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



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This document is to form the basis for discussions with relevant stakeholders of catfish farming to be conducted in October 2009 at two locations in the Mekong Delta, bringing together farmers from the four major provinces of catfish farming in the Delta, 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 five 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: General considerations
- Part E: Way forward

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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 environmental,
- 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, nearly 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.

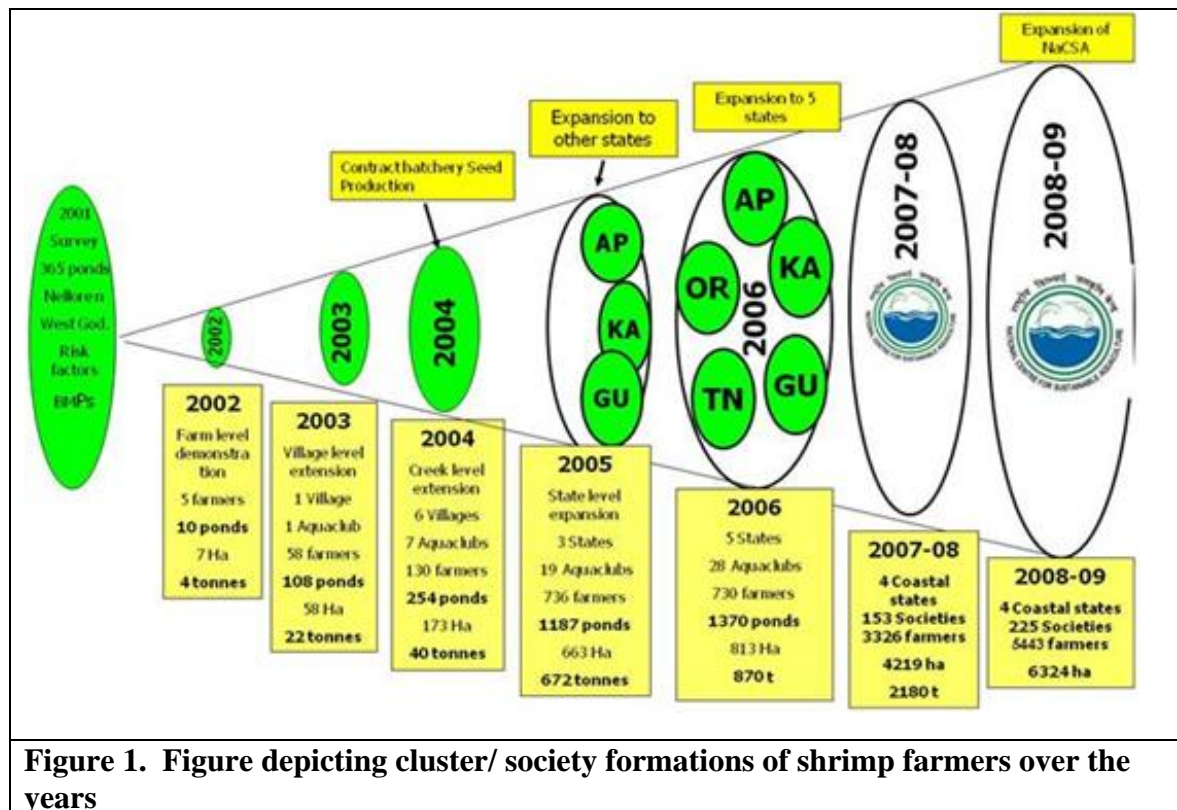


Figure 1. Figure depicting cluster/ society formations of shrimp farmers over the years

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 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

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 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 in 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

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 the current draft BMPs for catfish farming in the Delta;
- Ten selected catfish farmers and four Provincial/ District officials undertook a visit to witness and learn from the organisation, functioning and effectiveness of clusters/ associations of shrimp farmers in Andhra Pradesh, India.

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.

