

Draft Tanzania Standard

**Code of practice for aquaculture production
Part II - Freshwater and marine animal farms**

FOR PUBLIC COMMENT ONLY

Part II - Good aquaculture practices for freshwater and marine animal farms

0. FOREWORD

The science of cultivating marine or freshwater food fish, such as salmon and trout, or shellfish, such as oysters and clams, under controlled conditions has been developed and fish production is growing. Farmers have experienced survival of up to 100% with increased growth rates. Therefore, this code of practice has been prepared to guide fish farmers especially freshwater and marine animal farms tilapia farming in order to ensure safety and quality of produce under aquaculture.

1. SCOPE

This draft standard provides guideline on Good Aquaculture Practices (GAP) at all stages of farm practices in freshwater and marine animal culture ,harvesting and post-harvest handlings prior to transportation in order to produce safe and quality products for human consumption. This standard does not cover hatching and nursing.

2. NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CAC/RCP 52-2003, *Code of practice for fish and fishery products*

3. TERMS AND DEFINITIONS

For the purpose of this standard the following terms and definitions shall apply.

3.1 freshwater animal

animals living entirely or most of the time in freshwater or most of the life-cycle living in freshwater such as river, canal, swamp, and reservoir.

3.2 marine animal

animals living entirely or most of the life-cycle living in marine water such as ocean

3.3 farm

an aquaculture production unit (either land-or water based); usually consisting of holding facilities (tanks, ponds, raceways, cages), plant (buildings, storage, processing), service equipment and stock for raising of marine or fresh water animals as indicated in 3.1 and 3.2

3.4 pond

man-made water storage for freshwater aquaculture such as earthen pond, concrete pond, canvas pond and plastic pond

3.5 cage

container enclosed on all sides and bottom by mesh materials that permit free exchange with surrounding water

3.6 veterinary drug

any substance applied or administered to any food-producing animal, whether used for therapeutic, prophylactic, or diagnostic purposes or for modification of physiological functions or behaviour

3.7 residues of veterinary drugs

veterinary drugs as in 3.5 including parent drug, metabolites and associated impurities in the animal tissue, produce and products of animal which are used for human food.

4. GUIDANCE ON GOOD AQUACULTURE PRACTICES FOR FRESHWATER AND MARINE ANIMAL FARM

For the development of freshwater and marine animal farms production system to be in line with international standard, farmers should follow good aquaculture practices so as to visualize and understand the practical concept of standard operation procedures. Principles of the freshwater and marine animal farms production take into consideration some important factors.

4.1 Site

Site is the first priority which farmer should consider prior to farming commencement. The location of freshwater and marine animal farm should be complied with relevant laws and met with the technical requirements in order to obtain quality products with minimal problems.

4.2 Pond

4.2.1 Farm registration is required by contacting the designated competent authority at the local offices. The registered information will be useful for relevant government agencies to locate the farm and to provide assistance to the farmers. Farmers should provide legal document on land use rights, or lease contract for farm registration.

4.2.2 Farm should be kept distance from or not affected by polluted sources, such as industrial factories and waste from communities. Practically, farm should be kept distance from the polluted sources; however, polluted sources are now widely expanded and closer to aquaculture farm. Therefore, soil and water samples should be taken for analysis to assess the suspected risk factors from such sources. By current technology on aquaculture, appropriate method for preventing the impact from pollution can be applied. Moreover, farm site should not be, if possible, located in the area prone to flooding in order to avoid damage and contamination. In case farm is located in flooding area, protection should be provided.

4.2.3 Good design of water inlet and outlet system should be provided in order to prevent cross contamination among ponds and between inside and outside of farm. In addition, such good system can save energy and cost of water pumping in and out of the farm as well as facilitate the farm management.

4.2.4 Farm site should be conveniently accessed such as by road for cars, river or canal for boats to facilitate the transport of seed, feed, inputs and other farm utilities. Such convenient accessibility is essential for production management and marketing

4.2.5 Earthen pond should be impervious in order to reduce the leakage during the culturing period. Soil should have appropriate properties or be able to be improved for safe aquaculture practices.

4.3 Cage

4.3.1 Farmers should register their farms with the competent authority at the local office. The registration will be necessary for official and related authority for identification of location and facilitation of government support.

4.3.2 Cage should be located in the area where water source is of good quality, suitable, sufficient and of good circulation. Water quality suitable for freshwater aquaculture should have pH 6.5-9.5 and dissolved oxygen not less than 4 mg/l.

