare food for larvae** • **Stocking Moina before stoking fish fry at 20 kg Moina/ha (3 milk cans = 1 kg of Moina).** • **Water depth for stocking: ≥ 1.5 m.**

Larval to fry rearing

Larval to fry rearing is conducted in conjunction with hatchery operations and or as specialist units, where fertilized eggs and or hatchlings are purchased from hatcheries. For both types of operations the recommended BMPs are common.

BMP 3.2. Larval Stocking
• **Stock larvae after 2-3 days of filling up water.** • **Stocking density: 300-350 larvae/m^2.** • **Stocking time: early morning or late afternoon.** • **Water quality checking: suitable pH range: 7.5-8.5, not recommend to stock at higher pH.** • **Larvae quality checking: not deformed, uniform size, actively swimming in the bottom of containers.**

BMP 3.3. Feeds and feeding regime
• **In the first two weeks: duck (chicken) egg yolk and soybean meal prepared in the form of a fine emulsion.** • **Feeding regime: 6 times a day (at least 3 h interval) at 50 duck egg yolks and 2 kg of soybean meal/ha/time.** • **From the third week on: formulated feed.** • **The total nursery period should be around 3 weeks.**

BMP 3.4. Feeds and water exchange
• **No exchange water, only fill up water.** • **Filling water depends on water levels and water colour.**

BMP 3.5. Fish health management
• Rarely appear in the stage, if disease occurs or outbreak, it could be isolated and completely destroyed.

BMP 3.6. Harvest
• Harvest for selling or transfer to second stage. • Harvest size: approximately 3,000 fry/kg. • Desired Survival rate from the time of stocking: 30%.

Fry to fingerling rearing

As for hatchling to fry rearing, the same operation may continue to fingerling stage or specialise in the operation of fry to fingerling rearing. It is rather rare for hatcheries to be involved in rearing up to fingerling stage, primarily due to constraints on pond space requirements and the fact that hatchery operations are labour intensive and deviation from the practice could be counter productive. The BMPs for this stage of operations also by and large thiose for the previous types of operations with minor variations in detail, however.

BMP 3.7. Fry stocking
• Stocking density should be: 100-150 fry/m^2. • Stocking time: at early morning or late afternoon. • Water quality checking: suitable pH range: 7.5-8.5, not recommend to stock at higher pH. • Larvae quality checking: should not have deformed fish, stock should be of uniform size and active.

BMP 3.8. Feeds and feeing
• Feed: formulated feeds are recommended; feeds of appropriate particle size and nutritionally wholesome should be used. • Feeding regime: 2-3 times/day at 7-10% of body weight • Stock should be observed on a regular basis for activity and feeding.

BMP 3.9. Water exchange
• **Exchange water: every 7-10 day at 20-30% of water volume.** • **Ensure that toxic metabolite levels such as ammonia concentration is kept low**

BMP 3.10. Health management
• **Common diseases that occur: parasitic, fungal and bacterial infections.** • **Chemoprophylaxis and treatment: apply special drugs or chemicals (directly into the ponds or mix with feed), as prescribed and after consultation with a fish health specialist only.** • **If widely prevalent in the stock consider destroying the stock and disposing in the proper manner**

BMP 3.11. Health management
• **Most desirable harvest size: 30-70 fingerling/kg, the best size: 1.7 cm in body depth.** • **Desired survival rate: 50-70%.** • **Nursing period: 2 months.** • **To obtain uniform size, fingerlings should be screened after one month of nursing.**

PART E. GENERAL ASPECTS IN RELATION TO BMPs

1 Use of chemicals (also see food safety)

Consumers all over the world are becoming extremely conscious of the quality of the food they consume, and how it is produced. This is an unavoidable and indeed most welcome status, driven by increasing standards of living, improvements to technological advances on testing and detection, increasing advancement and awareness of food related health issues, made easily available to the public through the modern day mass media.

Food quality standards of importing countries could differ from each other. For example, though Britain is a member of the European Community (EU), it has its own food quality standards over and above that imposed by the EU. In the EU standards there is 'zero tolerance' for antibiotic residues, i.e. the food will be rejected if any antibiotic is found in the consignment.

