Internal Control Guideline for Fish Aquaculture Value Chain in Bangladesh

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Implemented by

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DANIDA

Bangladesh Shrimp and Fish Foundation

House# 03, Road#04, Flat# A5, Block#-F

Banani, Dhaka-1213, BangladeshPhone-+88-02-9893406, Fax-+88-02-9891056

E-mail: info@shrimpfoundation.org, Website: www.shrimpfoundation.org

Internal Control Guideline for Fish Aquaculture Value Chain in Bangladesh

Compiled by

Md. Rafiqul Islam, BSFF

Edited by

Liaquat Ali Choudhury, BSFF
Z. Hye Razi, BSFF
Nittya Ranjan Biswas, DoF
Md. Sainar Alam, Ph.D, DoF
Md. Abdur Rashed, BSFF
Hiranmoy Bhattacharjee, BSFF
Nahin Ferdous, Katalyst

Assisted by

Md. Shanewaz Chowdhury, BSFF
Md. Shahabuddin Chowdhury, BSFF
Md. Nurul Alam, BSFF
A.K.Patwary, BPC

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House# 03, Road#04, Flat# A5, Block#-F
Banani, Dhaka-1213, BangladeshPhone-+88-02-9893406, Fax-+88-02-9891056
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Message

Secretary
Ministry of Commerce

Fisheries and aquaculture sector occupies an important place in the Bangladesh economy. The sector's contribution to the country's Gross Domestic Product (GDP), export earnings and providing livelihood to millions of Bangladesh are well known. From the Ministry of Commerce we have been associated closely with all national efforts to accelerate development in the sector, especially, in order to significantly increase the export of our fisheries and aquaculture products.

I am glad to know that under the ATC-P project, the present control guidelines for the fisheries and aquaculture value chain in Bangladesh have been compiled in order to help various stakeholders in the sector to ensure that quality of product from fisheries and aquaculture sector in Bangladesh meet all the relevant national and international standards. The coverage of all safety related issues in the compilation has been most comprehensive and the guidelines for action recommended in it are most timely. I would urge all concerned to make good use of them.

I would like to thank Swiss-Contact Katalyst for the support which made this compilation possible. I would like to thank BSFF for facilitating the work on the compilation exercise.

07/11/2017

Shubashish Bose
Secretary
Ministry of Commerce

Message

Project Coordinator, BPC and
Joint Secretary, Ministry of Commerce

The Business Promotion Council (BPC) of Bangladesh under the Ministry of Commerce has been privileged to work with Swiss-Contact Katalyst and Bangladesh Shrimp and Fish Foundation on many recent initiatives to support and accelerate development in the fisheries and aquaculture sector, especially, addressing the trade promotion aspect as it relates to this important sector of the economy. It has long been felt that improving quality of fish and aquaculture products should form an integral part of our national efforts to increase experts from the sector.

BPC is glad to have been associated with the work relating to the present compilation entitled "**Internal Control Guideline for Aquaculture Value Chain in Bangladesh**" as it meets the need for a comprehensive compilation which all stakeholders in the fisheries and aquaculture sector can readily use. The fact that the compilation has been prepared taking into account all relevant national and international fisheries and aquaculture good practices, ideal hazard control measures and practical ways how they can be translated into concrete actions add to the richness and undeniable relevance of the compilation.

I commend BSFF for its serious and valuable contribution that made the compilation possible and also Swiss-Contact Katalyst for its unfailing support and assistance at every stage of the work undertaken to complete the compilation. The work on the compilation will be well requited if its end users find it useful, which I am sure, they will.

Fakir Firoz Ahmed
Project Coordinator, BPC and
Joint Secretary, Ministry of
Commerce

Message

Director General,
Department of Fisheries, Bangladesh

A country with significant fisheries and aquaculture sector, Bangladesh has an enduring interest to further develop this sector for a whole range of important reasons. It is indeed possible that by accelerating development in the sector we can further enhance its contribution to the GDP of Bangladesh, generate income and employment, improve the nutritional security of our growing population and significantly increase export earnings from the sector. Realizing the full potential of the sector, however calls for sustained efforts on wide front including in the critical area of improving the quality of the product from the sector both for domestic consumption and export destined for international markets.

I am glad to know that work on the present compilation of the guidelines entitled "**Internal Control Guideline for Aquaculture Value Chain in Bangladesh**" was undertaken to help all the stakeholders in the sector with a comprehensive document which they can readily access and use to improve their quality control efforts. The need for such a compilation has been felt for a long time and I believe that its availability now will help all the stakeholders in the fisheries and aquaculture sector to implement action based control strategy to address quality related issues in the sector.

Dr. Syed Arif Azad
Director General
Department of Fisheries,
Bangladesh

Message

Chairman,
Bangladesh Shrimp and Fish Foundation (BSFF)

I commend BSFF for a work well done in compiling the guidelines and my thanks go to BPC, Ministry of Commerce and Swiss-Contact Katalyst for supporting the work on the compilation.

Bangladesh Shrimp and Fish Foundation aims as of its main objectives to leverage its ongoing and panned activities to support the Government of Bangladesh, the private sector in Bangladesh and all the major stakeholders in the country's important fisheries and aquaculture sector to implement concrete actions needed to overcome impediments stymieing the sector's growth. The Foundation's works have thus been focussed to help address a whole range of supply side constraints standing in the way of modest growth of the fisheries and aquaculture sector. Equally importantly, it has also undertaken a number of important initiatives to promote norms, guidelines and practices considered critical for improving productivity in the sector and quality of fisheries and aquaculture products of Bangladesh origin. Food safety related issues have become a major concern both domestically and internationally which all stakeholders in our fisheries and aquaculture sector must take into account.

The present work of control guidelines titled "**Internal Control Guideline for Aquaculture Value Chain in Bangladesh**" has been compiled by the Bangladesh Shrimp and Fish Foundation to make available the broad guidelines which all stakeholders in the Bangladesh Fisheries and Aquaculture can readily use to improve the production practices and food safety related hazards through implement table concrete actions. The materials and inputs for the compilation have been obtained from standard international and national documents and some of BSFF's own recently compiled sectoral code of conducts adding to the comprehensive nature of the compilation.

Syed Mahmudul Huq
Chairman
Bangladesh Shrimp and Fish
Foundation (BSFF)

Message

General Manager,
ATC-P, Katalyst

Bangladesh Shrimp and Fish foundation is grateful to the Business promotion Council (BPC) under the ministry of Commerce and Swiss Contact Katalyst for generous help and assistance which facilitated the completion of the work on the compilation. We shall one work on the compilation a rewarding one if its target beneficiaries extensively use it with god and positive impact.

The Agribusiness for Trade Competitiveness Project (ATC-P), branded as Katalyst, is a pioneer market systems development project contributing to sustainable poverty reduction in Bangladesh. It is implemented by Swisscontact under the umbrella of the Ministry of Commerce, Government of Bangladesh. The project has been operating in Bangladesh since 2003 in three phases. The current phase (March 2014 - March 2018) is co-funded by the UK Government, Swiss Agency for Development and Cooperation (SDC), and the Danish International Development Agency (Danida).

Bangladesh has become a global player in aquaculture production as the fourth largest producer in the world. In order to contribute to the sustained growth of the fish sector in Bangladesh, Katalyst has been working in farmed fish sector since 2004. In spite of a phenomenal growth in production of fish in Bangladesh over the past decade, the demand of fish still outstrips the supply.

Safe production and distribution of fish and shrimp are crucial for consumer's health and safety. Thus the adoptions of Good Hygiene Practice, Good Manufacturing Practice and Good Aquaculture Practice within the value chain have become ever more important in Bangladesh. For the past several years, Katalyst has been working with Business Promotion council (BPC) and Bangladesh Shrimp and Fish Foundation (BSFF) to improve the food safety measures in the farmed fish sector. This internal control guideline is one of those important measures.

I am very happy to acknowledge this Internal Control Guideline developed by BPC and BSFF. I strongly believe, this will prove to be a useful tool for value chain actors in building capacity on food safety. This guideline will also be relevant to the regulatory authorities in ensuring the compliance for both domestic as well as international markets.

The guideline has been developed by experts with diverse knowledge on aquaculture and the international food safety measures. The guideline contains information on the overall scenario of the aquaculture value chain of Bangladesh and underlying hazards. It also contains information on how to undertake the hazard identification, control measures and many other relevant important aspects and recommendations. I want to thank both BPC and BSFF for publishing this Internal Control Guideline and making available to all concerned stakeholders.

Gupta Bahadur Banjara
General Manager
AT-CP/Katalyst

List of Acronyms and Abbreviation:

ALOP	Appropriate level of Protection
CCP	Critical Control Point
CAC	Codex Alimentarius Commission
FAO	Food and Agriculture Organisation of United Nations
GAqP	Good Aquaculture Practices
GHP	Good Hygienic Practice
GMP	Good Manufacturing Practice
HACCP	Hazard Analysis Critical Control Point
JECFA	Joint FAO/WHO Expert Committee on Food Additives
MRL	Maximum residu limits
ML	Maximum limit
SPS	Sanitary and Phytosanitary Agreement
UNEP	United Nations Environment Programme
WHO	World Health Organisation

Glossary

Appropriate Level of Protection- Level of protection deemed appropriate by a member country establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory.

Clean water-means water from any source where harmful microbiological contamination, substances and/or toxic plankton are not present in such quantities that they may affect the safety of fish, shellfish and their products intended for human consumption.

Cleaning-the removal of soil, food residues, dirt, grease or other objectionable matter.

Contaminant-any biological or chemical agent, foreign matter or other substances not intentionally added to food that may compromise food safety or suitability.

Control Measure- Any action and activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Critical Control Point-A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level

Decomposition- The deterioration of fish, shellfish and their products including texture breakdown and causing a persistent and distinct objectionable odour.

Disinfection- The reduction by means of chemical agents and/or physical methods in the number of microorganisms in the environment to a level that does not compromise food safety.

Establishment - Any building or area in which food is handled and the surroundings under the control of the same establishment.

Food handler - A person who directly handles packaged or unpackaged food, food equipments and utensils, food contact surfaces and is expected to comply with food hygiene requirements.

Food Hygiene- All conditions and measures necessary to ensure the safety and suitability of food at all stages of food chain.

Food safety - Assurance that the food will not cause harm to the consumer when it is prepared and/or consumed according to its intended use.

Food suitability - Assurance that the food is acceptable for human consumption according to its intended use.

Good Aquaculture Practices- Those practices of aquaculture sector that are necessary to produce quality and safe food products conforming to food laws and regulations.

Good Hygienic Practices- All practices regarding the conditions and measures necessary to maintain the safety and suitability of food at all stages of food chain.

Good Manufacturing Practice- A combination of manufacturing and quality control procedures aimed at ensuring that the products are consistently manufactured to their specifications.

Hazard- A biological, chemical or physical agent in, or condition of food with potential to cause adverse health effect.

Hazard Analysis - The process of collecting and evaluating information on hazards and condition leading to their presence in order to decide which are significant for food safety and therefore should be addressed in HACCP Plan.

Hazard Analysis Critical Control Point (HACCP)- A system that identifies, evaluates and controls hazards that are significant for food safety.

Microbiological contamination -The presence, introduction, reintroduction growth and/ or survival of pathogens of public health concern.

Risk- A functions of the probability of adverse health effect and the severity of that effect, consequential to a hazard in food.

Residues- Any foreign substances, including their metabolites, that remain in fish prior to harvesting as a result of their application or accidental exposure.

Traceability/Product tracing- The ability to follow the movement of food through specified stages of production, processing and distribution.

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.

With drawl time- The period of time necessary between the last administration of a veterinary drug to fish, or exposure of these animals to a veterinary drug and harvesting of them to ensure that the concentration of the veterinary drug in the edible flesh intended for human consumption complies with maximum permitted residue limits.

(Ref: CAC/RCP 1-1969 Recommended International Code of practice General Principles of Food Hygiene; CAC/RCP 52-2003 Codex Code of Practice for Fish and Fishery Products; CAC/GL 30 Principles and Guidelines for the conduct of microbiological assessment**)**

Part-I

1. Introduction:

Fisheries and aquaculture sector is an important component of the overall economy of Bangladesh. It contributes 3.69% to the national GDP, contributes significantly to total export earnings. About 1.8 million people in Bangladesh are directly and indirectly associated with this sector for their livelihood. Shrimp and fish product is the second largest export earning source of Bangladesh. In 2014-15 FY, 84,000 MT of fish and fishery products exported to EU, USA, Japan and some other developed countries and earned BDT 46610 million. Fisheries and aquaculture sector in Bangladesh also significantly contributes to the nutritional security of the 150 million population of Bangladesh meeting nearly 60 percent of their annual protein consumption.

Enhancing productivity in the fisheries and aquaculture sector in Bangladesh is an important as this will also be needed to fully realize Bangladeshi untapped growth potentials which the country also tries to continue good progress in achieving the Sustainable Development Goals. It is equally important that products generated from the sector are hygienically safe and consumer may be sure that consumption of fisheries and aquaculture products of Bangladesh origin do not pose any major hazard. In the year 2003, FAO proposed food chain based approach for food safety, wherein the responsibility for ensuring the product safety is shared by all those involved in different segments of food chain. This concept is broadly accepted internationally and forms the basic principle of food safety management. This is equally true about products originating from fisheries and aquaculture sector.

In fact, as in other food related sectors, in fisheries and aquaculture sector end product testing and rejection of non-compliant products cannot solve food safety issues. Food safety is based on adopting preventive approach throughout the supply chain. Implementation good aquaculture practice (GAqP) at primary production level (hatchery, nursery, farm), good hygienic practice (GHP) and good sanitary practice (GSP) throughout the value chain is the basis of food safety activity. These are the fundamental requirements to achieve food safety. Regulatory authorities may verify the implementation of GAqP, GMP, GSP, GHP and HACCP, the Codex Alimentarius Commission adopted The General Principles of Food Hygiene (CAC/RCP 1-1969) in 1969 and this is being regularly updated. The Codex Code of Practice for Fish and Fishery Products (CAC/RCP 52-2003) contains guidance for supply chain operators in fisheries sector. In that book there is a segment on aquaculture and provides guidance to farm operators on the elements of GAqP.