4.3.3 In general, cage site should be located away from polluted sources. In case the cage is subjected to tide or upstream or downstream area, farmer should acquire information demonstrating the cage is not affected by such pollution. . Pre requisite information such as possibility and levels of pesticide contamination in the water, outflow from the other agricultural activities located at upstream Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) analysis is required

4.3.4. Cage-site should be located in the area of good accessibilities (i.e. road, river, canal, etc.) This will be convenient for receiving seeds, feeds, and other inputs. This is essential for management and marketing throughout the farm's production processes.

4.3.5 Cage should have necessary basic infrastructures according to farm area condition for convenience of farm management such as electricity for water pump, aerator, or diesel engine water pump, tap, or underground water, or rain water or clean water that fits for consumption.

4.3.6 Permission from competent authority should be obtained to orderly place cages such that it does not obstruct the flow of water or the navigation of water vessels such as boats. It shall also be in a place that facilitates adequate aeration for best growth of the fish with minimal disturbances from aquatic plants. In addition, area for cage culture should be opened, no strong flow of water or wind nor crowded by aquatic plants which hinder water flow through the cage.

4. GENERAL FARM MANAGEMENT

Farm management is a plan to prepare for rearing which is vital for successful aquaculture. If farmers can apply the practices well, suitable to the site and season, there will be only few problems on daily basis. The recommendations are as follows:

5.1 Pond

5.1.1 Farmer should follow the manual on freshwater and marine animal farm published by the Department of Fisheries or other equivalent technical manuals. The recommended practices for earthen pond aquaculture are as indicated here below

5.1.1.1 Pond Preparation

Freshwater and marine animal farm requires good preparation. In particular, the old culture pond may have the decayed bottom where disease and hydrogen sulphide (H₂S) are accumulated. This may contribute to negative impact on the health of aquatic animal. Therefore, preparation of a new and old pond should be done as follows:

(a) New Pond

Problem involving acidic soil can be found in new pond. It can be observed by the orange-red rust or yellow colour of soil in the pond. In general, this soil indicates pH 2 - 3 and may not be suitable for aquatic farming because the acidic soil will result in acidic water. In such case, it is recommended to fill water into the pond to cover soil surface for approximately 7 days, and then drain water and repeat this until the pH of the soil reaches 6.5 to 9.5. Liming can also be used to adjust pH of the soil by scattering 200 to 300 kg of lime per 1600m² (0.6Hk) around the area. However, if there is not enough water supply, amount of lime should be increased to 400- 500 kg per 1600m² (0.6Hk) until the pH is adjusted as required. Also, chicken or cow manure, dried or decomposed for 60 days can be used.

(b) Old Pond

After each harvest, sludge at the bottom of pond should be taken out prior to pond drying process. This sludge should not be left on the dike or drained directly to the public water resource. It should be collected in a sludge pond or plowed with tractor approximately 2 to 3 times to incorporate oxygen into the soil and then dried for 2 weeks before the next crop. The dike should be adjusted to be ready for use. If there is waterlogging at the bottom of the pond where some other aquatic animals remain,

saponin at the concentration of 15 mg/l to 25 mg/l depending on the salinity of water, or 1 g of 100% rotenone solution per 1 m³ of water in culture pond, or 20 g of 5% rotenone solution per 1 m³ of water in culture pond should be diluted and splashed into the pond (rotenone is toxic to fish and insects). Liming should be used to disinfect and improve quality of the bottom of the pond thereafter.

5.1.1.2 Water preparation

Due to the fact that freshwater and marine animal farming techniques differ among species, water preparation techniques are also different. However, the principles are the same. After pond preparation, water should be pumped into the pond from 30 to 50 cm in depth, filtered with double layers of green cloth filter net (mesh size of 24-26 meshes/inch) to protect larvae from predators and other larvae from nature. For the first preparation, the dried or 60-day fermented compost at the rate of 100-150 kg/1600m² (0.6Hk) should be spread around the pond and left for 7- 8 days until the water turn green. This produces natural feeds in terms of phyto- and zooplankton.

During culturing period, natural feed should be produced at all times in order to save the cost of feed as well as to balance the ecosystem in the pond. This can be done by applying the principle of “small amount but high frequency” of the dried or 60-day fermented compost at the rate of 25-50 kg/1600m² (0.6Hk/month). Moreover, farmer should not overfeed during this period because the leftover feed will be the major cause of water pollution.