There are regularly updated published lists of banned chemicals, which are brought to the notice of farmers by Ministry of Agriculture and Rural development (MAR) Such chemicals should not be used under any circumstance.

On the other hand, farming communities the world over, more so in developing countries, are induced to use various forms of chemicals and other substances that are claimed to have a positive impact on production. As an example, in one country it was found that over 1000 such chemicals/ substances were traded, of which, as revealed by later studies, all essentially were of less than 20 substances sold under different trade names and claimed to have different impacts.

Bacterial diseases are commonly treated with antimicrobial agents (antibiotics). The industry survey indicated antibiotics are widely used by catfish farmers in the Delta. Use of antibiotics to treat diseases should be undertaken with extreme caution as bacteria have the ability to develop and transfer drug resistance. The occurrence of multiple antibiotic resistance by bacterial fish pathogens is becoming more evident in farmed fish, especially in areas where antibiotics are widely and indiscriminately used. Antibiotics must be used cautiously and done under the supervision of a qualified veterinarian. In extreme bacterial disease outbreaks, it may be necessary to destroy infected stock and eliminate the responsible pathogens by sterilisation of ponds, tanks and equipment. Vaccines should be developed for important bacterial diseases of catfish.

Probiotics are a group of substances, primarily bacterial inoculants, that are used in farming practices, based on the belief that these impact positively on water quality and hence productivity. The scientific evidence on the positive impacts on the use of probiotics in aquaculture remains controversial and undetermined. The bacteria used in probiotics are aerobic bacteria, which needs oxygen to be metabolically active, when only can it impact on water quality and not on pond sediments under anaerobic conditions. The balance of evidence therefore, suggests that use of probiotics in grow-out operations in catfish farming is likely to be ineffective, and if at all detrimental.

Reducing use of chemicals can contribute significantly to reduced cost of production and therefore increased profits.

BMP 4. 1. Use of chemicals
• **Do not use any banned chemical, at any stage of the farming process** • **Have regular consultations with authorities with regard to banned substances.** • **Do not use chemical and or other substances that are claimed to improve water quality** • **Any chemical usage should be carried out after consultation with qualified personnel and under supervision** • **Be conversant with the food quality and safety standards guidelines**

2. Community responsibilities

In aquaculture more often than not there is a need to share common resources, such as for example the water. Tra catfish farming is no exception in this regard. Use of common resources when done with social responsibility will only lead to sustainability for all users, bring about minimal environmental perturbations and most of all generate synergies that benefit all users. In fact the social responsibilities are a part and parcel of BMPs and need to be adhered by all users.

BMP 4. 2. Community responsibility

• **Property right and regulatory compliance:**
  o **All farms should have legal rights for land use, water use, construction, operation and waste disposal (predator control permit, well operation, protection wetland or other sensitive habitats).**
• **Community relations:**
  o **All farms should endeavour to establish good community relations and not block access to public areas, common land, fish ground and other traditional resources used by local community.**
• **Worker safety and employee relations:**
  o **All farms shall comply with local and national labour laws to assure adequate worker safety, compensation and where applicable, on site living conditions.**

Equally, a most crucial element of social responsibility of a farming community also entails a major facet of environmental responsibility; all farming whether on land and or in water perturbs trhe environment. The responsibility of the farming community is to keep such perturbations to a minimum. After all, a degraded environment will result in a degradation of your own farming practices, and hence its viability. Accordingly the following BMPS are recommended for adoption by the tra cat fish farming sector.