Since early 60's globally introducing HACCP in any food producing activity is also receiving great global attention. HACCP is a system that identifies, evaluates and controls hazards that are significant for food safety. As is shown below HACCP has a safety focused closely identified stage by stage grower to processor approach to address food safety adapted issues.

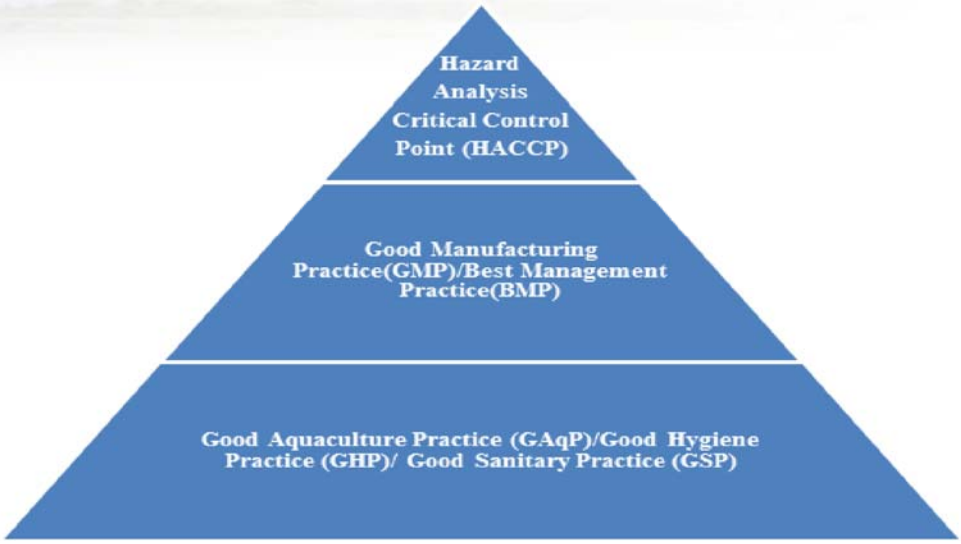

Fig 1: Relation between GAqP, GHP and HACCP

Adaptation of GAqP,BMP,GMP,GSP and GHP, is a pre-requisite for the implementation of Hazard Analysis Critical Control Point (HACCP) based preventive approach to food safety management. The implementation of GHP and where possible, HACCP requires enabling policy and regulatory environment at national and international level. The Codex Code of Practice for Fish and Fishery Products (CAC/RCP 52-2003) provides guidance on the pre-requisite requirements for implementation of HACCP in fisheries sector. HACCP is a science based system that accomplishes prevention of food safety problems by identification of specific hazards and implementation of appropriate control measures. HACCP system consists of seven principles.

The present guidelines for aquaculture value chain in Bangladesh have been compiled taking into account all the relevant national and international documentation on the subject. The main purpose of the compilation is to make available in one comprehensive document, which all stakeholders in the fisheries and aquaculture value chain in Bangladesh can consult and use with important impact in terms of positive improvement in productivity and product safety in the sector.

2. Need for Control Guidelines:

Control guidelines for aquaculture are needed to provide tools for food safety improvements by the relevant stakeholders and regulatory authority in the aquaculture supply chain. They provide help address food safety hazards in the aquaculture value chain and minimize risk from these hazards. Adherence to control guidelines also helps stakeholders to improve productivity in aquaculture water bodies and subsequent better returns for the main entities in the aquaculture supply chain.

3. Key Areas Where Controls May Help (Scope of Application):

3.1. Primary Production Level:

In the production cycles in aquaculture better management and controls in following areas may help:

3.1.1. Good Water Quality Management:

Good water management, considered vital for good control arrangement, should begin with choosing a farm site having source of good water quality. It will also need maintenance of water quality at non-stressing levels. For good water quality control in aquaculture water bodies following steps are recommended:

i. Well designed ponds as recommended

ii. Ponds must have at least 1 meter average water depth.

iii. Bottom and side seepage should be controlled.

iv. Stock management should be based on carrying capacity of water and proper feed

3.1.2. Control of Pollution:

During fish culture all farmers need to take precautionary measure to control water pollution. This will helps for keeping farm environment clean and healthy.

3.1.3. Use of Good and Healthy Stock:

For better yield and good quality of yield, only good and healthy stocks of fish should be used. During farming farmers should take care on putting disease free fry or PL in the pond. High density without aeration and proper feeding may lead to high mortality rate of fry or PL. Unscientific water management and high density in stocking may create problem for the farmers. Care must be taken to avoid both these risks.

3.1.4 Good Nutrition and Feed Management:

Good quality feeds prevent diseases resulting from inadequate nutrition level and are critical for the prevention of other pathogenic and stressed related diseases. High quality feed of proper nutritional and physical standards adequate amounts, Use of feed older than 2 months should be avoided with proper checking and leveling instruction on date of manufacture.

3.1.5. Breeding Cycles:

Hatchery owner should therefore try to use healthy graved females (25-30 cm body length and 200-320 g weight) and males (20-25 cm; 100-170 g) captured from the wild should be used as brood stock in hatchery. Brood stocks from greater depths (60-80 m), or more than 20 miles offshore, are preferable due to the lower prevalence of shrimp diseases in them. *Penaeus monodon,* in particular, matures and breeds only in tropical marine habitats and spends its larval, juvenile, adolescent and sub-adult stages in coastal estuaries, lagoons or mangrove areas. Breeding cycle of *Penaeus monodon* is about 10 to 15 days. Similar care would be necessary on specifics for other species as well.

3.1.6. Temperature Changes:

Aquaculture organisms as Poikilothermic (cold blooded) animal cannot maintain use form body temperature with rapid change environment of temperature, unlike the warm blooded animals, which can react to maintain the optimum body temperature. For example, the optimum range of temperature for the Black Tiger shrimp is between 28-30C °. Increase in temperature beyond 30°C increases the activity level and metabolism with definite negative impact.

3.1.7. Care at Post Hatchery Stages:

It is important to handle when collecting, holding, transporting, Stocking and sampling. Improper handling of fish/shrimp is one of the most serious and common stressors that result in poor fish/shrimp production, disease and death.

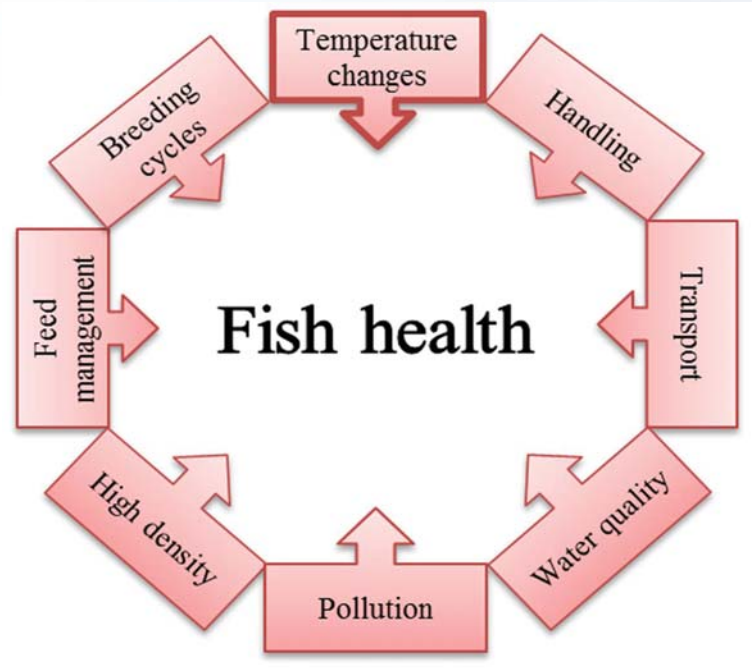

Fig 2: How to manage healthy fish/shrimp culture

3.1.8. Transportation:

During transportation fish/shrimp faces stress that results from the combined adaptive reaction to ecological factors are extended to or move towards its limit of acceptance. In the absence of post harvest care fish/shrimp may suffer injury, damaging its head and shell softening of meat, appearance of pungent smell. It results in market value reduction of products. Proper care is needed to avoid such problems.

3.2. Good Control at Supply Chain Level:

To ensure good quality seafood particularly shrimp, proper cool chain, good quality of water, hygiene, sanitation of first sell site and collection centre or depots should be maintained at required level. Washing of shrimp before transport reduces bacterial load/ multiplication. Moreover proper handling and proper hygiene-sanitation of workers are also the determining factors to keep quality of shrimp intact.

4. Importance of Hazards Control in Aquaculture Value Chain:

Addressing food safety hazards should constitute a major objective for any good control system. In 2003 FAO proposed a food chain based approach for food safety. Now it is widely recognized that multiple types of food safety hazards will have to be addressed in any good control system. For fish the following hazards need to be taken care of.

Table 1: Common hazards endangering food safety

Biological hazards	Chemical hazards	Physical hazards
▪ Bacteria* ▪ Virus ▪ Protozoa ▪ Fungus ▪ Macro-parasites Bio-toxins, mycotoxins **Bacteria-related food poisoning is the most common food-borne illness in Bangladesh and globally.*	▪ Arsenic & other heavy metals ▪ Pesticides ▪ Toxicants ▪ Prohibited antibiotics ▪ Residues of permitted antibiotics beyond their MRLs ▪ Dyes ▪ Growth hormones and Steroids ▪ Preservative: Formalin ▪ Others	▪ Presence of dart and filths, e.g., metal, glass, stone, parts of animals and plants

5. Details on Types of Hazards:

This section of the control guidelines elaborate further on types of hazards

5.1. Biological Hazards:

5.1.1. Pathogenic Bacteria and Viruses:

Pathogenic bacteria like *Salmonella* and enteric viruses like noro-viruses, hepatitis A virus may contaminate aquaculture ponds through contaminated water. *Salmonella* is a common inhabitant of the gut of warm blooded animals like poultry. Fecal material of animals may contain pathogenic microorganisms. Cattle are carriers of enter hemorrhagic *Escherichia coli* (O157:H7). Therefore use of untreated animal feces for fertilizing ponds or having poultry sheds over the ponds will lead to contamination of pond with pathogenic bacteria like *Salmonella.* Birds are also potential sources of Salmonella. Shelters for birds on pond dyke must be avoided to protect cross contamination of salmonella. To minimize this hazard, it is important to minimize animal access to pond area and to source water. While selecting a site for the ponds, it is important to ensure that the site is away from human or animal housing and that sewage from houses or animal farms does not contaminate the ponds. Contamination of fishponds with pathogens derived from fecal matter such as *Salmonella* can also occur due to fecal wastes being washed into the ponds with storm water during heavy rains. Pathways of contamination of aquaculture ponds with *Salmonella* have been reviewed (FAO, 2010). Some of the sources of contamination may be difficult to control eg contamination with storm water during heavy rains.

Picture 01: ***EMS and WSSV affected shrimp***

Outbreaks of noro-virus and hepatitis A infection have been associated with consumption of raw bivalve molluscs harvested from waters that are faecally contaminated. Thus it is important to avoid contamination of aquaculture ponds with fecal matter of animals and birds. Though in many countries, fish are consumed generally after cooking, contaminated fish may be source for cross contamination in kitchen. For example if contaminated fish and salad vegetables are handled without adequate care, there can be cross contamination. Cross contamination can also occur through containers used for raw and cooked fish. Light cooking may not be adequate to inactivate some microorganisms like hepatitis A virus. The Codex Guidelines on the Application of General Principles of Food Hygiene to the control of Viruses in Food (CAC/GL 79-2012) recommends that cooking procedures should ensure that internal temperature of food should reach 90C for 90 sec to inactivate viruses.

Traditionally, fertilization of aquaculture ponds with animal waste has been a common practice. But this is changing in many places. WHO has brought out guidelines for safe use of wastewater, excreta and grey water in aquaculture (WHO, 2006).According to this guideline, the animal waste and excreta need to be treated before use in aquaculture activities. Different methods of treatments have different efficiencies. For public health protection, WHO recommends use of microbial quality target.An example of microbial quality target for waste-fed aquaculture recommended by WHO is given below.

Table 2: Microbiological targets for pond water, waste water and treated excreta (from WHO, 2006)

Media	*Escherichia coli* (mean number per 100ml or g total solids)	Helminth egg (mean number per liter or g total solids)
Product consumers		
Pond water	$\leq 10^4$	≤ 1
Waste water	$\leq 10^5$	≤ 1
Treated excreta	$\leq 10^6$	≤ 1
Aquaculture workers and local communities		
Pond water	$\leq 10^3$	≤ 1
Waste water	$\leq 10^4$	≤ 1
Treated excreta	$\leq 10^5$	≤ 1

This could be used as guide to control fecal contamination of ponds through excreta and wastewater. The WHO Guideline recommends that verification of meeting the microbial targets in pond water should be done monthly, if the fish produced are intended for raw consumption and at 3-6 month intervals, if the fish are eaten after cooking.Various methods for treatment of waste water and storm water have been described in the UNEP Guidance on Muncipal Waste Water (2010).

