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Department of Fisheries

Ministry of Fisheries and Livestock, Bangladesh

Bangladesh Sustainable Coastal and Marine Fisheries Project (BSCMFP)

Pest Management Plan

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List of Acronyms

AGP	Antibiotic Growth Promoter
BLRI	Bangladesh Livestock Research institute
BSCMFP	Bangladesh Sustainable Coastal and Marine Fisheries Project
CEAL	Community Extension Agent for Livestock
CIG	Common Interest Group
DAE	Department of Agriculture Extension
DLS	Department of Livestock Services
DoE	Department of Environment
DoF	Department of Fisheries
ECA	Environmental Conservation Act
ECR	Environment Conservation Rules
EIA	Environmental Impact Assessment
EIL	Economic Injury Level
EMF	Environmental management Framework
EMP	Environmental Management Plan
ESA	Environmental and Social Assessment
ESMF	Environment and Social Management Framework
ESMP	Environmental and Social Management Plan
FAO	Food and Agriculture Organization
FMD	Foot and Mouth Disease
GoB	Government of Bangladesh
IPM	Integrated Pest Management
MDG	Millennium Development Goal
MFA	Marine Fisheries Academy
MoA	Ministry of Agriculture
MoFL	Ministry of Fisheries and Livestock
NAP	National Agriculture Policy
NATP	National Agriculture Technology Project
NEAP	National Agriculture Extension Policy
NGO	Non- Government Organization
NIPMP	National Integrated Pest Management Policy
NLDP	National Livestock Development Policy
PMP	Pest Management Policy
SOWT	Strength, Opportunity, Weakness and Threat
TOT	Training of Trainers
UAO	Upazila Agriculture Office
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Conference on Law of the Sea
UPCC	Upazila Project Coordination Committee
WB	World Bank
WBG	World Bank Group
WHO	World Health Organization

Executive Summary

The 'Bangladesh Sustainable Coastal and Marine Fisheries Project (BSCMFP)' is a two-phased proposed investment by the Government of Bangladesh (GoB) and the International Development Association (IDA) of the World Bank Group. The project will be implemented in the coastal and marine areas of Bangladesh by the Department of Fisheries (DoF), as the lead executing agency, under the guidance of the Ministry of Fisheries and Livestock (MoFL). The project aims to sustainably increase coastal and marine fisheries' contribution to the economy, poverty reduction through improving management of coastal and marine fisheries and aquaculture and fishing communities' access to alternative livelihoods activities in an environment friendly manner. The phase I BSCMFP will be implemented in 5 (five) years with a preliminary budget envelope of around USD 256 million and cover 75 upazilas of 16 coastal districts. Phase II of the project will be considered and its budget envelopes defined based on successful implementation of the reform project put in place under Phase I.

BSCMFP project supported by the World Bank involves improvement of aquaculture extensive production system, expansion of those in new areas and change of aquaculture practices, water management development for fish production, re-organization of aquaculture research and extension services, support for fish farmers organizations and similar programs.

Adequate measures are therefore required at project/ program development to promote appropriate management of pests and pesticides. This is to ensure that increased and sustainable fisheries and aquaculture production and fish farm incomes are achieved; that vector-borne diseases are managed in a sustainable manner, and that the risks to human health and the environment associated with pesticide use are kept to an acceptable minimum.

The World Bank's Pest Management Safeguard Policy (OP 4.09 and BP 4.01 Annex C) was established to address these concerns and to assist borrowers to manage pests in an appropriate manner. A major provision of the Safeguard Policy is the preparation of a comprehensive Pest Management Plan, or PMP, that will outline the various elements of and actions needed to be taken to adequately address these concerns during project implementation.

As the project formulation is underway, it is not conceivable to have all detail activities under different components at this stage. Hence, Pest Management Plan (PMP) is necessary to identify preliminary pesticides and pest management issues need to be considered at the later stages of the project. As the exact location and activities will be known only in the implementation stage, when detailed design will be available, this PMP has been prepared – as a constituent part of the overall environmental safeguards of the BSCMFP – to guide identification and management of pest and pesticides management issues, if in any way it comes, at the implementation level.