BMP 4. 3. Environemental responsibility
• **Wetland conservation and biodiversity protection:** o **Aquaculture facility shall not be located in mangrove or other sensitive wetland areas. Farm operations shall not damage wetland or reduce the biodiversity of ecosystems.** • **Effluent management:** o **Farms shall monitor and find the appropriate way to treat the effluent before discharging to public water systems, and make all efforts to comply with the BMPs that have been reccomened in this regard under the different farming practices (e.g., grow-out, hatchery, nursery rearing).** • **Fish meal and fish oil conservation:** o **Farms shall properly monitor feed input and minimise the use of fish meal and fish oil derived from wild fisheries that are not sustainably managed.** o **Farms need to ensure that the commercial feeds that they use manufactured in accordance with the accepted regulations and standards, and and if in doubt demand from the manufacturers the nature of ingredients used and the standards adapted in the manufacturing process.** • **Soil and water conservation:** o **Farm construction and operation should not cause soil and water salinisation and deplete ground water in surrounding areas. Farms shall be properly managed and disposal of ssediment doen as in the recommended BMPs for each sub sector previously.** • **Control of escapees and use of GMOs:** o **Farm shall take measures to minimise escape of stock and comply with governmental regulations regarding the use of native and non-native species, and genetically modified organisms.** • **Storage and disposal of farm supplies:** o **Fuel, lubricants and agricultural chemicals shall be stored and disposed in a safe and responsible manner and accordance with the existing reglations.** • **Animal welfare:** o **Producers shall demonstrate that all operations on farms that involved fish are designed and operated with animal welfare and well being in mind. Employees shall be trained to provide appropriate levels of husbandry.**

2 Food safety and traceability

In the modern world food safety and traceability of the produce are crucial elements that enable access to markets. These aspects are becoming increasingly important and also enable the produce to be certified and comply with international standards which are essential elements in marketing. In essence if one were to adopt the BMPs that have been recommended for each stage of the production cycle one would easily be able to comply with the food safety and traceability requirements of the market place. The following are the BMPs that are recommended for adoption, specific to food safety and traceability.

BMP 4. 4. Food safety

• **Drug and chemical management:**
  ○ **Banned antibiotics, drug and other chemical compounds shall not be used.**
  ○ **Other therapeutic agents shall be used as directed on product labels for control of diagnosed diseases or required pond management, not for prophylactic purposes.**
• **Microbial sanitation:**
  ○ **Human wastes and untreated animal manures shall not be permitted to contaminate pond water.**
  ○ **Domestic sewages shall be treated and not allowed to contaminate surrounding areas.**
• **Harvest and transportation:**
  ○ **Fish shall be harvested and transported to processing plants or other markets in a manner that maintains temperature, as far as possible under minimal minimise stress, physical damages and contamination.**

BMP 4. 5. Traceability

• **To establish product traceability the following data shall be recorded for each culture unit/area and each production cycle, and be made available for inspection and scrutiny at any point of time. The record keeping recommended is:.**
  ○ **Culture unit identification number.**
  ○ **Unit area or volume.**
  ○ **Stocking date.**

- **Quantity of seed stocked, and origin of seed stock.**
- **Antibiotics, drugs, herbicides, algicides and other pesticides used, including the brand name, date of purchase and application.**
  - **The dates and amounts used and reasons for use.**
- **Manufacturers and lot numbers for each feed lot used.**
- **Harvest date, total production.**
- **Details on processing plants or purchasers.**

3 Market aspects

Tra catfish caters to an overseas niche market where it has replaced the popularly known commodity 'whitefish'. However, the market has had to face many obstacles, starting with the embargo introduced by the US. Such obstacles, however, enabled the industry to develop and establish new markets which assisted in the stabilisation of market demand, world over, for catfish. However, this is no matter for complacency. There are many anonymous campaigns that are carried out in the world media, perhaps from competitors, to discourage the consumption of tra catfish (Annex 4). As such it is an ongoing battle to maintain and retain the market share for the tra catfish. Secondly, from a small scale producer view point, the farm gate price is often dictated by the processors in the Delta, and has very marginal bearing on the prevailing market prices *per se*, making it difficult for the small scale operators remain economically viable rather difficult.

Perhaps, the answers to the above lie in the adoption of BMPs and the operation of the BMP strategies through a cluster system i.e. formation of effective and functional Associations of small producer groups- a lesson to be learnt from the Indian shrimp farming systems.