Most Significant Pathogenic Bacteria Found in Farmed Shrimp/Fish:

- ***Salmonella spp*** is one of the major pathogenic bacteria causing human gastro-intestinal diseases, including typhoid, severe food poisoning, etc. No importing country will accept products contaminated with Salmonella.
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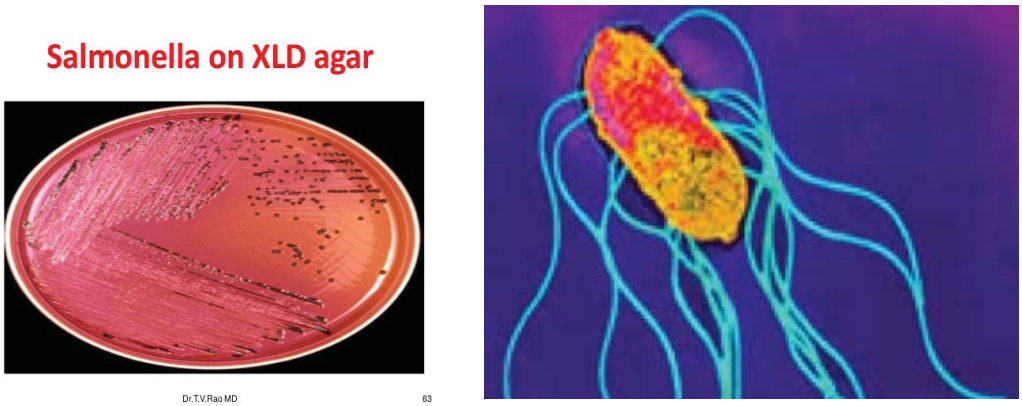
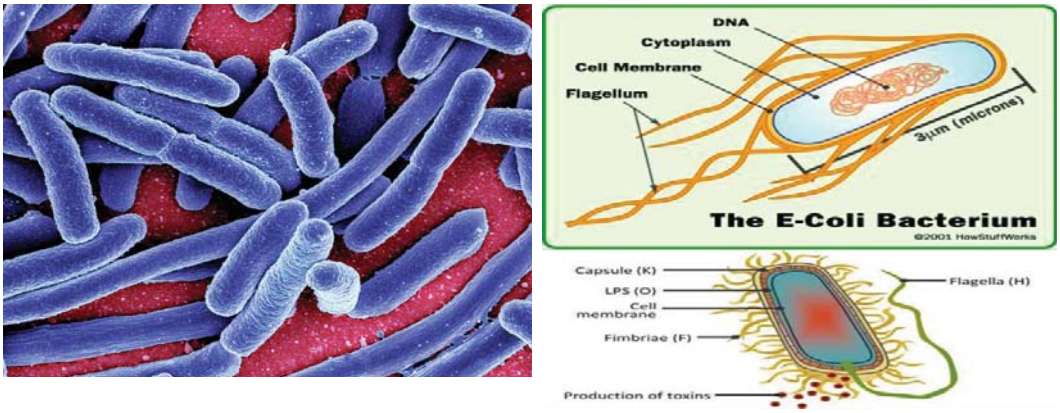


Picture 02: *Salmonella* (URL: …….[1])

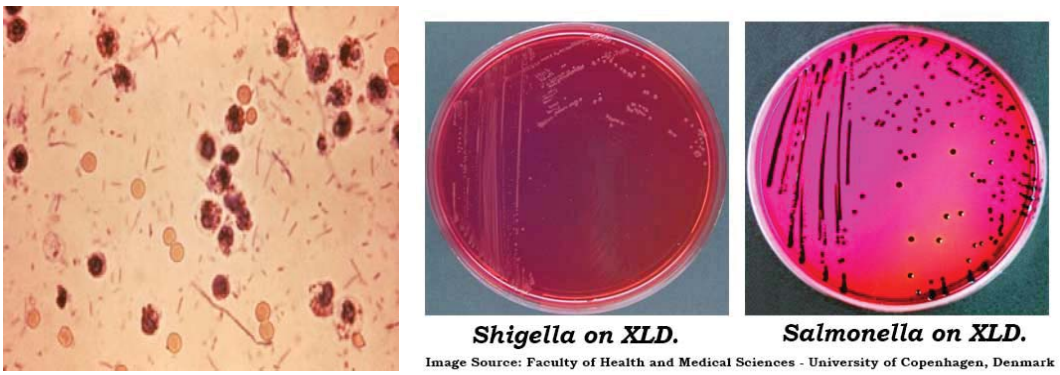
- ***Escherichia coli*** is often used as an indicator for contamination; however, some are pathogenic causing food borne illness ranging from mild to serious illness and even death.



Picture 03: *Escherichia coli* (URL: ……..……..[2])

- ***Shigella*** is other human pathogenic enteric bacteria. Shigella infection (shigellosis) is an intestinal disease caused by a family of bacteria known as shigella. The main sign of shigella infection is diarrhea, which often is bloody. Shigella bacteria also can be passed in contaminated food or by drinking or swimming in contaminated water.

  The source of Shigella is contaminated food or water, or contact with an infected person. Foods most often associated with *Shigella* outbreaks are salads and sandwiches that involve a lot of hand contact in their preparation, and raw vegetables contaminated in the field.

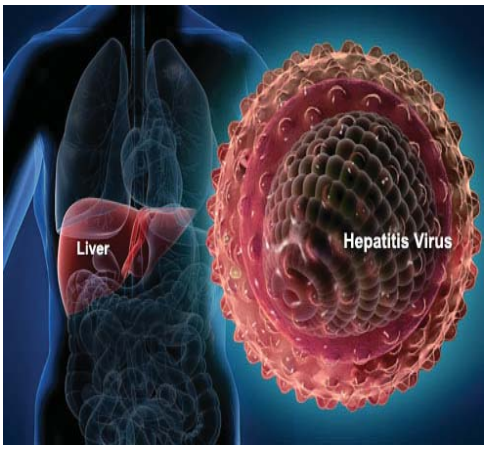


Picture 04: *Shigella* (URL: ……[3])

- ***Vibrio spp.*** These are generally salt-tolerant organisms occurring naturally in fresh and brackish-water environments in both tropical and temperate regions. The major source of vibrios is also coming from contaminated human waste. V. cholerae can cause cholera, diarrhoea, abdominal cramps, nausea and fever. V. parahaemolyticus has been recognized as a major cause of gastroenteritis and is particularly associated with the consumption of contaminated food and drink.

Picture 05: *Vibrio spp* **(URL: ……..[4])**

- **Viruses:** Hepatitis A causing nausea, vomiting, abdominal pain, liver pain, clay coloured bowel movements, severe fatigue, etc. The disease is transmitted through food and drink contaminated with fecal matter or vomits of Hepatitis A patients.



Picture 06: *Viruses* **(URL: ……..[5])**

- **Protozoans:** Entamoeba histolytica is a common pathogenic protozoan parasite causing severe dysentery, may be transmitted to the wet and pond environment through fecal materials.

Picture 07: *Protozoan* (URL: …….[6])

The above bacteria and viruses mainly cause various types of gastro-enteric problems, including, cholera, typhoid, diarrhoea, dysentery, hepatitis, vomiting, etc. Fecal materials of human, pet animals, poultry, cattle, wild birds, etc may contain and spread these pathogenic organisms through direct contact, food, soil and water.

These pathogen will be killed by cooking contaminated fish at temperature above $72^{0}c$ at least for 20 minutes.

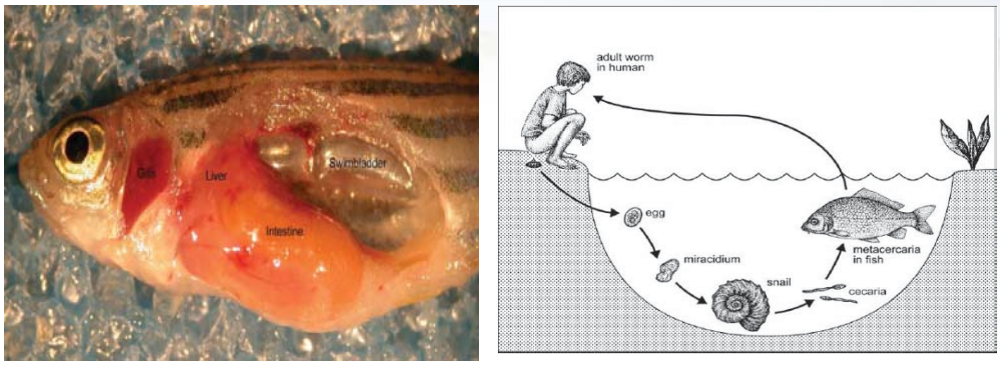
Water of the supply canal flowing through dense human habitations using mostly non-sanitary latrines on or close to the canal get easily contaminated with wide range of pathogenic organisms, pond receiving seepage from cattle and poultry sheds on or close to the farm itself, run-off water, etc.

Contamination of fish with fecally derived pathogens can occur due to poor personal hygiene of those working in farms or handling fish at post harvest stage. Individuals who have recovered from gastroenteritis due to *Salmonella* may continue to carry the pathogen in their gut for considerable period of time. Carrier state could be as high as 42% in case of subjects who have recovered from salmonellosis due to S. Enteritidis and 8.8% in healthy persons exposed to chicken (Kotova et al., 1988). Persons recovering from norovirus infection may shed the virus from periods ranging from 21-182 days (Seibenga et al., 2008). Thus the fecal matter of apprarently healthy individuals can carry pathogenic bacteria and viruses.

5.1.2. Fish Borne Parasites:

Parasites like trematodes, cestodes and nematodes may be transmitted through fish grown in fecally contaminated waters. For fish borne trematodes (*Clonorchissinensis*; *Opisthorchisviverrini*, *O. felinius*), also called liver flukes, humans and fish eating mammals are definitive hosts with aquatic snails acting as intermediary hosts. Fecal matter of infected humans or animals contain eggs of the trematodes, which hatch into miracidia and infect intermediate hosts snails, where they grow to the next larval stage, cercaria. Fish are infected by cercaria which grow into the next larval stage infective to humans or mammals, metacercaria. Raw fish consumption leads to infections in humans, where metacercaria migrate to common bile duct, extrahepatic and intrahepatic bile ducts and mature into adult worms. The infection leads to liver and pancreas disorders (cholangitis, cholidocholithiasis, pancreatitis) and could also lead to liver cancer (cholengiocarcinoma). The fish tape worm, *Diphyllobothrium*infections occur in regions with a habit of raw fish consumption. Fish eating birds and mammals are definitive hosts for this tapeworm and fish and copepods are intermediate hosts. The eggs in the feces of definitive hosts hatch into the larval stage coracidium and on ingestion by copepods, delelops into procercoid. When copepods are ingested by fish, the procercoid is released, gets into the tissue and develops into plerocercoid sage that is infective to humans, birds or mammals.

Cooking fish at a temperature above 72^{0}`c for at least 20 minutes must kill all these fish parasite.

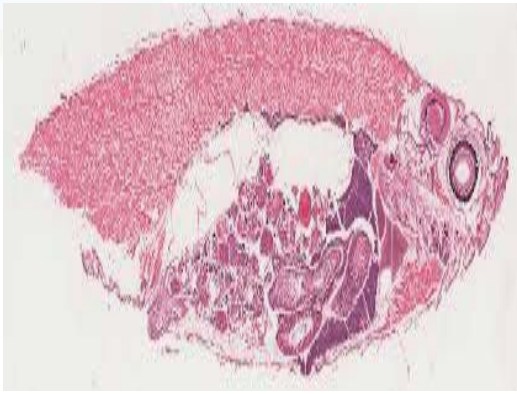


Picture 08: *Some Fish borne Parasite* (URL: …….[7])

5.1.3. Mycotoxins and Other Biotoxins:

Toxic chemicals may be produced by certain molds like *Aspergillus*, *Penicillium* and *Fusarium*, which may grow on feed ingredients exposed to moisture. These toxins are called mycotoxins. The toxins produced by *Aspergillusflavus* are called aflatoxins. The problem came to light when hatchery reared rainbow trout were affected by aflatoxicosis in the 1960s. Rainbow trout are very sensitive to the presence of aflatoxin in their diets, with as little as 0.4 ppb (µg/kg of diet) dietary aflatoxin producing heptocellular carcinoma in 14 percent of trout over a period of 15 months, but warmwater fish do not appear to be as sensitive to dietary aflatoxin. Ochratoxin A is produced by some species of Aspergillus and Pinicillium. Exposure of fish to ochratoxin through feed could lead to slower growth and damage to pancreatic tissue. The exposed fish may become more susceptible to bacterial infections. Ochratoxin may remain in fish tissue (muscle and liver) and enter human food chain.

Thus mycotoxins in fish feed could (a) affect fish growth (b) fish health and make them more susceptible to diseases (c) enter human food chain. The main control measure is (a) use of good quality raw materials in feed preparation (b) protection of feeds from exposure to moisture. If feed ingredients are contaminated with mycotoxins, heat processing will not eliminate these and the hazard will remain in feed.

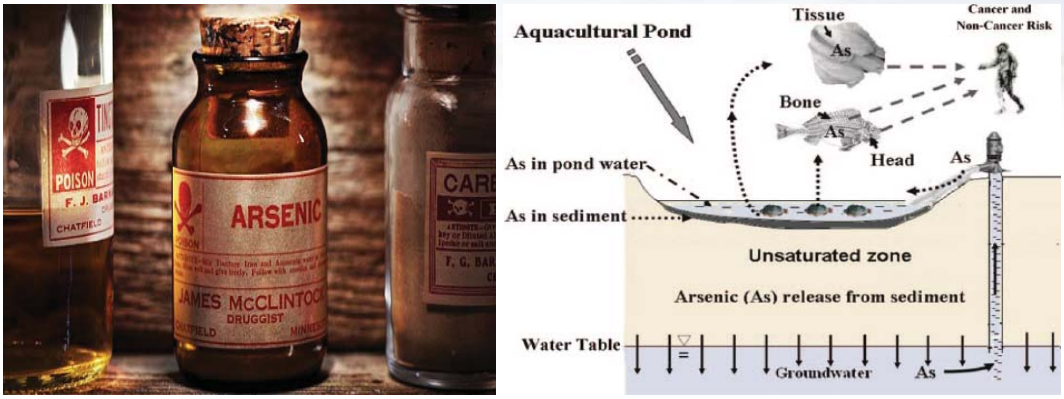


Picture 09: ***Aflatoxin in fish*** **(URL: ……..[8])**

5.2. Chemical Hazards- Arsenic and Other Heavy Metals:

5.2.1. Arsenic- is a metalloid element that occurs naturally in the mineral bound form in earth's crust. It may become easily available as a result of volcanic activity and weathering of minerals and attain aquatic environment. It may also be introduced due to anthropogenic activity such as smelting of ores, burning of coal, use of arsenic containing wood preservatives or pesticides. In food commodities, arsenic may occur in organic or inorganic forms due to metabolic processes in the biosphere. It is highly toxic in its inorganic form. In the marine environment arsenic is often found in high concentrations of organic forms, up to 50 mg/kg of arsenic on a wet weight basis in some seafood such as seaweed, fish, shellfish and crustaceans. In fresh water and in the terrestrial environments arsenic is normally found in much lower levels (typically 0-20 ug/kg) in crop plants and in livestock. Probability of arsenic contaminated fish in the supply is very in significant in Bangladesh that might not cause harmful effect on human health.