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 be formed 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

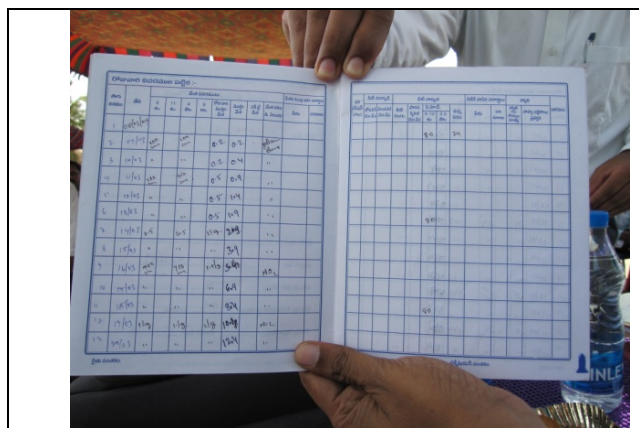


Figure 3. An example of the books used in record keeping in shrimp farms, India.

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.

Record keeping also permits and facilitate traceability, ensure to demonstrate to the buyers that the farms have been 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 \pm 0.48 se) and 0.12 to 20 ha (mean: 2.67 ha \pm 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 \pm 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 the 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.

- **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 into harmful gases such H₂S (also NH₃, NO₂⁻, CH₄). 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. rice and fruit) in the Delta.

BMP 1. Pond bottom treatment

- **Remove the bottom sludge preferably after every harvest, compulsory after every second harvest.**
- **Develop strategies for using the sludge as an income generator.**

- **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. The recommended levels of lime application during pond preparation are given in Table 1.

Soil pH	Quantity of CaCO ₃ lime (kg/hectare)	Quantity of Ca(OH) ₂ lime (kg/hectare)
> 6	<1,000	<500
5 to 6	<2,000	<1,000
< 5	<3,000	<1,500

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 2. Liming

- | |
|---|
| <ul style="list-style-type: none">• Apply lime, in recommended quantities, during pond preparation |
|---|

- **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 3. Intake water

- | |
|---|
| <ul style="list-style-type: none">• Water should be screened before entering the ponds using small mesh at the inlet pipe. |
|---|

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 donot 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 4. Selection of seedstock for stocking
<ul style="list-style-type: none">• A full history of the hatchery where seedstock were produced should be obtained: number of male and female broodstock, their age and size, and how the hatchery procure their broodstock (See more in Part E – BMPs for hatcheries).• It is recommended that seedstock be from broodstock of 3-5 years of age, which have noted spawn more than twice in the one season.• Seedstock should be healthy, and have no signs of external physical damage.• Seedstock should be uniform in size and properly weaned before transportation.

- **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 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 5. Seedstock transportation
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- | |
|--|
| <ul style="list-style-type: none">• Starve the purchased seedstock for 24 hrs before packing for transportation• Packing and transportation of seedstock to be done under mild conditions and not exposed to the sunlight• Pack less than 25 fingerlings per litre of water• The time gap on purchase and transportation of seedstock to farm to be less than 6 hours• If the transportation time is likely exceed 2 hrs a mild anaesthetic (sedative) may be used, under supervision, to make the fish inactive and reduce stress. |
|--|

- **Step 4: Acclimation and release of seedstock**

On arrival of seed stock to 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 be 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 6. Acclimatise seedstock

- **Acclimatise the seedstock to the pond conditions (temperature) prior to release specify duration**
- **Feed mildly for the first three to four days after release**

- **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 breathe 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/m² (mean 48 ± 2.1 se) and 5-31 fish/m³ (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 yield in the farms increased linearly in relation to SD. However, it is suggested that the SD should not exceed 80-100 fish/ m² and/or 18-22 fish m³.

BMP 7. Stocking density (SD)

- **The SD to be used should not exceed 80-100 fish/ m² and or 18-22 fish m³**

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 10th 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.

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 8. Water exchange

- **Reduce the water exchange rate and frequency by 5% of the current usage as an interim measure. Water exchange rates to be further evaluated when more scientific data becomes available in due course.**
- **Introduce a water intake and discharge schedule/ calendar for all farms in each 2 km stretch of the river.**
- **Evolve a simple communication strategy, such as by SMS, to inform all farmers of the group of discharge and intakes.**
- **Filter/screen the intake water.**
- **Endeavour to have a reservoir tank/ canal to store water before discharge**

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.

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 highly toxic hydrogen sulphide. The impacts of these may necessarily cause mortality but stress the catfish leading to increased susceptible to disease and reduced growth. Also, these impacts can become more intense when the oxygen levels in the water are relatively low, particularly at night.