As we are all aware independent groups are developing standards for tra catfish culture, and equally certification of the produce are needed to access markets. Adoption of BMPs performs two direct functions in the above respect:

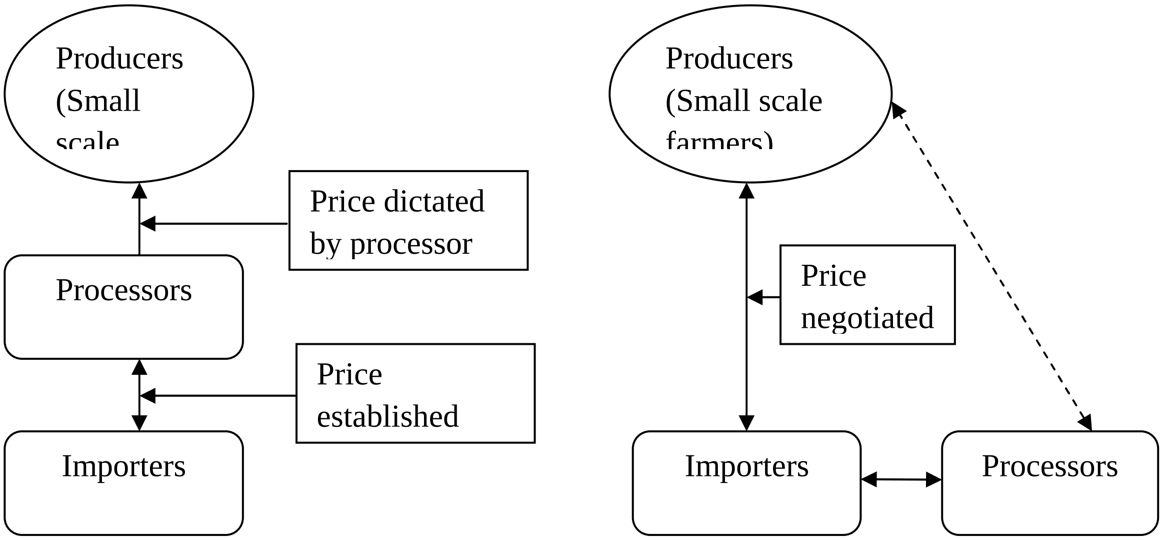
- The production process is clean and acceptable and will result in a produce that ensures food safety standards and quality
- Cluster based adoption of BMPs will enable to obtain cluster certification thereby reducing and or minimising the cost of obtaining certification by individual farmers, and also makes the process less cumbersome but more effective and creates less trouble for the individual small scale farmers
- Cluster based adoption of BMPs will eliminate the problem of the internal deadlock/ and or unilateral price determination between small scale producers and processors with

regard to the farm gate price; the produce will be sold as a cluster product and this will give greater bargaining power to all and will enable a fair farm gate price to be obtained.

Experience in India clearly showed that all of the above were achieved within a period of two to three years. In fact Indian shrimp farmers are less well off and more backward (in most cases) than tra catfish farmers who are well informed and are more enterprising in most ways. However, the lack of organizational structure in the catfish industry has hindered the catfish farmers in making better headway, and most of all break the price barriers imposed by the processors. The Indian experience has demonstrated that adoption of BMPs and cluster formations, has attracted major buyers to the producing cluster directly and improved prices. This is what the Vietnam catfish farmers need to achieve and there is no doubt it could be achieved only through the adoption of BMPs working through a cluster system.

As we prepare this document a similar status has been achieved in respect of a rural Thai shrimp farming activity, where premium prices have been agreed upon, through AquaStar, for a well renowned retailer Chain in the UK.

The above is simplified in the diagram below.



Current marketing **BMPs/ Clusters marketing**

PART F. THE WAY FORWARD

These consultations are conducted for a number of purposes. Foremost among these are:

- Pathway to adoption of BMPs,
- Pathway to formation of clusters/ Associations

1 Pathway to adoption of BMPs

- To "fine tune" the draft BMPs before the stakeholders, and develop a document on Better Management Practices, for the current time, acceptable to all
- Among the stakeholders select, preferably from each District, farmers who would volunteer to have demonstration farms that would adopt BMs, almost immediately, and stick to the guidelines agreed upon.
- The Demonstration farms will be available for visits by any other stakeholder, observe what is ongoing and discuss details with the operator/ farmer
- The information arising from the demonstration farms will be readily available to all, and will be utilized to demonstrate the impacts of adoption of BMPs to other stakeholders, such as information related to:
    - disease occurrences,
    - productivity,
    - cost of production,
    - economic viability,
    - market price obtained.