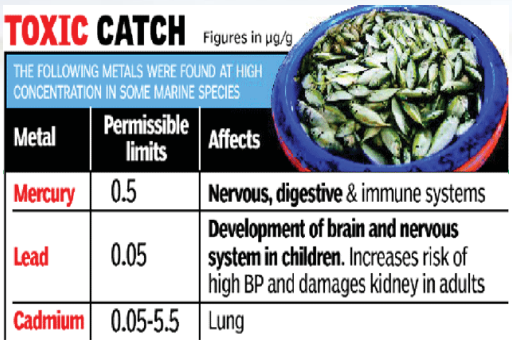
The Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 2011 withdrew the previously established Provisional Tolerable Weekly Intake (PTWI) inorganic arsenic (WHO, 2011a). WHO Guidance level for arsenic in drinking water is 0.01 mg/l (10 µg/l). Arsenic contamination of ground water is common in some parts of the world and in Bangladesh, 25% of household wells have been reported to contain concentrations above 50µg/l (Kinniburgh and Smedley, 2001). In ground water arsenic is present mainly in inorganic form. Ground water from depths of >150m have been reported to contain less aresic compared to shallow wells. It has been estimated that 19 million and 5 million people in Bangladesh use drinking water containing >50 µg/l and >200 µg/l arsenic respectively (Flanagan et al, 2012). Studies done in Taiwan show that tilapia grown in water contaminated with arsenic could accumulate this heavy metal (Chen and Liao, 2004). In fish, arsenic is found mostly in less toxic organic form, but it is estimated that 25% of arsenic in foods may be in toxic inorganic form (WHO, 2011b). Codex has maximum limits for arsenic only in certain oils in the Codex General Standard for contaminants and toxins in food and feed (Codex Stan 193-1995). The Draft Codex Standard for fish oils is under consideration by the Codex Committee on Fats and oils and in this standard; it has been proposed that fish oils meet the requirements as per the Codex General Standard for Contaminants and toxins in food and feed.



Picture 10: ***Arsenic and its source*** **(URL:……..[9])**

5.2.2 Cadmium- is widely distributed in aquatic environment. In addition to natural sources, contamination may result from from wastewater, fertilisers and pesticides used in agriculture. Molluscs, especially cephalopods are known to accumulate cadmium. JECFA evaluation resulted in recommendation of PTWI of 0.005 mg/kg bw and based on this the maximum level in Codex standard has been fixed at 2.0 mg/kg in marine bivalves and cephalopods. In most fish grown in aquaculture environments, this may not be a major issue unless there are sources of pollution that may reach the intake water. Therefore, it is essential to make an assessment of the sources of pollution reaching the intake water that is used in fish farms.

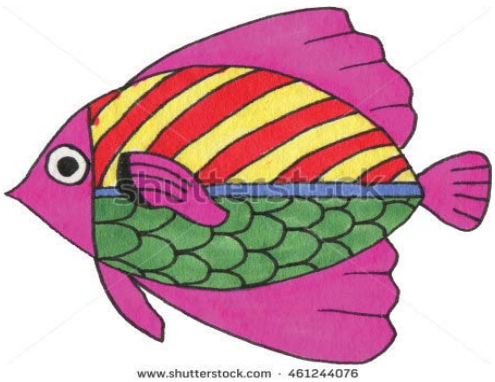
Ref.[**Journal of Environmental Research And Development Vol. 6 No. 3A, Jan -March 2012 and** Codex Pesticide residues online database http://www.codexalimentarius.org/standards/pestres/en/



Source: Brown-Peterson.
Figure 13: Gill deformities in *Orechromis spp.*

Picture 11: ***Cadmium and other heavy metals contamination*** **(URL: …….[10])**

5.2.3. Lead- Is ubiquitous in the environment and elevated levels may be found in waters receiving industrial effluents.Lead and its compounds can enter the environment during mining, smelting, processing, use, recycling, or disposal. The main uses of lead are in batteries, cables, pigments, plumbing, gasoline, solder and steel products, food packaging, glassware, ceramic products, and pesticides. Airborne lead may contribute significantly to contamination, depending on such factors as proximity to sources such as motorways and lead smelters. The maximum level permitted in Codex Standard is 0.3 mg/kg for lead. Since the major source is industrial pollution, it is necessary to make an assessment of the sources of pollution reaching the water used for aquaculture.

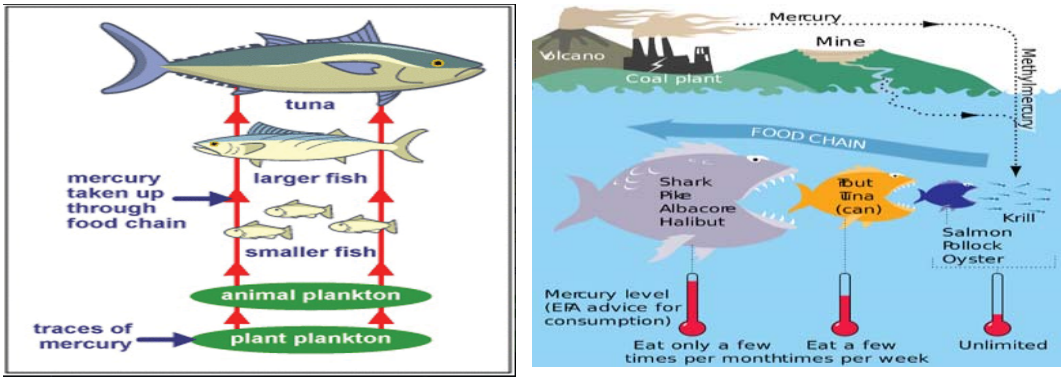


Picture 12: ***Lead*** **of Contamination (URL:.....[11])**

5.2.4. Methyl Mercury- is the most toxic form of mercury and in the aquatic environment and most of the mercury in fish is present in the methyl form. Methyl mercury can accumulate in the food chain; the levels in large predatory fish species are therefore higher than in other species and fish is the predominant source of human exposure to methylmercury. Methylmercury is readily absorbed (up to 95%) after oral exposure. Methylmercury crosses both the blood–brain barrier and the placenta effectively, resulting in higher concentrations of mercury in the brain of the fetus than of the mother. Methylmercury is eliminated mainly via the bile and faeces, neonatal animals having a lower excretory capacity than adults.

Methylmercury is toxic to the nervous system, kidney, liver and reproductive organs, neurotoxicity being the most sensitive end-point (WHO Food additives Series 52; 2004).

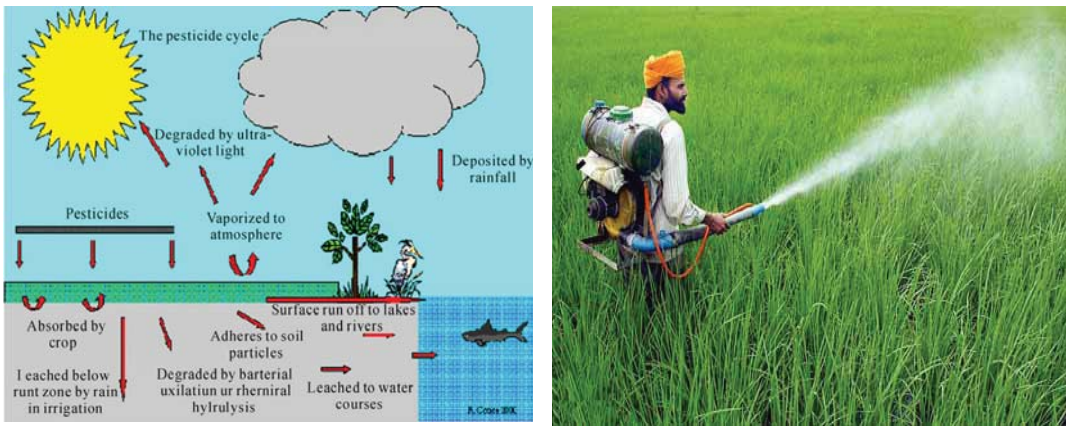
Codex has established only a "Guidance Level" for methyl mercury in fish (0.5mg/kg). A Codex Guidance Level is the maximum level of a substance in food or feed commodity, whichis recommended by the Codex Alimentarius Commission to be acceptable for the commodities in international trade. The Guidance Level should be reviewed for possible conversion to maximum level after risk assessment by JECFA. During the 9th Session of the Codex Committee on contaminants in foods, a discussion paper on risk management of methyl mercury in fish was presented. The Discussion paper reviewed the existing data on levels of methyl mercury in fish. Levels of concern were noted only in certain predatory fish. In fish such as big eye tuna, biomagnification of methyl mercury takes place from the food chain. Farmed fish such as salmon and tilapia had very low levels. Many countries favour managing risk due to methyl mercury by issuing advisories particularly, to the susceptible population like pregnant mothers on the type of fish to avoid. Risk of contamination with these heavy metals needs to be considered if source water used for aquaculture receives industrial effluents or wastewater.



Picture 13*:* ***Source of Mercury*** **(URL:.....[12])**

5.2.5. Pesticides- contamination of aquaculture systems may occur through drift from agricultural fields close to aquaculture ponds, or through storm water. Some pesticides are used in aquaculture to treat certain parasitic diseases eg use of pyrethroidslike deltamethrinto treat ectoparasites like argulus infection in carp aquaculture. This parasitic infection might lead to secondary bacterial infections. Cypermethrins and emamectins are commonly used in aquaculture and agriculture. In Codex Maximum Residue Limits for Pesticides, there are levels prescribed for various agricultural products and mammalian meat, but levels for fish have not been specified. These pesticides are also used for sea lice treatment in salmon aquaculture and EU regulation on MRLs (EU Commission regulation No 37/2010) indicates MRL of 50 µg/kg cypermethrin in salmonidae and 100 µg/kg for emamectin in finfish The problem of use of pesticides like pyrethroids is compounded by aquaculture practices. Practicing bio-security is the most important step for control of parasitic diseases. For this, it is important to completely empty the pond and dry the pond bottom after a culture cycle to eliminate the parasites surviving in the pond. If ponds are

stocked continuously the parasites remaining in the pond can easily infect the new stock. This will lead to more use of pesticides, development of resistance to the treatment by the parasites. Resistance to deltamethrin has been reported in a number of insects.



Picture 14: *Pesticide contamination* (URL:.....[13])

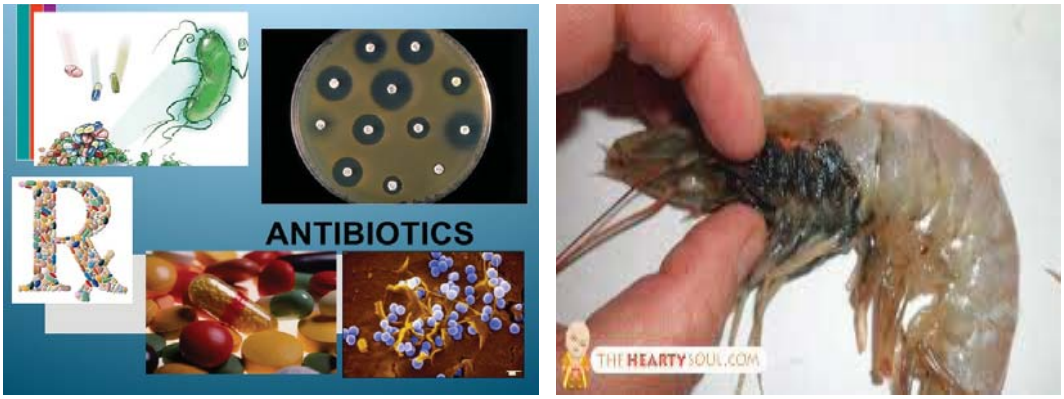
5.2.6. Toxicants-fish toxicants could be used in aquaculture to get rid of undesirable fish in a pond before stocking. There are also reports of use in ponds to remove fish that could not be completely harvested from pond before stocking. Such use may occur in ponds which can not be emptied for harvesting purposes. Fish killed using fish toxicants may also reach markets in some cases. Rotenone is a common fish toxicant used and this can be toxic to consumers. The US Environmental Protection Agency (EPA) has recommended a chronic reference dose (cRfD) of 0.0004 mg/kg bw/day (www.epa.gov/oppsrrd1/Red/rotenone_red.pdf). WHO has classified rotenone as "moderately hazardous". When exposed to sunlight, the compound decomposes at a half life of 12hrs at 24°C and 3.5 days at 0°C.

Picture 15: *Aluminium phosphide* contamination (URL:.....[14])

Some farmers also reportedly use the rodenticide phostoxin (Aluminium phosphide). This is highly toxic to humans and highly restricted use pesticide. Specially trained personnel may use it in a highly regulated way as a fumigant in certain agricultural commodities in some countries. But this is to be only used according to a written fumigation plan that includes plan for deactivation of partially spent residual dust and worker protection. This compound is for restricted use in agriculture for plant protection according to good practices (ec. europe.eu/food/plant/protection/evaluation/existactive/list_alu-phosphide.pdf) and is not approved for use in aquaculture ponds.