5.1.1.3 Water quality for culture pond

Water quality suitable for culture pond should be as follows:

- a) pH of 6.5 - 9.5;
- b) BOD not exceeding 20 mg/l;
- c) Dissolved Oxygen (DO) not less than 4 mg/l;
- d) NH₃-N not exceed 1.1 mg/l; and
- e) Alkalinity not less than 50 mg/l.

5.1.1.4 Procedures for resolving low level of dissolved oxygen

Level of dissolved oxygen in the pond should not be less than 4 mg/l. However, the lowest level of dissolved oxygen in water of the pond will commonly occur in early morning. Farmers should regularly check dissolved oxygen or observe whether there are numbers of aquatic animals swimming at the surface. In such case, aerator should be operated to increase dissolved oxygen or exchange water in the pond. In addition, temporarily stop feeding or decrease the amount of feed should be practiced.

5.1.1.5 Water exchange

In case where water quality is not suitable and it is necessary to exchange or refill water from outside the farm, water should be filtered with double layers of green cloth filter net (mesh size of 24-26 meshes/inch) to protect larvae from predators and from nature. Effluent from water exchange or during harvest should not be discharged directly to the public water resources. In case effluent is discharged directly to the public water resources, its parameters should meet the specification

required by laws.

5.1.1.6 Feeding

Feeding can be done either by sowing or using feed container. The amount of feed and number of meals in a day should be suitable for species and age of each aquatic animal. Farmers can start feeding with small amount at several spots and observe the feeding behaviour. For instance, if aquatic animals snatch feed which is thrown into the pond, it can be interpreted that the feed are insufficient. In this case, new feeding spots should be increased. If the aquatic animals do not seem to be interested in the feed, farmers should stop feeding and remove the leftover feed from the pond before it sinks to the bottom because this would easily cause the decay at the bottom of the cage or pond.

5.1.1.7 Farm map and layout

Farm map and layout should be made available for transportation of aquatic animal fry, delivery of inputs, feed, being visited by visitors, fishery extension officers, farm inspection officers, harvest and transport of aquatic produce by the collectors who distribute the produce. Moreover, farmer should have farm layout for management and planning purposes.

5.1.1.8 Effluent treatment

Effluent should be treated prior to discharging. If farm size is over 10 rai, the effluent parameters should meet specification required by laws as follows:

- a) BOD not exceeding 20 mg/l; and
- b) Suspension solid not exceeding 80 mg/l.

Source: Notification of the Ministry of Natural Resource and Environment entitled Specification of the Standard Controlling Discharge of Effluent from freshwater and marine animal Pond (B.E. 2550)

5.1.1.9 Herbivorous Freshwater Aquatic Species

5.1.1.10 Technical meetings or training programs on farm management, use of production inputs and harvesting and laws and regulation relevant to freshwater aquatic animals farming should be attended to enhance and develop knowledge.

6. CAGE

6.1 Farmers should prove that their farm practices followed the manual of freshwater and marine animal cage published by the competent authority or responsible agency, or other relevant technical information.

6.2 Cage sizes and materials, i.e. wood, bamboo, nylon, green cloth filter net, are varied depending on species and size of aquatic animals and location of the farm. Generally, farmers are to use the cage size of 3x3x2.5 m³ or 4x4x2.5 m³ or 5x5x2.5 m³.

6.2.1 Cage location

Cage location should not obstruct water transport. Setting the cage along the banks is recommended for culturing in canal. In a larger area, the size of cage location can be expanded as appropriate but it should not obstruct water traffic. The cage should not be lined up more than 4 or 5 rows.

6.2.2 Cage interval

Cage interval should be at least 50 cm to ease water flow through the cage and minimize waste accumulation at the bottom of the cage. Furthermore, the depth of the cage should not be deeper than 1 meter from the bottom even in the driest season.

6.3 Cage map and layout should be made available for transport of aquatic animal fry, delivery of inputs, feed, being visited by visitors, fishery extension officers, farm inspection officers, harvest and transport of aquatic produce by the collectors who distribute the produce. Moreover, farmers should have farm layout for management and planning purposes.

6.4 The number of cages should not exceed the capability of the water source in order to prevent the negative impact and preserve the sustainability of the environment. The total number of cages should not exceed that is permitted by the Department of Fisheries.