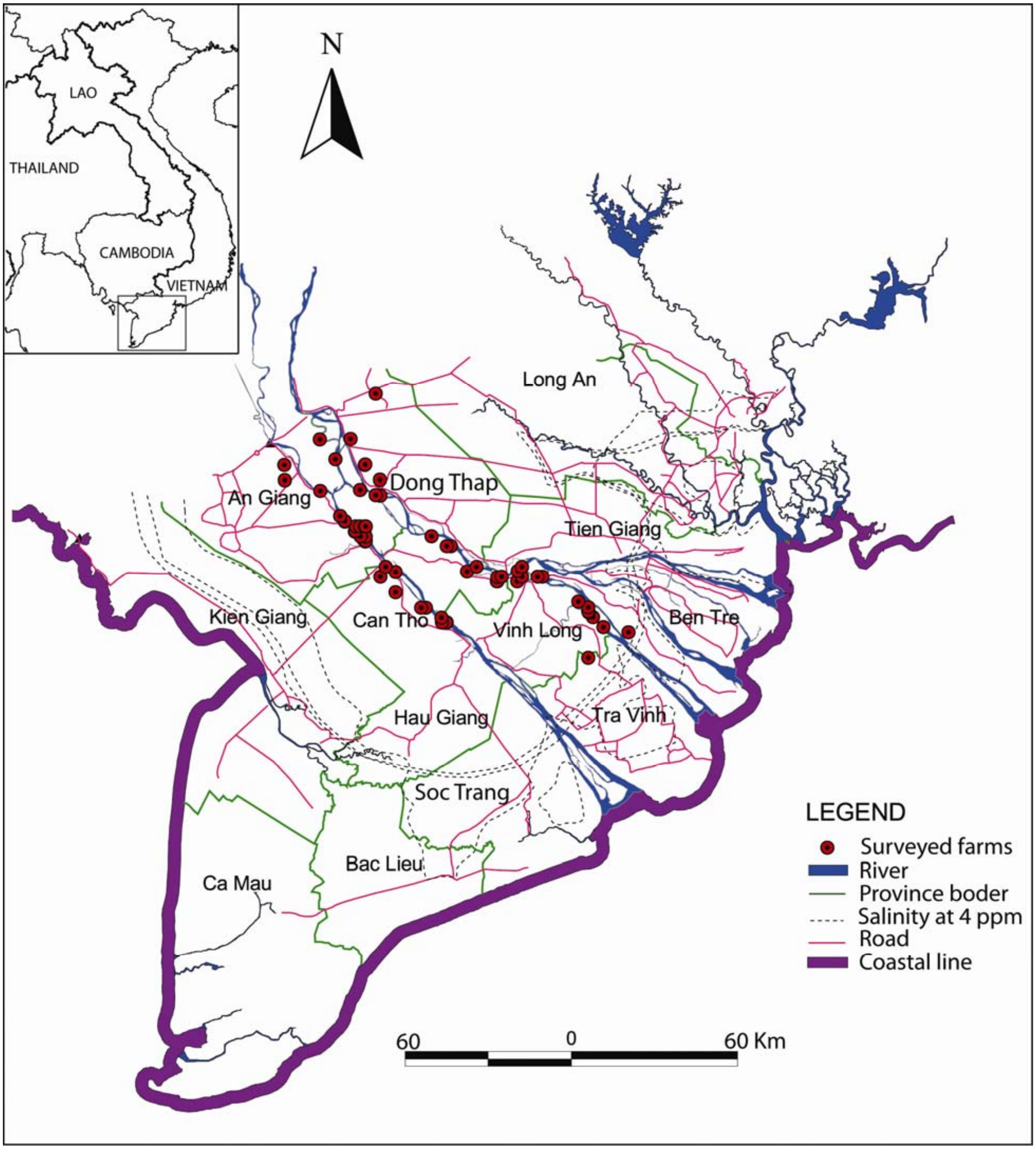
2 Pathway to the formation of clusters/ Associations