5.2.7. Antibiotics, Dyes and Other Veterinary Medicines-Veterinary medicinal products like antibiotics, dyes, and antifungal agents may be used in aquaculture to treat diseases in fish. But these are to be used only based on diagnosis of a disease and prescription by an authorized professional. The treated fish should not be harvested before the prescribed withdrawal time. It is often suspected that certain antibiotics may be used in feed either as a growth promoting agent or as a preventive measure. From food safety point of view, the hazards associated with use of veterinary drugs are (a) residues of drugs in fish tissue (b) selection and proliferation of microorganisms resistant to the antimicrobial agent. Certain antimicrobial agents can have carcinogenic or other harmful effects on human consumers and such compounds are banned for use in any food producing animals. Examples include chloramphenicol, nitrofurans and malachite green.

Codex has developed a Code of Practice to minimize and contain antimicrobial resistance (CAC/RCP 61-2005) and it is the responsibility of regulatory authorities to grant authorization for marketing of antimicrobials for use in food producing animals. In aquaculture, there are very few approved antimicrobial agents and generally, these are approved for specific pathogens or fish disease (eg against furanculosis) in specific fish species (egsalmonids) along with recommendations for withdrawl period and regulations on maximum residue levels when the products leave the farm. In order to approve any antimicrobial agents, data would be needed on susceptibility of the pathogen to the antimicrobial, pharmacokinetics (rate of absorption, tissue distribution and levels reached in different tissues, metabolism and excretion)of the drug in the fish species in question. This type of data is required for determining the withdrawl period. Codex has MRL of 200 µg/kg for tetracycline/ oxytetracycline/ chlortetracycline in fish and shrimp and 30µg/kg for deltamethrin in salmon and 500 µg/kg for flumequine in trout.



Picture 16*: Antibiotics (ban dugs) and its effect* **(URL: .....[15])**

BOX-1

6. Identification and Characterisation of Hazards in the Aquaculture Value Chain:

Identification and characterization of hazard in the aquaculture is the primary step in hazard control. The generally acceptable definitions in this regard are well documented.

In Codex documents, **hazard-** is defined as a biological, chemical or physical agent in, or condition of, food with potential to cause an adverse health effect.

Risk- is defined as a function of the probability of an adverse effect and the magnitude of that effect, consequential to a hazard(s) in food. It needs to be pointed out that it is not practically possible to arrive at a situation, where risk is zero. But the risk should be minimized and reduced to an acceptable level. But then the question arises as to what is acceptable. Under the Sanitary and Phytosanitary (SPS) agreement, World Trade Organisation (WTO) member countries have decided that the level of public health protection can be decided by any member country as an "appropriate level of protection" (ALOP) based on risk analysis.

Appropriate level of protection" (ALOP) - is generally expressed as a public health goal eg: Targeted to reduce food borne salmonellosis by 50% in the next 5 years. Measures to be taken to reduce foodborne illnesses are to be taken based on an analysis of the risk. In Codex documents, the term "Food Safety Objective" (FSO) has been included and

Food Safety Objective" (FSO) - is defined as "the maximum frequency or concentration of a hazard in food at the time of consumption that provides or contributes to the appropriate level of protection". FSO is to be decided by the countries through the process of risk analysis.

Hazard identification- involves identification of biological, chemical or physical agents capable of causing adverse health effects and which may be present in a particular food. During this process, epidemiological link between the food and the hazard is considered. There are very few records of investigation of food borne illnesses. Therefore, often epidemiological data is difficult to get in many developing countries.

Hazard characterization- involves qualitative and/or quantitative evaluation of the nature of adverse health effect associated with biological, physical or chemical agents that may be found in food. In microbiological risk assessment, this requires consideration of the pathogen, its ecology, occurrence, survival, multiplication in foods, virulence factors, factors in foods that effect survival/multiplication of the pathogen, host factors that influence susceptibility. If possible, a dose-response analysis needs to be done. This involves determining the relationship between the magnitude of exposure (dose) to a biological, chemical or physical agent and the severity and/or frequency of adverse health effects (response). Information required for dose response analysis could come from outbreak investigations, human volunteer studies or from animal studies.

Exposure assessment- involves qualitative and/or quantitative evaluation of the likely intake of biological, chemical or physical agent via food and exposure from other sources, if relevant. This requires data from food production (primary production, processing), retail, food consumption, population demographics.

Risk management- is a process, distinct from risk assessment, of weighing policy alternatives in consultation with all interested parties ("stakeholders"), considering risk assessment and other factors relevant for the protection of health of consumers and for the promotion of fair trade, and, if needed, selecting and implementing appropriate prevention and control options. When a food safety issue come to the attention of a food safety managers (eg authorities responsible for food safety management in a country), who are risk managers need to make decision as to whether a risk assessment if necessary to address the problem. Risk managers also develop questions the risk assessors need to address eg how many people are likely to fall ill due the hazard in food (risk estimate), what are the interventions possible at different steps in the supply chain (eg time temperature control, processing parameters), how much risk reduction can be achieved by these interventions.

BOX-2

7. Hazards Analysis and Risk Evaluation:

Hazard identification is the first step in risk assessment. This step can be accomplished in a number of ways. First, an observation of the aquaculture ponds and surrounding areas as well as farming practices is made. Sampling and testing may confirm suspicion of chemical or microbiological contamination and help getting a better understanding of the extent of problem.

Testing for each hazard would be complicated and requires laboratory facilities and availability of skilled personnel. On the other hand, some simple tests that can be done to detect the presence of indicators pond contamination. Some of these are indicated in the Table 3 below:

Table 3: Simple tests useful in monitoring pond water quality

Test	Hazard indicated
Water turbidity (tested using Secchi disc)	Turbidity exceeding limits indicates deterioration of water quality affecting fish health leading to use of chemotherapeutic agents
Hydrogen sulphide levels in water	
(might be seen as bubbles from sediment or foul smell of water or by lab tests)	Deterioration of sediment quality affecting fish growth and survival
Ammnonia levels in water (ammonical smell in water or by lab tests)	Excess ammonia levels indicates deterioration of water quality affecting fish health leading to use of chemotherapeutic agents
pH	If pH is out of range for the area, it indicates deterioration of water quality and effects on fish health and growth
Dissolved Oxygen (DO)	If DO is lower than expected, this indicates deterioration of water quality
Total dissolved solids	If this exceeds limits, then it indicates deterioration of water quality
Escherichia coli count	If this exceeds limits suggested by WHO guidelines, then it indicates unacceptable level of fecal contamination of water

Levels of heavy metals, pesticides, residues of veterinary drugsetc cannot be estimated by simple field level tests. Samples need to be sent to laboratory for determining the levels. A risk based monitoring programme may be implemented for collecting data on these hazards.

In order to assess the likelihood of a hazard entering the aquaculture value chain, due the aquaculture practices, and the impact of this hazard, a simple risk ranking matrix illustrated below could be used. This figure4 illustrates risk matrix for Salmonella contamination of fishponds. If there are poultry sheds overhanging the ponds, then the likelihood of contamination is high and the impact (high level of Salmonella) would be high. On the other hand, if partially dried animal waste is used for pond fertilisation, the likelihood of contamination is medium and the impact is still high. With storm water, the likelihood of contamination is low, but impact would be still high, since Salmonella will be directly reaching the ponds. With animals around the ponds, the likelihood of contamination is high, but impact would be medium, since level of contamination would be less than direct entry of the waste into the pond water. If the formulated feed is contaminated with rodent wastes, then the likelihood of contamination is medium but impact would be low.

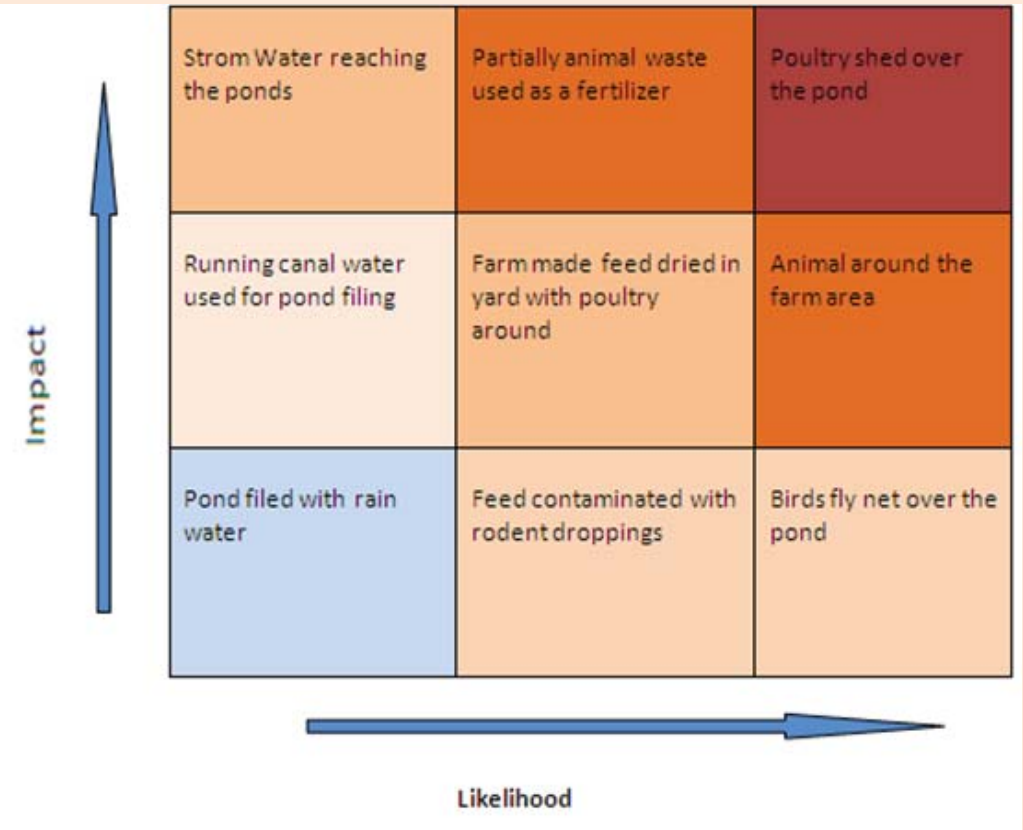


Illustration of application of risk matrix for Salmonella contamination in aquaculture ponds.

Part-II

1. Control measures for food safety improvement in the aquaculture value chains, from farm to fork

Following key good practices key control measures recommend below will, it is hoped, help handle both microbiological and chemical hazards. These control measures are based on principles of Good Aquaculture Practice (GAqP) and Good Hygienic Practice (GHP). HACCP is required only at processing establishments or feed manufacturing units. The Table below illustrates the control/ good management requirements at different segments of the value chain.

Table 4: Requirement of implementation of GHP, GAqP, GMP and HACCP in aquaculture value chain

Control system	Hatchery	Nursery and Farm	Feed company	Farm input supplier	Fish trans-porter	Ice making facility	Fish auction center	Fish market
Good hygiene Practices (GHP)	+	+	+	+	+	+	+	+
Good Aquaculture Practices (GAqP)	+	+	-	-	-	-	-	-
Good Manufacturing Practices (GMP)	-	-	+	-	-	+	-	-
Hazard Analysis and Critical Control Point (HACCP)	-	-	+	-	-	+	-	-

2. Control measures for microbes/ germ in aquaculture pond/ shrimp gher

Five Key control measures for microbes/ germ may be considered for the aquaculture pond/ Shrimp Gher. They are illustrated below:

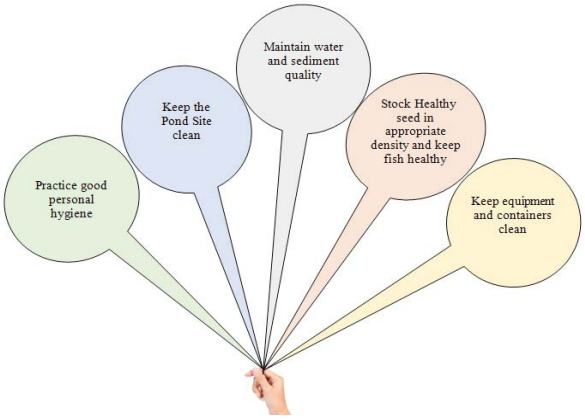


Fig 3: Five Key control points for microbes

Details and Rationale

POND/SHRIMP GHER KEY CONTROL MEASURES	HOW	WHY
1. Practice good personal hygiene while working in a pond, harvesting and handling fish	-Use toilets for defecation and urination. - wash hands after use of toilets or after handling animals or animal waste. - wear clean cloths while harvesting or handling fish. - do not handle fish or participate in harvesting if you have any diarrhoea or gastroenteritis. - Cover any cut or wound in the hands.	-Pathogenic microorganisms can be associated with human and animal waste and human skin. -Washing hands after use of toilet use is important to prevent contamination of fish handled -Persons suffering from diarrhoea or gastroenteritis can harbour pathogenic microorganisms in their gut

POND/SHRIMP GHER KEY CONTROL MEASURES	HOW	WHY
2. Keep the pond site clean	- Make a survey of the areas around the pond site to make an assessment of the risk of contamination of ponds with animal or human excreta, sewage and risk of chemical pollution from pesticides, heavy metals, industrial effluents or other chemicals. - During pond operations, prevent access to animals by fencing the area around animals. Minimise access to birds using ribbons or scarecrow. - Do not keep rubbish, old equipment, containers of chemicals, oil around the pond. - Clear weeds and other rubbish around ponds. - While constructing a pond, choose a site, where there is facility for water intake and discharge. After each cycle of operation, empty the pond fully, remove excessive organic matter, dry the pond before stocking again. - If the water intake is derived from underground water, check the water for levels of arsenic.	-Human and animal excreta, sewage would be a source of harmful microorganisms. Pesticides, heavy metals and other chemicals from soil or around the pond site will contaminate pond water and reach fish tissue and make fish unsafe for human consumption. -Rubbish around the ponds could attract pests and birds, which may contaminate pond water with their excreta. -Weeds around the pond could harbor snails that are intermediary hosts for some fishbornetrematodes. -At the end of culture period, the pond bottom will be rich in organic matter consisting of any unutilized feed and fecal matter of fish. These need to be flushed out before the next culture cycle, otherwise, water quality cannot be maintained.