In BMP it is desirable to have at least one paddle wheel, that is operated for a few hours in the night to maintain oxygen levels and circulate the water.

BMP 9. Improve oxygen content in the pond in the at night
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- | |
|---|
| <ul style="list-style-type: none">• Introduce and operate at least one paddle wheel for at least a few hours at night. |
|---|

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.

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 suitable 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 10. Monitor pond water quality and record keeping for water quality
<ul style="list-style-type: none"> • Water quality (temperature, pH, salinity, ammonia) should be monitored at least once a week. • Regular and uniform record keeping of water quality parameters.

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 2. 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 3. 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.

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

BMP 11. Management of stock when fish have “whole body yellow” symptom (likely and thought to be caused by feed)
<ul style="list-style-type: none"> • Stop feeding stock for two to three days • Check whether the feed used is rancid; if so discard. • Change the feed used.

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 tend to get 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 12. Feed procurement and storage

- **The time between manufacture and use of the feed should not exceed two weeks.**
- **Feed should be stored to permit good 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 must be discarded.**

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 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 13. Feeding

- **Ensure that the feed is not rancid and of good quality**
- **Feed no more than three times a day, when the air and water temperatures are at a minimum; do not feed on mid-day when the sun is up**

Feed up to a maximum of 5 % of the body weight per day in the early stages (up to about 50 to 80 g body weight), and as the stock grows reduce the feeding rate to about 2 to 3% body weight per day

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.***

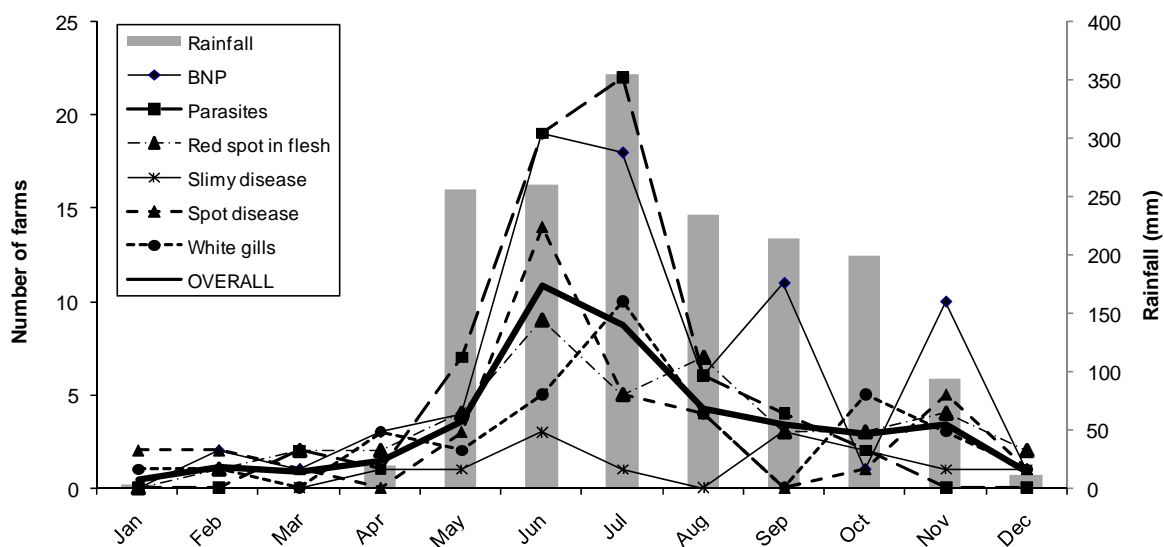


Figure 4. Common diseases found in catfish in the production cycle. Rainfall (mm) are average values obtained from nine provinces of the Mekong Delta.

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.

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.