The project will take up and promote certain rural aquaculture development activities including SPF hatchery establishment, PCR laboratory and mariculture, as well as certain livelihoods interventions in the target fishers'communities. There is lesspossibility that these interventions may require use of approved chemicals as per recommended dose. The PMP takes into account of the relevant legislation, policies, and strategies on marine and coastal fisheries. The suggested guidelines and procedures of the PMP would adhere to the due diligence principles, especially it will ensure compliance with the World Bank's environmental and social safeguard policies and the relevant provisions under the related policies of GoB, and associated rules, regulations and procedures.

This PMP will also serve as the guideline for the staff designated by the implementing agencies - the DoF to oversee and monitor the PMP compliance of the project components coming under their implementation responsibility. Therefore, this PMP would be used as the template and guideline to ensure diligent pest and pesticides compliance of the planning and implementation of the activities envisaged under the BSCMF project. However, all processes described in the PMP can be adjusted based on implementation experience. The PMP will be a living document and will be reviewed and updated periodically as needed.

The present PMP has been prepared following the standard methodology consisting of the steps listed below:

- Review of the program details and meeting/discussions with the DoF team;
- Reviewed and evaluated the pest problems, disease and pest attack in major coastal aquaculture, and reviewed various methods and techniques currently in use for pest control in Bangladesh;
- Review of the policy and regulatory requirements related to aquaculture production or use of pesticides in Bangladesh, rules/guidelines of WHO, World Bank and other organizations on pest management;
- Reconnaissance field visits by DoF team and initial scoping and screening to determine level of use and extent of the project activities involving use of chemicals in aquaculture practices, and describing what the nature of the usage would be (high, low, moderate) as caused by the project and the kinds of chemical that would be used;
- Reviewed the Integrated Pest Management (IPM) measures and determined (a) the extent to which current practices are consistent with IPM, including the policy framework and incentive structure; (b) problems and opportunities for improvement;
- Consultations with the stakeholders including beneficiary/ affected communities and developing the consultation process;
- Developed a strategy for implementation of IPM for various project sites.

BSCMFP has four components (see ESMF), out of which Component 2: Improving Infrastructure and Production Practices includes two relevant sub-components 2.2 Value chain and food safety, and 2.3 Boosting Coastal Aquaculture Productivity, those may have requirement of PMP implementation. Other components especially relevant to infrastructure development might also need to follow the PMP framework during construction phase.

The proposed project has triggered OP 4.09, considering that the proposed program targets to increase extension services in aquaculture and mariculture production, and also operation of small- to medium-scale construction sites, laboratories which may involve usage of chemicals and fertilizers. Specifically, processing facilities as well as feed storage areas may need to control pests as well utilizing pesticides or rodenticides.

Aquaculture is a rapid growing sector in Bangladesh. Over the last decade the rapid expansion of shrimp culture in coastal areas has drawn an outstanding development in the country's fisheries sector. In recent years most of the farmers in coastal areas culture both shrimp and prawn in the same gher or pond. On the other hand, inland fisheries also expands rapidly having new aquaculture techniques with improved extensive and semi-intensive culture systems. For successful aquaculture, technology is most needed as well as the application of different aqua-drugs and chemicals which enhance production, preventing from disease or create immune system or antibody against diseases.

A variety of aqua-drugs and chemicals are used in both inland and coastal aquaculture, that can be classified according to use, types of organisms under culture, life cycle stage for which they are used, culture system and intensity of culture and the type of farmers who use them.

There are about 33 pharmaceutical companies producing 18 branded antibiotics and 23 pharmaceutical companies are active for producing and marketing aqua-drugs in greater Khulna region. The common commercial chemicals used by the rural fish/ shrimp farmers are Geotox, Geolite, Benzo, Ammonil, Megageo, EDTA, Timsen, BKC, Microdine iodine, Oxyflow, Oxymax, Oxy-plus, Oxy-gold, Eco-solution, Melathion, Sumithion, Dipterex, Virex, Malachite green, Spa, Oxytetracycline, Renamycine, Renamox, Bactitab, Bactrol, Vitamin, Cevit vet, Growmax, Panvit aqua, Aquamin, Aqua boost and Acimix supper-fish (Table 3.1).