POND/SHRIMP GHER KEY CONTROL MEASURES	HOW	WHY
3. Maintain water and sediment quality	- Take water from a source where the risk of contamination from chemicals and harmful microorganisms is minimal. Look for chances of contamination from human or animal waste, chemical pollutants. - Some fish utilize natural feed and require minimal supplementary feeding. Some fish/shrimp require feed with high protein content. Different feed may be required at nursery and growing stage and at finishing stage. Use feed appropriate for species, stage of growth and feed at required levels. - Monitor water quality based on simple measurable parameters like turbidity, colour, pH, dissolved oxygen, ammonia, nitate and nitrite content. - Monitor sediment for organic matter accumulation, ammonia and hydrogen sulphide content. - If the water and sediment quality are not good, consider options like water exchange, aeration, optimizing feeding regime for improving water quality.	-Source water could be a pathway for the entry of harmful microorganisms and chemicals into an aquaculture pond. -Feeding should based on species requirement and stage of growth. Excess feeding would lead to accumulation of unutilised feed in pond sediment, which along with fish fecal waste could accumulate in pond sediment, leading to formation of toxic ammonia and hydrogen sulphide. -Deterioration of water quality could lead to stress in fish, increase susceptibility to diseases and trigger use of chemicals and veterinary drugs that are harmful to human health.

POND/SHRIMP GHER KEY CONTROL MEASURES	HOW	WHY
4. Stock healthy seed in appropriate density and keep fish healthy	- There are different ways by which the healths of fish seeds are checked. In addition to visual observation for any external signs of infection, one can perform, depending on species, tests like salinity stress test, formalin stress test etc. -Excessive stocking density could lead to stress on fish and increase susceptibility to diseases leading to use of veterinary drugs. - Depending on pond conditions, the type of fish to be stocked and feeding practices are to be optimized. Utilisation of natural fish food (phyto and zooplankton) in the pond could minimize use of artificial feed and reduce input costs. Some fish feed on floating plankton, other could utilize plankton in water column and others could be bottom feeders. It would be good to have a mixture of these, so that natural fish feed is optimally utilized. - Monitor fish health. This can be done by visual observations for any signs of disease. Sick fish are generally inactive and floating. Remove any sick fish, so that they do not transmit the disease to other fish.	-Choosing healthy seed is important to keep fish healthy in a fish farm. Infection with certain fish bornetrematodes could occur at hatchery or nursery level. Stress tests help to differentiate fish seeds that are weak and more susceptible to diseases. Keeping fish healthy is important to minimize the use of veterinary drugs. -Emptying ponds after each cycle is important for maintaining biosecurity. Without emptying ponds, you can not harvest all fish and parasites like Lernea that are a problem for carps will persist in the pond and infect newly stocked seeds.

POND/SHRIMP GHER KEY CONTROL MEASURES	HOW	WHY
5. Keep equipment and containers clean	- For fish harvesting and handling, use equipments and containers that are made of impervious material that can be easily cleaned. - Wash and clean the containers and fish handling equipments before use. - Use clean water for washing fish - Do not allow waste water to contaminate fish or the containers - Prevent access of animals and birds to the equipments and containers. - Keep the fish cool after harvesting. Once out of water, add adequate ice made from clean water.	-If equipments and containers for handling fish are not made from impervious material, they will not be easy to clean, organic matter is difficult to remove, and the accumulated organic matter will be a good medium for bacteria to grow and contaminate fish. -Pathogens like Listeria monocytogenes, Salmonella may survive and multiply in the organic matter. This will be a source of contamination for fish that come in contact with the equipment and containers. -Animals and birds can carry pathogenic bacteria like Salmonella and if animals and birds come in contact with equipments and containers, they can transfer contamination. -If wish are washed with water that is not clean, they will be contaminated with harmful microorganisms.

3. Control measures for chemicals in aquaculture pond/ shrimp gher

Similarly 5 (Five) control points for chemicals in the aquaculture pond/Shrimp Gher should be kept in mind. They are as follows:

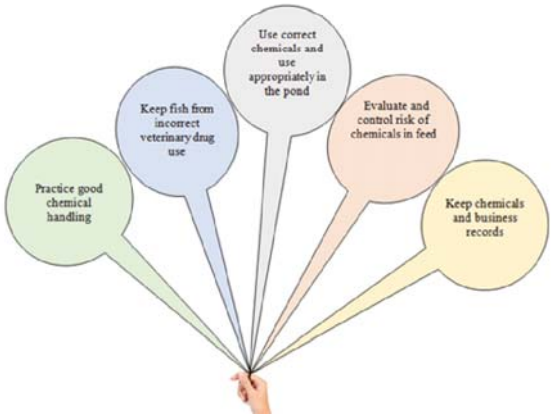


Fig 4: Five Key control points of chemical uses

Details and Rationale

CHEMICAL HAZARD CONTROL MEASURE	HOW	WHY
1. Practice good chemical handling	- The premises for storing and dispensing feed and other inputs like chemicals, veterinary drugs should be well separated and clean. - The equipments used for weighing and dispensing chemicals should be clean. - The layout of the storage and handling area should be such as to prevent cross contamination between feed and chemical inputs - Do not leave used chemical containers near the pond. - Animal access should be prevented and pest control measures should be in place.	- Lack of good handling practices could lead to contamination of feed with chemicals and harmful microorganisms. - Chemicals and veterinary drugs handled without care could be an occupational hazard for farm workers. - If equipments used for weighing feed or dispensing inputs are not clean, there could be cross contamination between feed and other chemical inputs stocked.

CHEMICAL HAZARD CONTROL MEASURE	HOW	WHY
2. Protect fish from incorrect veterinary drug use.	- Consult with local authorities regarding approved chemicals and veterinary drugs for aquaculture and conditions at which they can be used, appropriate dosages and withdrawl period to be observed. - Do not use veterinary drugs without diagnosis of a disease and without prescription from a qualified professional. - When drugs are being used, do not harvest fish before the prescribed with drawl period.	-Certain veterinary medicines such as chloramphenicol, nitrofurans and malachite green are banned for use in food producing animals. Unapproved veterinary drugs could be harmful for human health and may even be carcinogenic. Indiscriminate use of antimicrobial agents could lead to selection of antimicrobial resistant bacteria and the genetic determinants of antimicrobial resistance could be transferred to human pathogens, fish pathogens making treatment with such microbial infections very difficult.
3. Use correct chemicals and use them correctly	- Do not use toxicants such as phos toxin in the pond. Empty the ponds by discharging water completely. - Use only approved chemicals like water and sediment disinfectants, at appropriate dose, according to professional advice and only when required.	-Ponds without water intake and discharge facilities cannot be emptied and farmers tend to use toxicants before next stocking. This practice compromises safety of fish for human consumption. -Chemicals like disinfectants can be toxic to fish and may disturb water quality. Inappropriate use could stress the fish and lead to mortalities or susceptibility to diseases
4. Evaluate and manage risks of chemicals in the feed	- Ensure that the feed comes from a reliable producer and the feed ingredients are clearly indicated in the label. - Check the label of feeds to ensure that they do not contain antibiotics or other unapproved chemicals as growth promotors	-Chemicals like antibiotics may get into aquaculture ponds through feeds. -Use of antibiotics as growth promoters is not internationally accepted. Such use could lead to antibiotic residues in fish and selection of antibiotic resistant bacteria in pond water.

CHEMICAL HAZARD CONTROL MEASURE	HOW	WHY
5. Traceability Keep chemical records and business records	- Maintain a pond record book with details of operations like use of stocking, feeding rate, details of feed used, use of chemicals, veterinary drugs and other inputs used. - In the pond record, maintain details of costs of inputs used - For each cycle, monitor the feed conversion ratio, input and output. costs	-Keeping proper records of inputs used in ponds is a part of good aquaculture practice. -The record will help working out the feed conversion ratio and help the farmer to improve feeding practice. -The record will be a good evidence of implementation of GAqP and could convince buyers about safety and quality of fish produced.

4. Control measures for fish hatchery

Similarly 5 (Five) control points for chemicals in the aquaculture pond/Shrimp Gher should be kept in mind. They are as follows:

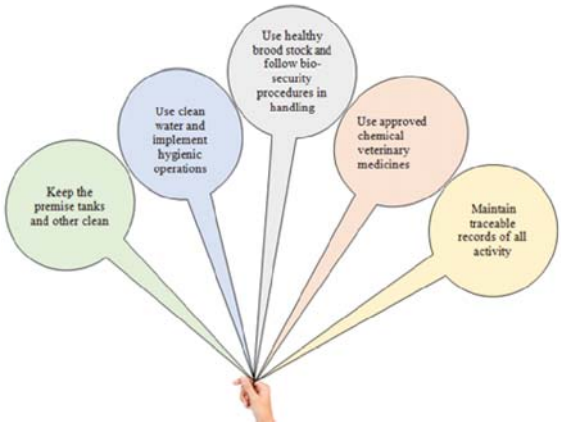


Fig 5: Five Key control points in fish hatchery

Details and Rationale

HATCHERY SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
1.Keep the premises, tanks and other containers holding fish/larvae clean, control pests and animal access	- Perform hatchery operations in an enclosed and protected area and control access to pests and animals. - Clean and dry the floor, tanks in which fish and larvae are held. - Store broodstock and larval feed in clean areas and well separated from chemicals, cleaning and sanitizing agents and equipment. - Provide adequate sanitary facilities for staff.	- Good hygienic practices are important to prevent build up of harmful microorganisms in hatchery tanks that may cause mortalities and warrant use of veterinary medicines that may persist in larvae. Pests and animals may contaminate hatchery tanks with harmful microorganisms

HATCHERY SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
2.Use clean water, implement hygienic operations and strong personal hygiene.	- Use water from a source where harmful microorganisms, chemicals or toxic phytoplankton are not present in such quantities that may affect health of fish or safety of fish for human consumption - Hatchery operations should be done in a hygienic manner to avoid cross contamination with chemicals veterinary medicines and sanitizers and personals.	- Contaminated water may contain harmful microorganisms or chemicals that may impact fish health and safety of brood stock and Pl. - Contamination of water during operations with chemicals, sanitizers or veterinary medicines will compromise food safety. Lake of personal hygiene may jeopardise all the activity.
3.Use healthy brood stock and follow bio-security procedures in handling animals and feed	- Choose healthy brood stock for hatchery operations and avoid cross contamination that can come though live feed, nets, equipment that were in contact with infected brood stock or larvae.	- Healthy brood stock would yield healthy larve. Cross contamination coming from live feed, nets and equipment could lead to outbreaks of diseases. Preventing disease outbreak is important to avoid use of veterinary medicines.
4. Use approved chemicals, veterinary medicines only when required, in a responsible manner	- Check which veterinary medicines and chemicals are authorized to be used in a fish hatchery. Use veterinary medicines only when there is diagnosis of a disease. Follow the directions of use eg. Dosage, period of use. - Other chemicals like sanitisers should also be used at appropriate doses.	- Certain veterinary medicines like chloramphenicol, nitrofurans and malachite green are banned for use in food producing animals. Chemicals and veterinary medicines leave residues in fish. Unwarranted use of veterinary medicines will lead to rapid spread of resistant bacteria and resistance determinants may be transferred to human pathogens. Sanitisers used in excessive doses could persist in hatchery environment and cause larval mortalities.

HATCHERY SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
5. Maintain Traceable records of all activity	- Maintained records of all activity during operation of hatchery. Records of use of drugs, chemicals, artemia or any other inputs used in Hatchery. Workers health condition, cleaning sanitation, water purification, materials used, Brood collection, Pl production and sale records should be kept in traceable fashion.	- For any types of production failure records can help cause of failure. Records helps boast up marketing of hatchery produces. Contaminated water may occur during handling which contains harmful microorganisms or chemicals that may impact fish health and safety. -Contamination of water during operations of hatchery with chemicals, sanitizers or veterinary medicines or microbes will increase mortality risk of post larvae and hindered growth of overall production. Records help to prevent any failure. On the other hand it is the regulatory requirement of CA.

5. Control measures for fish nursery of fish/shrimp farm/gher

The following are recommended for fish nursery of fish/shrimp farm/gher:

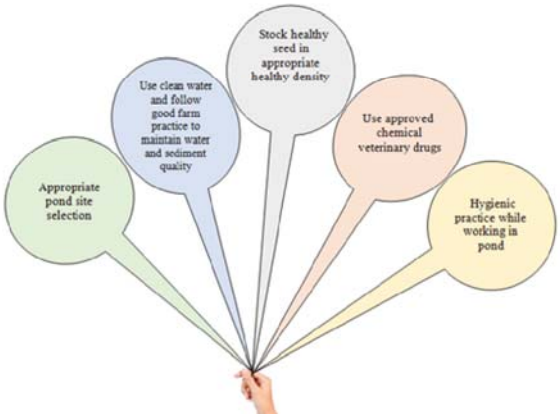


Fig 6: Five Key control points in fish/ shrimp farm

Details and Rationale

NURSERY SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
1.Choose a pond site where contamination with chemicals and harmful microorganisms are minimal and can be controlled and maintain pond hygiene	- Make a survey of the areas around the pond site to make an assessment of the risk of contamination of ponds with animal or human excreta, sewage and risk of chemical pollution from pesticides, heavy metals, industrial effluents or other chemicals - During pond operations, prevent access to animals by fencing the area around animals. Minimise access to birds using ribbons or scarecrow - Do not keep rubbish, old equipment, containers of chemicals, oil around the pond. - Clear weeds and other rubbish around ponds.	-Human and animal excreta, sewage would be a source of harmful microorganisms. Pesticides, heavy metals and other chemicals from soil or around the pond site will contaminate pond water and reach fish tissue and make fish unsafe for human consumption. -Rubbish around the ponds could attract pests and birds, which may contaminate pond water with their excreta. Weeds around the pond could harbor snails that are intermediary hosts for some fishbornetrematodes. -At the end of culture period, the pond bottom will be rich in organic matter consisting of any unutilized feed and fecal matter of fish. These need to be flushed out before the next culture cycle, otherwise, water quality cannot be maintained.