BMPs

- **Regularly observe fish for abnormal or unusual behaviour.**
- **Record all disease symptoms and progression of development and size of the affected stock.**
- **Remove and safely dispose all dead fish (preferably cooked before disposal – and not selling to other fish farmers).**
- **Submit moribund samples for disease diagnosis**
- **Do not use chemicals without understanding the primary etiology of the disease (for example - for yellow coloration in catfish - this condition could be mainly a non-infectious condition. No chemical will help to solve the underlying problem.**
- **Use treatments very judiciously based on diagnosis results**
- **When discharging water from diseased ponds, inform other farmers in the area**

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 continually 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 xxx 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 14. Broodstock ponds

- **Broodstock ponds should not be larger than 1 ha in size.**
- **Pond dike should be strong and higher than the maximum flood level to prevent broodstock from escaping due to flood.**
- **Remove all obstructs from the pond bank for easy netting and transportation of brood fish.**
- **See BMP 1 and 2 for suggestions on pond bottom treatment.**

1.2 Broodstock conditioning

Currently the stocking density for broodstock is highly variable, ranging from 240 -20,000 tails/ha. Broodstock should be maintained under less crowded conditions than in grow-out. *Ideally, no more than 1 fish per m², 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.***

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 commercial 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 2-3 months prior to spawning. It is noted that attempts were made to improve protein content in the diet for broodstock. However, 60% protein in catfish broodstock diet seems **too high and it is necessary** but better 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 15. Broodstock conditioning

- **Broodstock density should be less than 1 tail/ m²**
- **If commercial grow-out diets are used for broodstock, improve the diet to minimum level of protein of 30% but it is not necessary to increase the dietary protein levels beyond this.**
- **Providing diets with protein content higher than that required for normal growth and well being of catfish will be wasteful. What has to be ensured is that the protein in the diet is digestible and has a *balanced amino acid profile* which is best provided for through the use of fish meal of marine origin, and a mix of diets**
 - **However in the absence of fish meal of marine origin it is best to use a range of animal protein sources to obtain a proper amino acid balance.**
- **Ensure that the fish get a variety of lipid sources in its diet over the three month period prior to spawning to ensure that the fatty acid requirements for oocyte maturation are fulfilled**
- **Special diet for broodstock should be used about 2-3 months before breeding.**

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.*

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

BMP 16. Spawning

- **Fish of under 2.5 or over 8 years old should not be used for breeding.**
- **Only matured and healthy fish should be used for spawning.**
 - **Male: running thick milt**
 - **Female: uniform egg size and colour**
- **Anaesthetics should be applied during hormone injection and stripping to reduce stress on broodstock.**

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 17. Hatching/ care of hatchlings

- **Ensure that the fertilized eggs are kept in constant motion and water is exchanged continuously.**
- **Use subdued light condition.**
- **If there is evidence that the female performance is below average, do not use for spawning and remove the animal from the broodstock.**
- **Remove dead eggs on a regular basis, where possible.**
- **Do not use any chemicals during incubation and hatching.**
- **Maintain each spawning separately, and record the performance (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 (Figure 5).