In coastal regions of Bangladesh, the recorded diseases of shrimp are WSD, YHD, External Fouling, MBVD, Black gill disease and Bacterial diseases. Common fish diseases in Bangladesh are: EUS, Ulcers,

Bacterial infections and Fungal infections, Cloudy eye, Fin-rot, Dropsy, White Spots, Pop eye, Lymphocystis and Edwardsiellosis. The symptoms, reason for infection, action to be taken and treatment including using aqua-drugs and chemicals are furnished in Table 3.5. Banned steroid hormones Decason, Oradexon, Prednisolon, Betnenal, Cortan, Steron and Adam-33 are often found in the local market in the name of remedial medicines for fish/ and or shrimp diseases. These are banned in the country according to the Fish and Animal Feed Act, 2010. Besides those, Nitrofurans (Furazolidone, Furaltadone, Nitrofurantoin, Nitrofurazone) Chloramphenicol, injectable Dichlofenac sodium are also banned in the country. List of banned pesticides and chemicals in Bangladesh is shown in Table 3.6.

Framework of PMP and Its Implementation Strategies is described in Chapter 4.

Steps to planning PMP

The following 6 steps will assist in effective pest management planning:

1. Understand the pest issues
2. Develop a draft pest management plan
3. Consultations
4. Finalize and implement the plan
5. Monitoring
6. Evaluate and review the overall results

Principles of Pest Management

Eight principles of pest management are suggested to follow as common basis for the management of pest throughout project area of BSCMFP. The consideration of all these principles is critical to the success of any pest management activity, regardless of scope and scale. These are:

1. Integration: Pest management in aquaculture is an integral part of managing natural resources and agricultural systems.
2. Public awareness: Public awareness and knowledge of pest must be raised to increase the capacity and willingness of individuals to participate in control.
3. Commitment: Effective pest management requires shared responsibility, capability, capacity and a long-term commitment by fish farmers/ hatchery operators/ processors/ land owners/ managers, the community, industry groups and government. Those that create the risks associated with pest introduction or spread and those that benefit from the pest management should help to minimize the impacts of pest and contribute to the costs of management.
4. Consultation and partnership: Consultation and partnership arrangements among the users, local communities, industry groups, government agencies and local governments must be established to achieve a collaborative and coordinated approach to management.
5. Planning: Planning for pest management should be based on risk management to ensure that resources target the priorities identified at local, regional, and national levels.
6. Prevention and early intervention: Preventive pest management is generally more cost-effective than other strategies and is achieved by: preventing the spread of pest species, and viable parts of these pests, especially by human activity early detection and intervention.
7. Best practice: Pest management must be based on ecologically and socially responsible practices that protect the environment and the productive capacity of natural resources while minimizing impacts on the community. It should balance feasibility, cost-effectiveness, sustainability, humaneness, community perceptions, emergency needs and public safety.

8. Improvement (research, monitoring and evaluation): Research about pest and regular monitoring and evaluation of control activities is needed to make evidence-based decisions and improve pest management practices.

Transition to a PMP program requires a diverse, action-oriented PMP Committee. This PMP Committee will be an environmentally conscious committee lead by the Project Director at PMU, DoF. A representative of the District Fisheries Office and Fish Farming Group will be the members of this committee. The leader of this team should be familiar with pests, pesticides and pesticide regulations. This arrangement is appropriate, because implementation of an IPM program can be tracked as a performance indicator.

PMP leadership is guided by pest management principles and environmental issues. Leadership with such academic background and experience qualifies to serve as an authority to supervise PMP implementation. Other team members will include Environmental, Agriculture Extension, agronomists, crop protection experts (entomologists, pathologists), aquaculture experts, health officer and livestock officer.