6.5 Technical meeting or training program on farm management, use of production inputs and harvesting and laws and regulation relevant to freshwater aquatic animals farming should be provided to enhance and develop knowledge of farmers and other relevant workers in applying good aquaculture practices correctly and appropriately.

7.6 Farmers should manage the area, buildings, cages, and culture according to good hygienic practices both inside and outside the cage. Equipment should be cleaned and kept orderly.

7 SIZE OF AQUATIC ANIMAL SEED AND STOCKING DENSITY

Size of the aquatic animals for stocking varies with the mesh size of the cage while stocking density depends on the size of the aquatic animals and cage size. In addition, season is also vital to stocking density. In case of the winter season, the stocking density should be lower than other seasons because aquatic animals are weaker and more susceptible to diseases. Conditions of the water source are other important factors for stocking density. For example, stocking density in still water such as dam or reservoir should be less than in the river, which has more suitable flow speed and better quality of water.

7.1 Cleaning of cage

Regular cleaning of the cage should be done, especially for the cage located in the area of still water which can accumulate waste and later cause problem of water pollution.

7.2 Aeration

In case of low dissolved oxygen in the water, aeration is recommended. This can also be done by exchange of water through the cage by aerator, or pumping the water from the cage up to the air by electric pump.

7.3 Feeding

Feeding can be done either by sowing or using feed container. The amount of feed and number of meals in a day should be suitable for species and age of each aquatic animal. Farmers can start feeding with small amount at several spots and observe the feeding behaviour. For instance, if aquatic animals snatch feed which is thrown into the pond, it can be interpreted that the feeds are insufficient. In this case, new feeding spots should be increased. If the aquatic animals do not seem to be interested in the feed, farmers should stop feeding and remove the leftover feed from the pond

before it sinks to the bottom because this would easily cause the decay at the bottom of the cage or pond.

8 INPUTS

There are varieties of inputs for aquatic animal farming such as fry, feed, feed supplement, vitamins, probiotic, veterinary drugs, liming, salt and chemicals. However, selection of the inputs depends upon age and size of the aquatic animal, stocking density, methods of aquaculture and harvest size. Recommendations are as follows:

8.1 Selection of good quality fry

Quality of fry is an important factor for the success of farming. Good quality and healthy fry, which can better adapt to the environment, or fry from the brood stock with good growth rate are other factors for farmer should be taken into account. Before purchasing, farmer should request for reliable documents. In addition, appropriate stocking density of the fry should be considered as over stocking density will cause stress and sickness easily, which will create problems and slow growth.

8.2 Farmer should request official fry movement document (FMD) from hatchery in order to ensure product quality and traceability in case any problem occurs.

8.3 In case of using manufactured inputs such as feed, feed supplements, and vitamins purchased from factory or distributor, they should be registered products with the competent authority and label specified nutrition values, production and expiry dates. Before use, farmer should observe the label to ensure that the feed is in good condition. There should not be laceration of the package, excessive moisture, mouldy, and the product should be within the expiry date to ensure good quality of feed.

8.4 Inputs excluding feeds, feed supplements, vitamins, minerals, and other relevant feedstuffs should be free from prohibited veterinary drugs and chemical residues according to the official notifications e.g. nitro furan, chloramphenicol, and malachite green. For instances, colouring solution for adjusting water quality should not contain malachite green; or fine rice bran should not contain nitro furan, or chloramphenicol; or antibiotics permitted to use should not be contaminated with nitro furan, chloramphenicol or malachite green.

8.5 In case of feed prepared on farm, raw materials such as fish meal, soybean meal, rice bran, and broken milled rice should be free from prohibited veterinary drugs and chemicals according to official notifications in order to avoid residues of veterinary drugs and chemicals in the animal tissues.

8.6 Tools and equipment for preparing feed on farm should be clean and hygienic. For instances, prior to or after using those tools and equipment they should be clean and dried up, maintained to be ready for use and kept orderly. In addition, preparing feed on farm should be hygienic, clean, and safe for the aquatic animals and consumers. For instance, ingredients and feeds should be placed on clean containers, not to contact directly to the ground or the processing floor to protect them from germs and hazardous substances residues. Attention should be paid to prevent contamination from cockroaches, flies, birds, rats, dogs and cats during the feed preparation process

8.7 Feed prepared on farm should have appropriate quality to meet the nutrient recommendations of aquatic animals. Low quality feed will cause slow growth rate which will require longer culturing period, high cost of production, and undersized aquatic animal. These will certainly cause low price of the product.