NURSERY SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
	- While constructing a pond, choose a site, where there is facility for water intake and discharge. After each cycle of operation, empty the pond fully, remove excessive organic matter, dry the pond before stocking again. - If the water intake is derived from underground water, check the water for levels of arsenic.	
2.Use clean water and follow good farm practices to maintain water and sediment quality	- Take water from a source where the risk of contamination from chemicals and harmful microorganisms is minimal. Look for chances of contamination from human or animal waste, chemical pollutants. - Some fish utilize natural feed and require minimal supplementary feeding. Some fish/shrimp require feed with high protein content. Different feed may be required at nursery and growing stage and at finishing stage. Use feed appropriate for species, stage of growth and feed at required levels. - Monitor water quality based on simple measurable parameters like turbidity, colour, pH, dissolved oxygen, ammonia, nitate and nitrite content. - Monitor sediment for organic matter accumulation, ammonia and hydrogen sulphide content. - If the water and sediment quality are not good, consider options like water exchange, aeration, optimizing feeding regime for improving water quality.	-Source water could be a pathway for the entry of harmful microorganisms and chemicals into an aquaculture pond. -Feeding should based on species requirement and stage of growth. Excess feeding would lead to accumulation of unutilised feed in pond sediment, which along with fish faecal waste could accumulate in pond, leading to formation of toxic ammonia and hydrogen sulphide. -Deterioration of water quality could lead to stress in fish, increase susceptibility to diseases and trigger use of chemicals and veterinary drugs that are harmful to human health.

NURSERY SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
3.Stock healthy seed in appropriate density and keep fish healthy	- There are different ways by which the health of fish seeds are checked. In addition to visual observation for any external signs of infection, one can perform, depending on species, tests like salinity stress test, formalin stress test etc. Excessive stocking density could lead to stress on fish and increase susceptibility to diseases leading to use of veterinary drugs - Depending on pond conditions, the type of fish to be stocked and feeding practices are to be optimized. Utilisation of natural fish food (phyto and zooplankton) in the pond could minimize use of artificial feed and reduce input costs. Some fish feed on floating plankton, other could utilize plankton in water column and others could be bottom feeders. It would be good to have a mixture of these, so that natural fish feed is optimally utilized. - Monitor fish health. This can be done by visual observations for any signs of disease. Sick fish are generally inactive and floating. Remove any sick fish, so that they do not transmit the disease to other fish.	- Choosing healthy seed is important to keep fish healthy in a fish farm. Infection with certain fishbornetrematodes could occur at hatchery or nursery level. Stress tests help to differentiate fish seeds that are weak and more susceptible to diseases. Keeping fish healthy is important to minimize the use of veterinary drugs. - Emptying ponds after each cycle is important for maintaining biosecurity. Without emptying ponds, you can not harvest all fish and parasites like Lernea that are a problem for carps will persist in the pond and infect newly stocked seeds.

NURSERY SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
4.Use approved chemicals, veterinary drugs, only when required, in a responsible manner	- Consult with local authorities regarding approved chemicals and veterinary drugs for aquaculture and conditions at which they can be used, appropriate dosages and with drawl period to be observed. - Do not use veterinary drugs without diagnosis of a disease and without prescription from a qualified professional. - When drugs are being used, do not harvest fish before the prescribed with drawl period. - Do not use toxicants such as phos toxin in the pond. Empty the ponds be discharging water completely.	-Certain veterinary medicines such as chloramphenicol, nitrofurans and malachite green are banned for use in food producing animals. Unapproved veterinary drugs could be harmful for human health and may even be carcinogenic. Indiscriminate use of antimicrobial agents could lead to selection of antimicrobial resistant bacteria and the genetic determinants of antimicrobial resistance could be transferred to human pathogens, fish pathogens making treatment with such microbial infections very difficult. - Ponds without water intake and discharge facilities cannot be emptied and farmers tend to use toxicants before next stocking. This practice compromises safety of fish for human consumption.
5.Follow hygienic practices while working in pond, harvesting and handling fish	- Maintain personal hygiene and use clean equipment, containers for harvesting fish. - Do not allow sick persons to handle fish. - Any cuts or wounds in the handlers should be covered with impervious material. - Use containers made of materials like plastic that can be easily cleaned. - Use clean water for washing fish and containers. - Limit access to animals to areas stocking fish harvesting equipment, containers and to harvesting and handling areas. - If fish are not transported live, harvest fish during cool part of the day, and transport quickly in ice made from potable water.	- Contamination of fish with harmful microorganisms could occur while handling fish from unclean equipment, or water. Lack of personal hygiene in fishers and handlers could lead to contamination of fish with harmful microorganisms.

6. Control measures for fish feed manufacturer

The following are recommended for fish feed manufacturer:

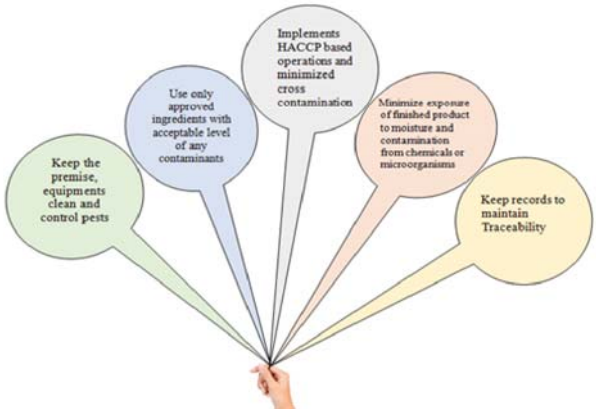


Fig 7: Five Key control points for fish feed manufacturer

Details and Rationale

FEED MANUFACTURER SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
1. Keep the premises, equipments clean and control pests and animal access	- Fish feed manufacturing facility should not be located in an environmentally polluted area, subjected to flooding, prone to infestation with pests and from where wastes cannot be removed easily. - Internal design and layout should permit implementation of good hygienic practice and prevent cross contamination during operations. - The establishment should have sanitary facilities for staff and clean water should be available. - Adequate drainage and waste disposal facilities should be available.	- Contamination of feed with harmful microorganisms and chemicals can occur if the premises are not clean. Access to animals and birds could lead to fecal contamination. Salmonella contamination is often a problem due to access to animals and pests. - Personal, equipment and premises cleanliness is important to avoid contamination with harmful microorganisms. Pathogenic microorganisms like Salmonella are known to form bio film on processing equipments.

FEED MANUFACTURER SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
	- Equipments should be maintained clean and the establishment needs to implement a standard operating practice for cleaning	
2. Use only approved ingredients with acceptable level of any contaminants, procured from known sources	- Check the ingredients for the composition and see if they are approved as per national regulation. Ask for certifications regarding quality control, certificate of analysis	- Feed ingredients could be a source of harmful chemicals such as antibiotics, heavy metals or pesticides. When dry fish is used as a source of fish meal, it needs to be checked for presence of pesticides. Fish meal may be made from fish harvested from polluted waters.
3. Implement HACCP based operations and minimize cross contamination	- Make an analysis of potential hazards, identify critical control points and implement the HACCP plan in the process.	- When a HACCP plan is developed, some hazards can be controlled at receiving stage of raw materials like feed ingredients. -Cross contamination during operations could lead to contamination of feed with undesirable substances that may impact food safety. HACCP plan will help implementation of control measures during the process.
4. Minimise exposure of finished product to moisture and contamination from chemicals or microorganisms	- Store the ingredients and finished product separately, protected from sunlight and moisture. Prevent contamination of ingredients and products with agents used in cleaning and disinfection.	- Feed exposed to moisture could support growth of molds and formation of mycotoxins. Contamination of feed could occur, if not well separated from agents used for cleaning and disinfection.
5. Keep records to maintained Traceability	- Maintain a record for all operations, ingredients used, source of ingredients, production process, quality, quantity ,supply recodes etc.. on ratio, input and output costs	- The record will be a good evidence of implementation of GMP and could convince buyers about safety and quality of fish produced. Proper record keeping for all activity ensure market excess and buyers satisfaction.

7. Control measures for fish feed and other aquaculture input supplier

The following are recommended for fish feed and other aquaculture input suppliers

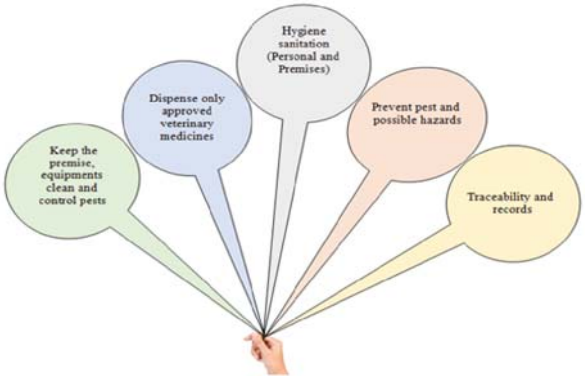


Fig 8: Five Key control points for aquaculture input suppliers

Details and Rationale

FISH FEED AND OTHER AQUACULTURE INPUT SUPPLIERS SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
1.Keep the premises, equipments clean and control pests and animal access	- The premises for storing and dispensing feed and other inputs like chemicals, veterinary drugs should be clean. - The equipments used for weighing and dispensing should be clean. - The layout should be such as to prevent cross contamination between feed and chemical inputs	- Lack of cleanliness could lead to contamination of feed with chemicals and harmful microorganisms. - Animal feces could be source of harmful microorganisms. - If equipments used for weighing feed or dispensing inputs are not clean, there could be cross contamination between feed and other chemical inputs stocked.

FISH FEED AND OTHER AQUACULTURE INPUT SUPPLIERS SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
2.Dispense only approved veterinary medicines based on professional prescription	-Stock only approved veterinary medicines. -Dispense medicines only against diagnosis of a disease and professional prescription. Do not stock harmful chemicals such as phos toxin or banned veterinary drugs.	- Certain veterinary medicines are banned for aquaculture: eg chloramphenicol, nitro furans, malachite green. These should not be stocked by the supplier. Veterinary medicines should not be used for growth promotion or for diseases caused by viruses. Thus professional advise.
3.Minimise exposure of feed to moisture and contamination from chemicals or microorganisms	- Store the feed in a clean and dry place, protected from rain, hand washing, toilet area and other possible means of exposure to moisture and contamination. - Store feed away from chemicals and other inputs.	- Feed exposed to moisture may be contaminated with mycotoxins. Cross contamination during storage with chemicals and harmful microorganisms could lead to contamination of fish through feed.
4. Prevent pest and Possible Hazards	- Store the ingredients and finished product separately, protected from sunlight and moisture. Prevent contamination of ingredients and products with agents used in cleaning and disinfection.	- Feed exposed to moisture could support growth of molds and formation of mycotoxins. Contamination of feed could occur, if not well separated from agents used for cleaning and disinfection.
5.Keep Records for Traceability of the products	- Maintain a record for all operations, ingredients used, source of ingredients, production process, quality, quantity ,supply recodes etc..	- The record will be a good evidence of implementation of GMP and could convince buyers about safety and quality of fish produced. Proper record keeping for all activity ensure market excess and buyers satisfaction.

8. Control measures for fish transporter

The following are recommended for fish transporter

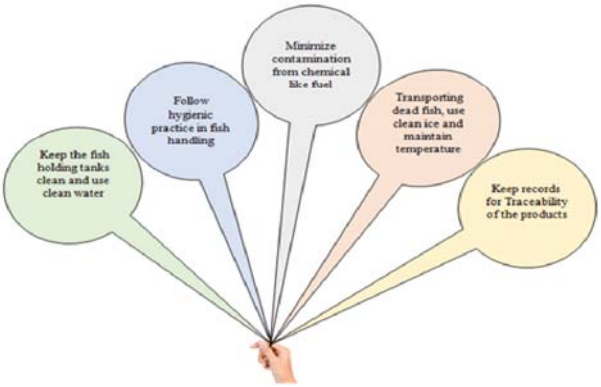


Fig 9: Five Key control points for fish transporter

Details and Rationale

FISH TRANSPORTER SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
1. Keep the fish holding tanks clean and use clean water, if transporting fish live	- Use fish tanks made of materials that are easy to clean. - Wash and dry fish holding tanks. - Ensure that tanks are filled with clean water for transporting live fish.	- Fish tanks may hold organic matter, which will encourage bacterial growth and contamination of fish. If fish are transported in contaminated water, food safety will be compromised.
2. Follow hygienic practices in fish handling	- Follow personal hygiene like wearing clean cloths, washing hands after using toilet, handle fish in clean area. - Sick persons should not handle fish.	-Lack of personal hygiene while handling fish could lead to contamination of fish with harmful microorganisms.

FISH TRANSPORTER SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
3. Minimise contamination from chemicals like fuel, oil and grease	- Do not store fuel, oil, grease in area with fish tanks	- If not stored separately, during transport, fish may be contaminated with fuel, oil and grease.
4. If transporting dead fish, use clean ice and maintain temperature as low as possible	-Ice used for cooling fish should be clean, made from potable water. -Fish should be cooled with ice as soon as possible after harvest. -Icing should be done adequately and every layer of fish should have ice to ensure uniform cooling.	- If fish is not cooled after harvest, microorganisms, including harmful ones can multiply and compromise fish safety.
5. Keep Records for Traceability of the products	- Maintain a record for all operation during transportation and loading. Record transportation temperature, ice used, duration of transportation, Loading and unloading time etc.	- Proper record ensure safety and quality of raw materials. The record will be a good evidence of implementation of GHP practice during transportation.