Selection of pesticides, under the BSCMFP project will be guided by the consideration of several pest management approaches for cultural, physical and biological measures before resorting to application of chemical pesticides.

The use of pesticides must be guided by the principles of cost efficiency, safety to humans, the bio-physical environment and effectiveness in controlling the pests. Pesticides selection will be made in accordance with the World Bank guidelines for the selection of pesticides (World Bank Operational Manual, Good Practice (GP) 4.03) as follows:

i. Pesticides requiring special precautions should not be used if the requirements are not likely to be met;
ii. Pesticides to be selected from approved list, taking into consideration of: toxicity, persistence, user experience, local regulatory capabilities, type of formulation, proposed use, and available alternatives;
iii. Type and degree of hazard and availability of alternatives; and the following criteria will be used to restrict or disallow types of pesticides under Bank loans:
    a. **Toxicity**: acute mammalian toxicity, chronic health effects, environmental persistence and toxicity to non-target organisms;
    b. **Registration status** in the country and capability to evaluate long-term health and environmental impacts of pesticides.

The guidelines in Annex A provide internationally accepted standards on pesticides to minimize the hazards associated with pesticide use.

The Integrated Pest Management and Monitoring Plan (IPMP) is to be developed from the impacts and mitigation measures identified at the implementation stage based on the principles mentioned in this chapter and also the available techniques for aquaculture farms are described in Chapter 3. The IPMP should include impacts from application of chemical as well as non-chemical pesticides. The reason why chemical pesticides are included is that in the initial stages of implementation of the IPM, chemical pesticides will still be used but will be gradually phased out as the IPM gets established.

Table 4.1 is a typical environmental management and monitoring plan, which should be updated during implementation of the BSCMFP. Estimated costs for managing and monitoring some of the recommended enhancement and mitigation measures are provided in Table 4.1 need to be developed in the implementation period. A sample of cost estimation format is provided in Table 4.2.

Training programs on various aspects of the pest and disease management and judicious use of chemical pesticides have to be organized by the BSCMFP for the members of the fish farmer groups, pesticides dealers and retailers. It would be the responsibility of the EMC to train the relevant staff in the BSCMFP.

Training modules for pest management in ponds, hatcheries and nurseries should be developed. Following training programs will be provided under BSCMFP: Fish farmers' training, Pesticides dealers' training, Aquaculture extension personnel including BSCMFP staff training, and Local service providers training.

To initiate the promotion of IPM and sound pesticide use will be effective by organizing awareness program involving Fish Farmer's Groups and different stakeholders. Awareness will be raised through demonstrations, discussion meetings, dissemination of information about pest arrival, distribution of leaflet, booklet, etc.

Chapter 1: Introduction

1.1 Background

The 'Bangladesh Sustainable Coastal and Marine Fisheries Project (BSCMFP)' is a two-phased proposed investment by the Government of Bangladesh (GoB) and the International Development Association (IDA) of the World Bank Group. The project will be implemented in the coastal and marine areas of Bangladesh by the Department of Fisheries (DoF), as the lead executing agency, under the guidance of the Ministry of Fisheries and Livestock (MoFL) The project aims to increase coastal and marine fisheries' contribution to the economy, poverty reduction, and environmental stability through improving management of coastal and marine fisheries and aquaculture and fishing communities' access to alternative livelihoods activities in an environment friendly manner. The phase I BSCMFP will be implemented in 5 (five) years with a preliminary budget envelope of around USD 256 million and cover 75 upazilas of 16 coastal districts. Phase II of the project will be considered and its budget envelopes defined based on successful implementation of the reform project put in place under Phase I.

BSCMFP project supported by the World Bank may involve improvement of extensive aquaculture production systems, expansion into new areas and change of aquaculture practices, water management development for fish production, re-organization of aquaculture research and extension services, support for fish farmers organizations and similar programs.