8.8 Inputs should be properly and orderly stored, and clearly separated and defined in a hygienic and safe condition in the warehouse and designated area, away from heat, moisture, sunlight, rain, strong wind, with good ventilation system. In addition, the warehouse should be protected from disease

carriers of aquatic animals and human such as rats, cockroaches, flies, birds, dogs, and cats etc. The inputs should be placed on a pallet, not contact the ground, to prevent from deterioration. For example, feed bag should be kept in a warehouse and separated from other inputs on a pallet approximately 10 cm above the floor and away from the wall to protect moisture causing the feed to be easily mouldy. Veterinary drugs should be stored in accordance with the instruction specified in the label or attached document. Prescribed veterinary drugs should be kept separately from others. Veterinary drugs and chemicals for different aquatic animals should be kept orderly in groups, in closed containers and away from children and pets.

9. HEALTH MANAGEMENT FOR AQUATIC ANIMAL

Protection is the best measures to control and manage aquatic animal health. Major factors which should be considered in aquatic animal farming are management and environment. Improper management, such as too high stocking density, mismanagement in production system or farming in vulnerable environment such as climate fluctuation, polluted water, and accumulation of leftover feeds, will lead to stress and causing disease infection of the aquatic animals. The use of veterinary drugs and chemicals for treatment of disease should be the last option. Better management will result in better health to recover from sickness. Prevention and treatment of disease depend upon the cause of disease. Recommendations for aquatic animal health management are as follows:

9.1 Pond

9.1.1 Proper preparation of pond and equipment appropriate for culture can prevent disease. In particular, improper preparation of earthen pond used to rear the aquatic animals can cause diseases. Equipment should be regularly cleaned because they may be in contact with the animals and cause infection, for instance, dirty feed container and leftover feed will be deteriorated and harbor diseases. Wounded animal or animal wounded by scratching with container will be susceptible to the disease and become weak and finally infected.

9.1.2 When the aquatic animals show abnormal sign, the causation should be considered before applying veterinary drugs or chemicals. After the cause is found, corrective actions on farm and environmental management and improvement should be taken. For example, a lot of animals floating on the water surface in early morning indicate insufficient dissolved oxygen, therefore aeration should be carried out by using aerator or spraying water through the air down to the pond using electric pump. If there are other associated occurrences, such as dark green color in the pond which indicates over blooming of phytoplankton, water exchange and reduction of the additional feed should be undertaken. Farmer should record the symptoms of aquatic animals and other analysis report, where possible, together with each corrective action for further diagnosis of the symptoms effectively.

9.1.3 Where necessary, registered veterinary drugs and chemicals should be used. Prohibited veterinary drugs and chemicals should not be used. The instruction on how to use them, especially the withdrawal period, should be strictly followed. The use of veterinary drugs and chemicals should be recorded each time and used under advice of veterinarian or fishery officer with expertise in aquatic animal disease. The expired drugs should not be used. Records should be kept for at least 2 years.

9.1.4 Nitro furan, chloramphenicol, and malachite green, etc., which are prohibited veterinary drugs and chemicals, should not be used.

9.1.5 Normally, immediate inspection for the cause of death should be conducted but in the case of outbreak, where large number of death occurred, the competent authority should be promptly notified. Appropriate methods for carcass disposal e.g. burning, burying with the use of disinfectant or lime, etc. should be used. Water from the infected pond should be disinfected and treated before discharge.

9.2 Cage

9.2.1 Cage preparation is very important and necessary for culture such as cleaning and unblocking the mesh of cages to improve water circulation. If the cage has been used for diseased aquatic animals, the cage should be disinfected by chlorine, formaldehyde or potassium permanganate before reuse to prevent the spreading of disease. Cage setting location is also an important factor to be considered in order to prevent negative effect on the environment, and accumulation of feed leftover around the cage.

9.2.2 Cage and equipment should be regularly cleaned throughout the culture process to allow water flow in out at all time in order to remove the waste. In this case, the good condition for culture will be maintained at all time and will encourage the animals to move and grow more rapidly.

9.2.3 The aquatic animal's health should be regularly monitored and taken care of, together with checking water quality, for example random checking or observing the abnormal signs, namely floating on the water surface, imbalance swimming, anxious sign, and improper water quality, etc., should be regularly done. In case of problems, diagnosis should be conducted so that the corrective action can be appropriately taken prior to disease spread.