9. Control measures for ice manufacturer

The following are recommended for ice manufacturer

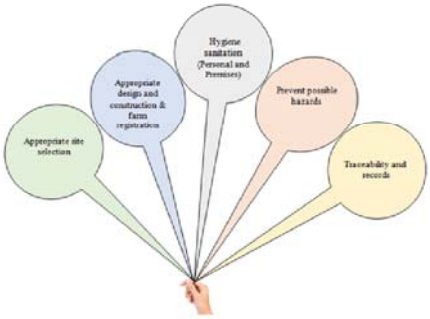


Fig 10: Five Key control points for ice manufacturer

Details and Rationale

ICE MANUFACTURER SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
1. Keep the premises, equipments clean and control pests and animal access	- Ice manufacturing facility should not be located in an environmentally polluted area, subjected to flooding, prone to infestation with pests. - Internal design and layout should permit implementation of good hygienic practice and prevent cross contamination during operations. - The establishment should have sanitary facilities for staff and clean water should be available.	- Cleanliness of the equipments and premises, controlling pests and access to animals is required to prevent contamination of ice with harmful microorganisms.

ICE MANUFACTURER SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
2. Use potable water for making ice and minimize exposure of ice to contamination during storage and handling	- Ensure that water used for making ice is potable water. - Implement hygienic practices while taking ice blocks out, crushing and handling	- Ice made from contaminated water will contaminate fish with harmful microorganisms and chemicals. - Ice could get contaminated with harmful microorganisms, if not handled with hygienic practices.
3. Hygiene Sanitation (Personal and premises	- Follow personal hygiene like wearing clean cloths, washing hands after using toilet, handle fish in clean area. - Sick persons should not handle ice	- Lack of personal hygiene while handling ice could lead to contamination of ice as well as fish with harmful microorganisms.
4. Prevent Possible Hazards (Pest control to prevent contamination by microbes.	-Pest, bird or any animal access should be prevented and pest control measures should be in place to prevent occurrence of hazards.	-Lack of cleanliness could lead to contamination of ice with pest and harmful microorganisms. -Animal feces could be source of harmful microorganisms.
5. Keep Records for Traceability of the products	- Maintain a record for all operation during production and loading and unloading of ice. Record ingredient used during production of ice, water quality.	- Proper record ensures safety and quality of ice which directly help maintained quality of fish and shrimp. Use contaminated ice may contaminate whole lot of products .Which caused huge financial lose.

10. Control measures for fish auction center

The following are recommended for fish auction center

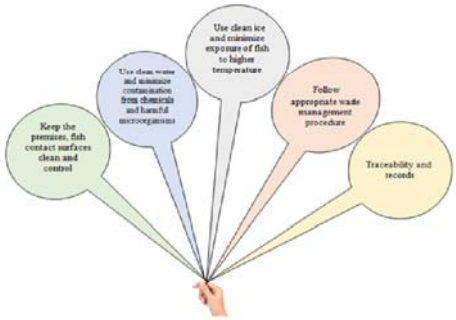


Fig 10: Five Key control points for fish auction centre

Details and Rationale

FISH AUCTION CENTER SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
1. Keep the premises, fish contact surfaces clean and control pests and animal access	- Clean the surroundings of the auction center and the area in which fish is handled, auctioned and repacked by the buyer. open into fish handling areas. - Implement pest control and animal access prevention measures.	-Unclean premises, lack of hygiene in fish handling areas, presence of animals and birds could lead to contamination with harmful microorganisms.
2. Use clean water and minimize contamination from chemicals and harmful microorganisms	- Ensure that the water used for fish contact surfaces and for fish washing is clean. - Store cleaning equipment, sanitizers in area that is well protected from fish handling area.	-Water could be source of harmful chemicals and microorganisms. -Cross contamination with detergents and sanitizers used for cleaning in fish handling area should be avoided.

FISH AUCTION CENTER SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
3. Use clean ice and minimize exposure of fish to higher temperatures	- During and after auction, ice may have to be replenished. Procure ice from a supplier known to use clean water and handle ice with hygienic practices. - While replenishing ice, ensure that adequate quantity of ice is used and all layers of fish are adequately cooled.	-Ice made from contaminated water will contaminate fish with harmful microorganisms and chemicals. -If ice is not handled under hygienic practice, it may get contaminated with harmful microorgaisms. -If fish are subjected to temperature abuse during handling and auctioning, microorganisms including harmful ones may multiply and impact food safety.
4. Follow appropriate waste management procedures	- Containers for collecting waste should be separated from fish holding containers and labeled properly. - Dispose waste, water used for washing fish properly, so that fish does not get contaminated.	-Fish waste would be good medium for microorganisms to flourish and these may contaminate fish. -Water used for washing fish, handling areas would contain microorganisms, which can multiply, if not drained and disposed properly.
5. Keep records all the activity to trace the products and source of contamination.	-Maintain a record book with details of operations like use of Qty landed, l Quantity, Species, name of Collection Centre or Pond ID , Loading and unloading time, cleaning & disinfection etc.	-Keeping proper records of inputs used in auction centre. -The record will be a good evidence of implementation of GAqP and could convince buyers about safety and quality of fish produced.

11. Control measures for wholesale/retail market

Five key control measure for whole sale and/retail market are recommended as follow:

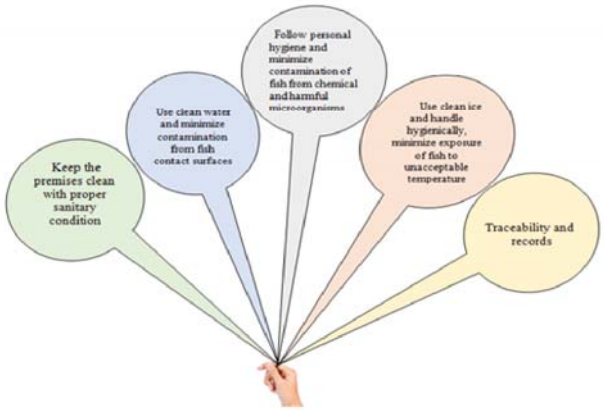


Fig 12: Five Key control points for whole sale/ retail market

Details and Rationale

WHOLE SALE AND/ RETAIL MARKET SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
1. Keep the premises clean with proper sanitary, water drainage, fish display facilities and control pests and animal access	- Clean the surroundings of the market and the area in which fish is handled and displayed. - Market structures (walls, partitions, doors) should be soundly built, made of durable material, easy to clean. - Ceilings and overhead fixtures should be constructed and finished to minimize build-up of dirt, condensation, and shedding of particles. - The fish handling and display area should be well drained so that drain water does not contaminate fish. - Fish holding containers and contact surfaces should be made of impervious non-toxic material that is easy to clean. - There should be staff toilets and these should not open into fish handling areas.	-Unclean premises, lack of hygiene in fish handling areas, presence of animals and birds could lead to contamination with harmful microorganisms.

WHOLE SALE AND/ RETAIL MARKET SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
	- Implement pest control and animal access prevention measures. - Fish market should be well separated from area where other animals like poultry are slaughtered and sold. - The market should have a daily cleaning schedule, which should be strictly implemented, recorded and monitored.	
2. Use clean water and minimise contamination from fish contact surfaces	- Persons working in market should be healthy. Those handling fish should follow hygienic practices like wearing clean cloths, washing hands after using toilet. - Cleaning equipment, detergents, sanitizers should be stored away from fish handling area to minimize cross contamination. - Containers for collecting waste should be separated from fish holding containers and labelled properly. - Dispose waste, water used for washing fish properly, so that fish does not get contaminated.	-Lack of personal hygiene could lead to contamination of fish with dangerous microorganisms. -Cross contamination in market could lead to presence of harmful chemicals and microorganisms in fish.
3. Follow personal hygiene and minimize contamination of fish from chemicals and harmful microorganisms	-Maintain a record book with details of operations like use of Qty landed, l Quantity, Species, name of Collection Centre or Pond ID , Loading and unloading time, cleaning & disinfection etc.	-Keeping proper records of inputs used in auction centre. -The record will be a good evidence of implementation of GAqP and could convince buyers about safety and quality of fish produced.

WHOLE SALE AND/ RETAIL MARKET SEGMENT OF VALUE CHAIN AND KEY CONTROL MEASURES	HOW	WHY
4. Use clean ice and handle hygienically, minimize exposure of fish to unacceptable temperatures	- During and after sale, ice may have to be replenished. Procure ice from a supplier known to use clean water and handle ice with hygienic practices. - While replenishing ice, ensure that adequate quantity of ice is used and all layers of fish are adequately cooled.	-Ice made from contaminated water will contaminate fish with harmful microorganisms and chemicals. -If ice is not handled under hygienic practice, it may get contaminated with harmful microorganisms. -If fish are subjected to temperature abuse during handling and auctioning, microorganisms including harmful ones may multiply and impact food safety.
5. Keep records all the activity to trace the products and business records.	-Maintain a record book with details of operations like Qty of fish landed, its quantity, Species, name of hygienic condition, Loading and unloading time, cleaning & disinfection etc.	-Keeping proper record of inputs used in wholesale /retail sale market. -The record will be a good evidence of implementation of GHP, GSP and could convince buyers and consumers about safety and quality of fish marketed.

Conclusion:

The introduction of above measures may not only make important contribution to improve the overall prductuctuvity in the aquaculture sector in Bangladesh but will also help Bangladesh to address qiality concerns about quality of aquaculture products from Bangldesh. Development of the aquaculture sector in Bangladesh will definitely be positively suported by the introduction wide accepatable and practice of these controlmeasures at eachimportant points of the value chainin the sector. Their introduction will also epecially welcome to improve food safety in so far as aquaculture products are concerned as well as acceptance of these products both by domestic and international consumers with consequent important economic implications.

Annex-1:

A Typical Fisheries and Aquaculture Value Chain in Bangladesh
Aquaculture Production and its Potential:

The fisheries and aquaculture supply chain in Bangladesh may involve different actors and a typical supply chain is illustrated below. For example the operations start with production of fish/Shrimp seeds in a hatchery. Most of the fish/Shrimp seed for stocking in ponds come from hatcheries, but some wild seed collection from rivers is also practiced. Collection of wild seed has implications for biodiversity and wild seed may carry naturally occurring pathogens. Controlled breeding in hatcheries would enable implementation of good practices. Hatcheries need to have access to clean water. Practices in hatchery eg use of chemicals and veterinary drugs, use of contaminated water may impact food safety, hence good practices need to start at hatchery level. If this is to be achieved, good practices are to be followed by input suppliers to the hatchery, eg manufacturers and suppliers of chemicals, feed that are used in hatchery.

From the hatchery, fish/Shrimp seeds may be stocked in nursery ponds. Good Aquaculture practices are essential at the level of nursery ponds. Infection with fish-borne parasites like trematodes could occur at nursery level and once infected the parasite stages remain in fish till they reach table size. Therefore nursery operators need to follow GAqP and GHP. Grow-out farms form the next link in aquaculture value chain.

In case of shrimp, there could be middlemen or fish collectors, who collect the harvest from different producers and then sell them to the market or to processors. Food safety can be compromised if good hygienic practices are not followed at this level too. Therefore, food safety guidelines are applicable to all actors in supply chain.

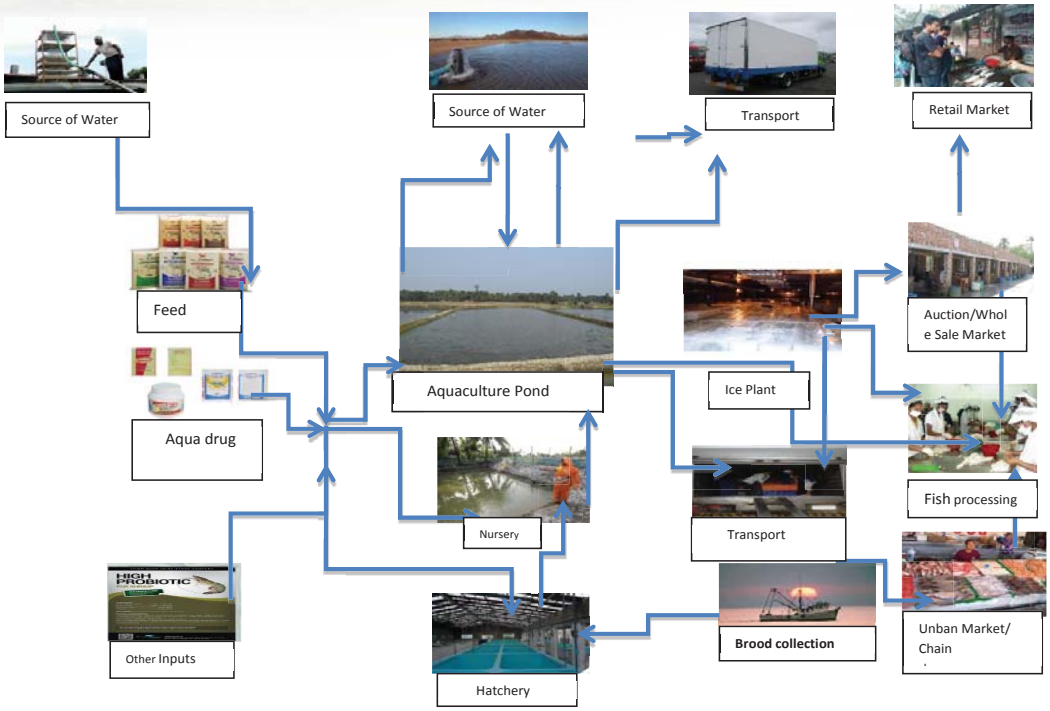


Fig 13: Extended Value Chain

The control guidelines in this compilation cover the broad segments of the above extended value chain, namely the ponds/ghers, hatchery, fish feed manufacturer, input suppliers, fish transportation, ice manufacturer, fish auction center and wholesale markets in the shrimp sector.

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