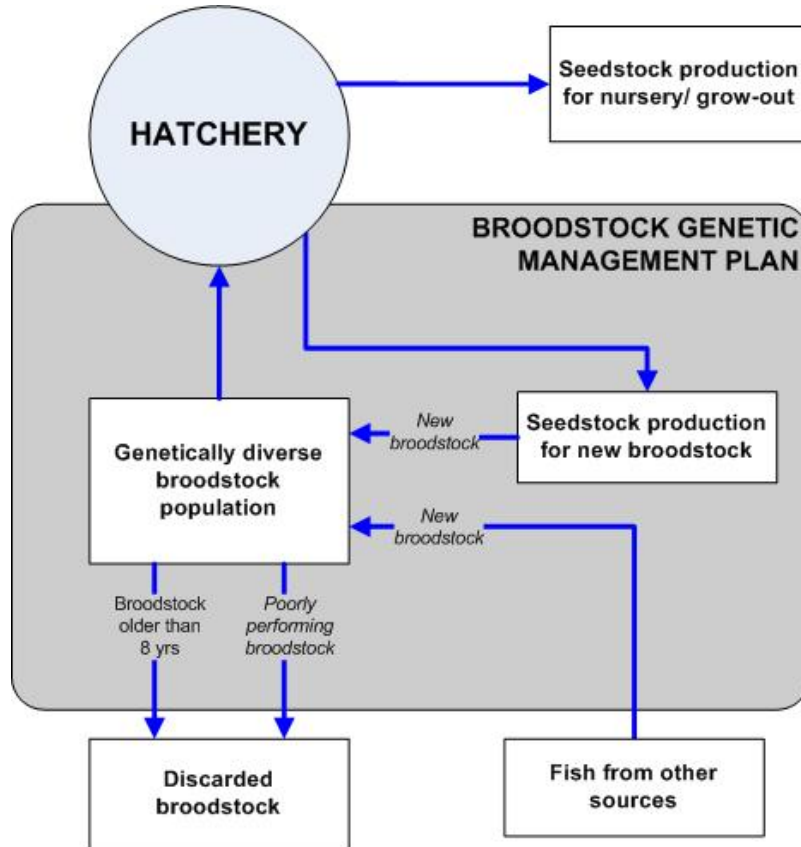


Figure 5. Schematic diagram showing major activities of a catfish hatchery

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 large 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 18. Genetic management

- **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:**
 - **Spawn as many different parents as possible to increase EBN.**
 - **Maintain a sex ratio of 1:1 in spawnings.**
 - **Increase number of parents can be done by 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.**
 - **Stretch generation time interval for the replacement of parents with their offspring.**
 - **Procure broodstock from other sources as new broodstock. If 10-25% of new brood fish are procured each generation, the amount of inbreeding can be drastically reduced.**
 - **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.**
 - **A factorial mating pattern can be used to increase EBN, which will minimise inbreeding.**

PART D. GENERAL ASPECTS IN RELATION TO BMPS

1 Use of chemicals

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 MARD, 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 19. 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 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:

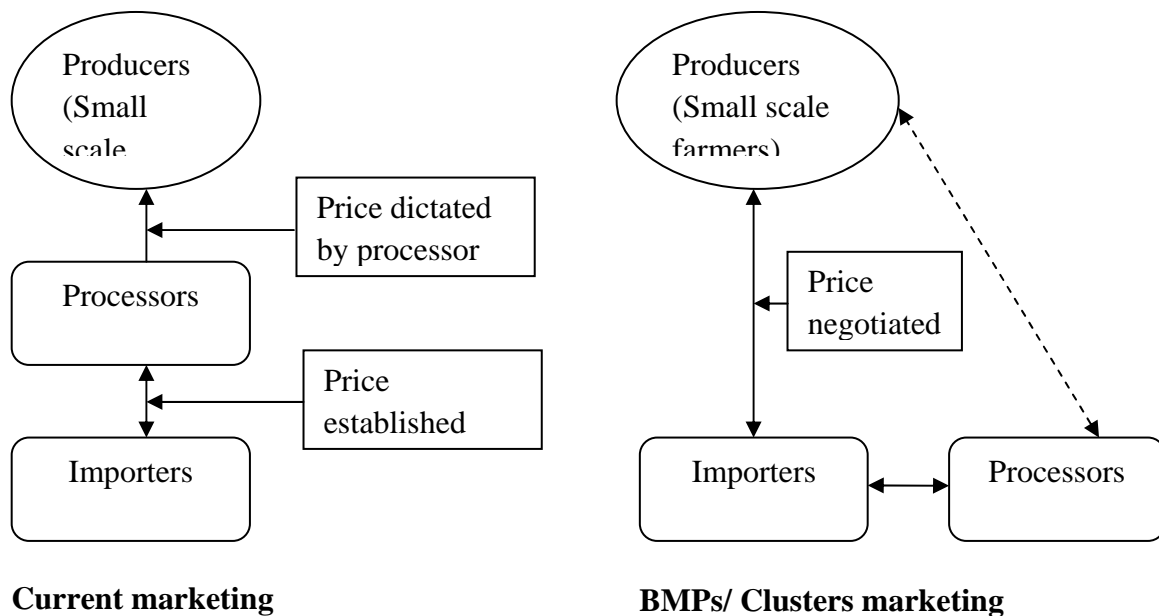
- The production process is clean and acceptable and will result in a produce that ensures food safety standards and quality

- 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.



PART E. 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.