Adequate measures are therefore required at project/program development to promote appropriate management of pests and pesticides. This is to ensure that increased and sustainable fisheries and aquaculture production and fish farm incomes are achieved; that vector-borne diseases are managed in a sustainable manner, and that the risks to human health and the environment associated with pesticide use are kept to an acceptable minimum.

The World Bank's Pest Management Safeguard Policy (OP 4.09 and BP 4.01 Annex C) was established to address these concerns and to assist borrowers to manage pests in an appropriate manner. A major provision of the Safeguard Policy is the preparation of a comprehensive Pest Management Plan (PMP), that will outline the various elements of and actions needed to be taken to adequately address these concerns during project implementation.

As the project formulation is underway, it is not conceivable to have all detail activities under different components at this stage. Hence, Pest Management Plan (PMP) is necessary to identify preliminary pesticides and pest management issues need to be considered at the later stages of the project. As the exact location and activities will be known only in the implementation stage, when detailed design will be available, this PMP has been prepared – as a constituent part of the overall environmental safeguards of the BSCMFP to guide identification of pests and pesticides management issues, if in any way it comes, at the implementation level.

1.2 The Context of Integrated Pest Management (IPM) in Fisheries and Aquaculture Sector

Integrated Pest Management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop/ fish with the least possible disruption to agro-aqua-ecosystems and encourages natural pest control mechanisms.

The development of high aquaculture production has been associated with increased pest infestation requiring increased use of pesticides with all kinds of adverse impacts. Environmental pollution is increasing, soil productivity is declining, beneficial insects are getting wiped out, and water bodies are getting polluted endangering aquatic flora and fauna, the most important of which is the open water

fisheries. Among many factors, pollution of water bodies by pesticide wash outs is believed to be a major reason for the decline in fish production in Bangladesh. Many pesticides used in Bangladesh are banned or restricted under international agreements. In addition, several studies have shown that inadequate product labeling and farmers' lack of information have led to widespread overuse of dangerous pesticides. In fact, pesticide brands having adverse impacts have been banned in Bangladesh and these are shown in Table 3.6. In addition, farmers' lack of knowledge about precautions pertaining to handling of pesticides often creates health problems.

Pesticides use has been increasing fast in Bangladesh. In 1997, pesticide use in the country was 8,000 tons. It doubled to 16,000 tons in 2000. The figure again increased to 20,000 tons in 2005-2006. The import cost for pesticides is estimated to be about USD 712 million in a year. The National Agriculture Policy (NAP) 1999 proposed discouraging the use of pesticides and banning of chemical pesticides directly or indirectly harmful to human, animal and aquatic health. In its place, the policy document emphasized Integrated Pest Management (IPM), mechanical and biological control of pests. The Draft NAP 2010 is silent on pest management. In view of the prevailing pollution problems in the country, the NAP 1999 strategies for pest management need to be reinforced.

Aquaculture is an important component of agricultural economy of Bangladesh performing multifarious roles. Pest's infestation and outbreak of infectious diseases are the most significant constraint to fisheries/ aquaculture development in Bangladesh. The impacts of diseases and pests are multifaceted: loss to the farmers due to mortality and morbidity, loss of productivity, cost for disease management including treatment and sanitation, low quality of aquaculture products, reduced production and public health hazard, affecting livelihood of the fishermen/ fish farmers, etc.

Climatic condition of Bangladesh is highly conducive to fish pests and diseases. Indiscriminate pests control procedure using aqa-drugs and chemicals in fish ponds is also related with the ecosystem and food safety issues. Some insects and diseases are increasing due to change in climatic conditions. Many less abundant pests are becoming highly abundant and attaining predominant positions and rising to destructive levels. All these changes are destroying ecological balance as well as increasing producing costs of fish products. Therefore, it is utmost necessary to identify and control the pests using environmentally acceptable methods through making aware the fish farmers on the economic loss as well as public health hazard from the pests.