9.2.4 When the aquatic animals show abnormal sign, the causation should be immediately identified and corrective actions on farm and environmental management and improvement should be taken before applying veterinary drugs and chemicals. For example, if there is unusual number of animals floating on the water surface, water quality should be analysed and the daily record of animal's health from the past week should be checked in search for the cause of problem. At the same time, the symptoms of aquatic animals and corrective actions implemented should be recorded. In case of low level of dissolved oxygen, spraying water through the air using electric pump, cage cleaning, and reducing feed should be considered.

9.2.5 Where necessary, registered veterinary drugs and chemicals should be used. Prohibited veterinary drugs and chemicals should not be used. The instruction on how to use them, especially the withdrawal period, should be strictly followed. The use of veterinary drugs and chemicals should be recorded each time and used under advice of veterinarian or fishery officer with expertise in aquatic animal disease. The expired drugs should not be used. Records should be kept for at least 2 years.

9.2.6 Nitro furan, chloramphenicol, and malachite green, etc., which are prohibited veterinary drugs and chemicals, should not be used.

9.2.7 Immediate inspection for the cause of death should be conducted. Transfer of the aquatic animals, where necessary, should be done carefully and gently. In the case of outbreak competent authority i.e. veterinarian or fishery officer or local officer of the Department of Fisheries should be immediately notified. Appropriate methods for carcass disposal e.g. burning, burying with the use of disinfectant or lime, etc. should be used. In such case, the waste water from treating of infected animal should be disinfected and treated before discharge.

10. FARM SANITATION

Cage and pond culture should require good management including farm sanitation as it is necessary for keeping good quality of aquatic products. Daily supervision of farm sanitation will facilitate farmer establishing farm standard in compliance with recommendations as follows:

10.1 Pond

10.1.1 Discharge from household should be separated from farm in order to prevent contamination in the water system of the farm, or the release to the pond or farm nearby. For example, household discharge should not be drained to the same furrow of farm water system or reservoir.

10.1.2 Lavatory should be completely separated from the farm area. Waste management system should consider hygienic condition. It is needed to ensure that waste water cannot leak to the farm system. Bacteria contamination, a major cause of gastrointestinal disease, should be monitored by collecting water sample for analysis of coliform bacteria. Immediate response to such problem should be conducted. The number of coliform bacteria should not exceed 5,000 most probable number per 100 millimetres (MPN/100ml), and the faecal coliform bacteria should not exceed the natural level. In case that the number of bacteria exceeds the value specified by the standard, it is an indication of contamination of waste disposal from lavatory, household, or pets.

10.1.3 Availability of proper treatment system of aquaculture waste i.e. aquatic animal's carcass, veterinary drug and chemical containers required for disposal method of burning or bury depending on type of waste.

10.1.4 Tools used on farm should be orderly arranged, clean, in hygienic condition, and maintained to be ready for use. Workers' housing, office, feed store, warehouse, feed preparation area, and buildings should always be kept clean and well maintained.

10.1.5 Good management system and routine collection for garbage are required. Trash bin should have lid in order to prevent flies, rodents, cockroach, and pets. Garbage should be correctly abolished in designated area using the proper method.

10.2 Cage

10.2.1 Lavatory should be completely separated from the cage area. Sanitary condition should be considered to ensure that waste will not leak and contaminate the system. In case that lavatory is located on land, sewage should not be directly discharged or leaked to the cage area.

10.2.2 Tools used on farm should be orderly arranged, clean, in hygienic condition, and maintained to be ready for use. Workers' housing, office, feed store, warehouse, feed preparation area, and buildings should always be kept clean and well maintained.

10.2.3 Garbage should not be discarded to the cage area. Garbage collection area should be properly arranged and well managed. Trash bin should have lid in order to prevent flies, rodents, cockroach, and pets. Garbage should be correctly abolished in designated area using the proper method.

11. HARVEST AND POST-HARVEST PRACTICES

Harvest is the final step in the aquaculture which is vital for maintaining quality of the products. As the aquatic products will be sold for human consumption, farmer should therefore pay attention to the following recommendations:

11.1 Farmer should have a good harvest plan and rapid distribution emphasizing on freshness of the product and harvest of healthy aquatic products in order to keep premium quality. The good plan is also to avoid contamination of aquatic products during harvest and post-harvest.