Throughout this document it has been stressed that BMPs will be most effective when adopted and operated through a cluster/ Associations system approach. Evidence was cited from other farming systems in other countries that such an approach is advantageous to all stakeholders, and brings about better harmony and well being to the community as well. It was shown that this approach has advantageous in meeting food quality and safety requirements, and also enables "Cluster/ Associations" to obtain certification as a unit rather than individual farmers having to pay more and achieve the same objective.

As such the current stakeholder meetings/ consultations will need to make the following decisions through a consensus:

- Do the tra catfish farmers agree that a "Cluster/ Associations" approach is required to sustain the industry and meet the modern day demands of markets?
- What should be the nature of "Cluster/ Associations""
  - Should each "Cluster/ Association" be restricted to a District/ Sub District/ or a defined number of farms along a pre-determined length of the river
  - How would you make the "Cluster/ Association" functional?
  - Elect by consensus a Chair, Secretary and Treasurer, and five to sic Committee Members
  - Prepare guidelines for the conducting the day-to-day affairs of the "Cluster/ Association"
  - Proceed to obtain registration with the appropriate governmental body

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



Annex 2. List of chemicals/ products used for pond bottom treatments

Anti-bacteria
BKC
Chlorine
$CuSO_4$
TCCA
Dipterex
Ensova
Formalin
$KMnO_4$
NPK fertilizer
Saponin
TCA
TCCA
Thiodan
Vimidime
Virkon
Yucca
Zeolite

Annex 3. List of chemicals/ products used for pond water treatments

Biozyme
BKA
BKC
Caximex
Chlorine
Copper sulfate
Damexiton
Formalin
Iodine
$KMnO_4$
Lime
Oxytetracyline
Probiotics
Protextol
Salt
Saponine
Super churge
Sytado, eftalo
TCCA
Vikon
Vimmekong
Yucca
Zeolite

Annex 4. Extract of the negative publicity conducted on the world wide web on the hazards of eating tra catfish

http://4udiary.blogspot.com/2009/05/be-careful-when-you-buy-fish-and-chips.html

http://groups.yahoo.com/group/dbinit2007/message/43

http://ummisal.multiply.com/journal/item/58/Dory_Fish......Sutchi_or_Pangas............

Beware Fish Lover

Please share this forwarded article with your family!

It is called Sutchi and I saw many housewives snatching up the fish at supermarkets as they are really reasonably priced. The fish looks good but read the article and you will be shocked.

My colleague (person who send out this massage) who deals with seafood confirmed that this is true. This product is from Vietnam and unless you know the right supplier which most of us won't, so be safe!

Hi all: Sutchi is sold in Singapore supermarkets and I've got a stinking feeling its the same thing!

To be 100% sure that we're not eating Pangas, better not order fish n chips when eating out!!

Do you eat this frozen fish called Pangas ?(Pangasius, Vietnamese River Cobbler, White Catfish, Gray Sole)

Industrially farmed in Vietnam along the Mekong River, Pangas or whatever they're calling it, has only been recently introduced to the French market. However, in a very short amount of time, it has grown in popularity in France. The French are slurping up Pangas like it's their last meal of soup noodles. They are very, very affordable (cheap), are sold in filets with no bones and they have a neutral (bland) flavor and texture; many would compare it to cod and sole, only much cheaper. But as tasty as some people may find it, there's, in fact, something hugely unsavory about it. I hope the information provided here will serve as very important information for you and your future choices. Here's why I think it is better left in the shops (and not on your dinner plates):

1) Pangas are teeming with high levels of poisons and bacteria. (industrial effluents, arsenic, and toxic and hazardous by-products of the growing industrial sector, polychlorinated biphenyls (PCBs), DDT and its metabolites (DDTs), metal contaminants, chlordane-related compounds (CHLs), hexachlorocyclohexane isomers (HCHs), and hexachlorobenzene (HCB)).