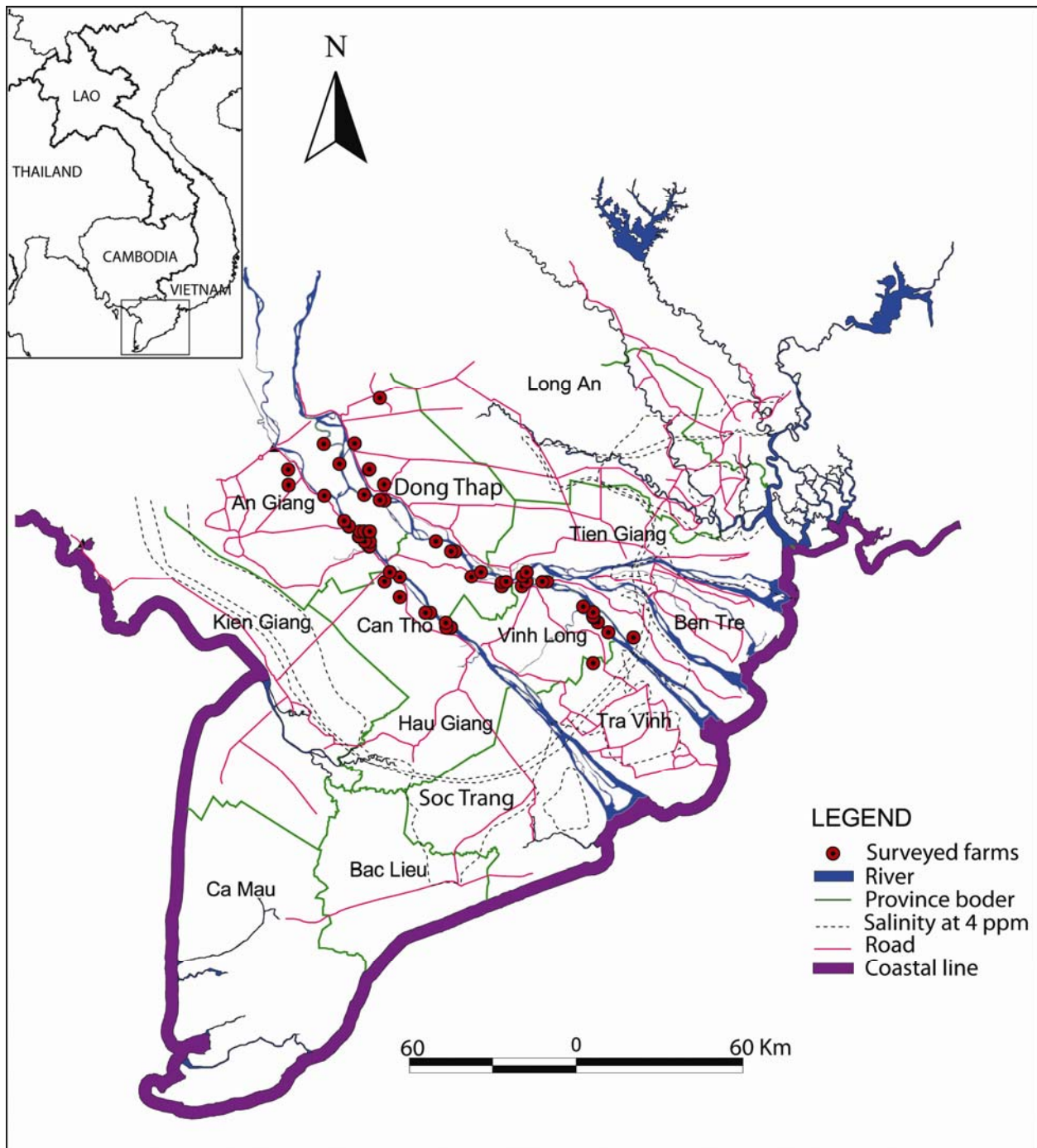
2 Pathway to the formation of clusters/ Associations

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 six 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 Delta



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

Anti-bacteria
BKC
Chlorine
CuSO₄
TCCA
Dipterex
Ensova
Formalin
KMnO₄
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
KMnO₄
Lime
Oxytetracycline
Probiotics
Protexol
Salt
Saponine
Super charge
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 message:

1. <http://www.bar.gov.ph/agfishtech/fish/pangasius.asp> Filpine Bureau of Agricultural Research. An online program to rnsure adequate, accessible, affordable and nutritious food for all Filipinos.
2. <http://www.whytaveltofrance.com/2007/08/03/buying-fish-in-france-a-warning/> Some comment from France blogger own experience.

So Which is true??