11.2 The Movement Document (MD) issued by the Department of Fisheries or equivalent authorized agency should be made available to provide consumers or relevant stakeholders or processing its background information on the source of aquatic animal products for further consumption.

11.3 During the process of freshwater aquaculture grow-out period in the pond or cage, tissue sample of the aquaculture product should be randomly checked by the authorized laboratory or well recognized institute accredited by international standard organization at least once a year. The analyses are for the veterinary drugs and chemicals which are allowed and prohibited for use according to the official notification as well as bacteria causing the gastrointestinal disease. The prohibited veterinary drugs and chemicals should not be found. The allowed veterinary drugs and chemicals and bacteria causing the gastrointestinal disease should not exceed the maximum limits specified by the standard.

11.4 For good quality and safety of freshwater aquaculture product, guidelines for management method and maintenance during harvest and post-harvest process should be as follows:

11.4.1 During the aquaculture, farmer should not bring pets (e.g. duck, chicken, cow, dog, cat, etc.) close to cultured pond or cage area. In case of using pet to protect farm's asset, farmer should keep their defecated waste away from cultured area and frequently clean the area.

11.4.2 Some freshwater aquaculture products may have problem with muddy taste such as in tilapia meat. The cause of muddy taste is mainly due to the accumulated consumption of blue-green algae in the pond. Recommendations for solving this problem are as follows:

11.4.3 In order to reduce the blue-green algae in the water, compost should not be used at least 2 months prior to harvest; additional feed or supplementary feed should be provided, together with water exchange. However, the caution should be emphasized on over-feeding of supplementary feed because accumulated feed is a source of blue-green algae blooming.

11.4.4 Muddy taste in the meat should be determined by tasting the steamed fish sample without seasoning. If the meat does not contain muddy taste, the product can be sold.

11.4.5 Prior to selling product, feeding should be stopped one day before harvest for self-adjustment and defecation of the aquatic animals. This way, quality and freshness of the aquatic product can be kept during transportation as well as can prolong rotting.

11.4.6 The personnel handling and relating to aquaculture animal should be healthy and has no infectious diseases which are not accepted by the consumers. Worker(s) who has been infected should take leave and return to work after recovery.

11.4.7 Tools, equipment, and harvesting method should not cause negative effect to the quality of aquatic animal and post-harvest storage as well as cause contamination affecting food safety. Harvested products should not be directly contacted on the ground.

11.4.8 Equipment used with aquatic animals e.g. media immersing and transporting, etc. should be clean and made of strong materials withstanding corrosion; and be in good condition and ready for use. After work, all equipment should be immediately cleaned and stored so as not to harbour the microbes.

11.4.9 Clean and chemical-free ice should be used. Reuse of the ice is not recommended. Aquatic transport should be designed in order to prevent heat during the transportation. Area for transferring the aquatic product should be made of materials easy to be cleaned, preventing dust, and avoiding moisture losses caused by sunlight and wind.

11.4.10 In case of transporting dead aquatic animals, they should be chilled immediately after harvest to maintain freshness as much as possible. The use of ground or flake ices is recommended because smaller size of ice has larger contact surface with the product, thus can chill the product faster. Water used for cleaning aquatic animal should be clean and not be reused. For best quality, pack the product

in appropriate-size container after putting the ice at the bottom. Then the product should be packed in alternate layers with ice to preserve the quality and freshness of the aquatic animal.

11.4.11 In case of transporting live aquatic animals, container used during transport should be designed for heat protection. Aeration should be used during the transportation. Area for transporting aquatic product should be made of materials easy to be cleaned and preventing dust. During transportation, the use of ice is recommended in order to numb the aquatic animal and reduce the damages that may occur. However, the temperature should not be too low that can cause injury to the animal. Injured, infected, or dead aquatic animals should not be included in the transporting container. They should be separated from the healthy animal and other species during the transportation to reduce the possibility of contamination.

12. RECORD KEEPING

To ensure that the aquaculture management system can be efficiently implemented and improved from time to time, it is necessary to have a good data keeping system and to record every step of the aquaculture, such as rearing management, seed sources, health check, growth rate, feeding, the use of veterinary drugs and chemicals, purchasing document or source of production inputs, analysis result of residues from laboratory, official document related to purchasing aquatic animal seeds. Farmers can use this information in reviewing previous farm practices in order to improve efficiency of farming system of the next crop. It can help solving the problems in farm practices such as disease outbreak. In addition, farmer should analyze the record of each batch, and record should be kept for at least 4 years.