The reasons are that the Mekong River is one of the most polluted rivers on the planet and this is where pangas are farmed and industries along the river dump chemicals and industrial waste directly into it. To Note: a friend lab tests these fish and tells us to avoid eating them due to high amounts of contamination. Regardless of the reports and recommendations against selling them, the supermarkets still sell them to the general public knowing they are contaminated.

2) They freeze Pangas in contaminated river water.

3) Pangas are not environmentally sustainable, a most unsustainable food you could possibly eat - 'Buy local' means creating the least amount of environmental harm as possible. This is the very opposite end of the spectrum of sustainable consumerism. Pangas are raised in Vietnam . Pangas are fed food that comes from Peru (more on that below), their hormones (which are injected into the female Pangas) come from China . (More about that below) and finally, they are transported from Vietnam to France . That's not just a giant carbon foot print, that's a carbon continent of a foot print.

4) There's nothing natural about Pangas - They're fed dead fish remnants and bones, dried and ground into a flour, from South America , manioc (cassava) and residue from soy and grains. This kind of nourishment doesn't even remotely resemble what they eat in nature. But what it does resemble is the method of feeding mad cows (cows were fed cows, remember?). What they feed pangas is completely unregulated so there are most likely other dangerous substances and hormones thrown into the mix. The pangas grow at a speed light (practically!) : 4 times faster than in nature¡Kso it makes you wonder what exactly is in their food? Your guess is as good as mine.

5) Pangas are Injected with Hormones Derived from Urine - I don't know how someone came up with this one out but they've discovered that if they inject female Pangas with hormones made from the dehydrated urine of pregnant women, the female Pangas grow much quicker and produce eggs faster (one Panga can lay approximately 500,000 eggs at one time). Essentially, they're injecting fish with hormones (they come all of the way from a pharmaceutical company in China) to speed up the process of growth and reproduction. That isn't good. Some of you might not mind eating fish injected with dehydrated pee, so if you don't, good for you, but just consider the rest of the reasons to NOT eat it.

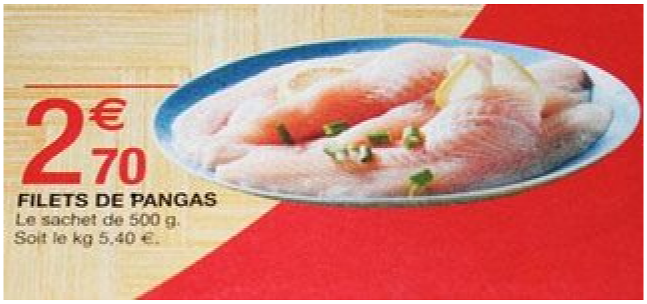
6) You get what you pay for - and then some. Don't be lured in by insanely cheap price of Pangas. Is it worth risking your health and the health of your family?

7) Buying Pangas supports unscrupulous, greedy evil corporations and food conglomerates that don't care about the health and well-being of human beings. They only are concerned about selling as many pangas as possible to unsuspecting consumers. These corporations only care about selling and making more money at whatever cost to the public.

8) Pangas will make you sick - If (for reasons in #1 above) you don't get immediately ill with vomiting, diarrhea and effects from severe food poisoning, congratulations, you have an iron stomach! But you're still ingesting POISON not poisson.

Final important note: Because of the prodigious amount of availability of Pangas, be warned that they will certainly find their way into other foods: surimi (those pressed fish things, imitation crab sticks), fish sticks, fish terrines, and probably in some pet foods. (Warn your dogs and cats and hamsters and gerbils and even your pet fish!)

So, when you do your next round of shopping of frozen fish, or eating out at cafes / food stalls by choosing fish-&-chips, think twice !!You have been warned !!!



However I myself have do some research to clear up this massage:

1. http://www.bar.gov.ph/agfishtech/fish/pangasius.asp Filipine Bureau of Agricultural Research. An online program to rnsure adequate, accessible, affordable and nutritious food for all Filipinos.

2. http://www.whytraveltofrance.com/2007/08/03/buying-fish-in-france-a-warning/ Some comment from France blogger own experience.

So Which is true??