1.3 Rationale for PMP

The project will take up and promote certain rural aquaculture development activities including SPF-hatchery establishment, PCR laboratory and mariculture, as well as certain livelihoods interventions in the target fishers'communities. There is less possibility that these interventions may require use of approved chemicals as per recommended dose. However, the number, type and locations of sub-component interventions will be decided over the project implementation stage. Beneficiary groups and sites for any small infrastructures will be known in the implementation level and therefore, chemical/ pesticide issues and impacts could not be identified and specified for mitigation at the preparation stage. DoF will screen sites for project interventions and identify the target group beneficiaries at the implementation level for preparation and implementation of any pest management action plans. Hence, there is a need for procedural guidance for preparation and management of pest and pesticides. DoF has therefore prepared Pest Management Plan (PMP) as a constituent part for guidance in the implementation stage.

Although the fisheries and aquaculture development activities of BSCMFP is designed to assist fishermen and fish farmers to boost fish production and increase aquaculture farms incomes, they can have major implications for the use of inputs such as chemicals/ pesticides and fertilizers. However, sometimes the use of pesticides to reduce vector populations is also included in such project.

The use of chemicals may contribute to disease control and improved fish/ shrimp health conditions yieldingincreased aquaculture production. However, inappropriate or excessive use of pesticides

often results in a reduction of aquaculture production or its sustainability, increases in disease vectors, adverse environmental and health effects, and negative effects on other economic activities (e.g. fisheries). This, in turn, leads to increased economic costs, both at the farmer/ fishermen level and for the country as a whole.

Aquaculture and fisheries sector is taking an increasingly important role in ways, accounting for approximately 20% the agricultural GDP and emerging as a major driver in the last two decades showing an incremental GDP growth rate. The fisheries sector also plays a vital role in the food supply, food security and livelihood security of the country's millions of small holder fish farmers and other stakeholders. Fish provides 60% of all animal protein consumed in Bangladesh. It also acts as a major driver in employment. A number of challenges are facing to reach the goal in aquaculture production along with other agricultural sectors. Among the challenges fish pest and its management is an important issue. Fish pests have potential negative influence on production, quality assurance, and environmental health. There is no effective protocol for pest management in fish/aquaculture sector at present though various methods are being practiced for IPM in Bangladesh which are creating predicament to some extent to fisheries, human and environment. Considering these facts, it is indispensable to think of making a plan of fish disease/ pest management before commencing of development of a program on sustainable coastal fisheries and aquaculture.

The main yield contributing factors for increasing production of aquaculture species include inputs and good pond management practices. Good pond management practices, among others, include control of pests and diseases. A wide range of diseases attack the growing fishes and various kinds of chemicals are available in the markets which are used almost indiscriminately.

Indiscriminate use of inappropriate chemicals in over or lower doses often results into loss of crop/ livestock/ fish production causing huge financial losses to the farmers. In addition, improper utilization/ application methods/ procedures occasionally cause environmental pollution in the surrounding areas resulting in various kinds of problems through:

1) Extermination of useful flora and fauna, contamination of common waterways containing indigenous fishes and common grass lands grazed by cows and goats.
2) Contamination of food crops, vegetables, meat, milk and eggs through systemic pesticides as well as through residual effects have been causing myriads of problems and unknown damages to human health.

Agro-chemical dealers, especially retailers, are observed to handle agro-chemicals with their bare hands ignoring the danger of contamination. Also, the farmers are seen to applying and spraying chemicals/ pesticides without taking the necessary precautions. Direct contact with chemicals/ pesticides during weighing by the dealers/ retailers and applications by the farmers lead to skin diseases while inhaling chemicals/ pesticides during spraying may lead not only to respiratory problems, but also to all types of infections as well.

Indiscriminate use of all types of chemicals/ pesticides is contaminating the bio-physical environment in addition to killing beneficial insects. Wash out of chemicals/ pesticides is finding their way into the wetlands and water bodies, thus adversely impacting the aquatic flora and fauna. From an environmental perspective, chemically-polluted run-off from fields has contaminated surface and ground waters, damaged fisheries, destroyed freshwater ecosystems and created growing "dead zones" in ocean areas proximate to the mouths of rivers that drain agricultural regions.

1.4 Objectives of the Pest Management Plan

The PMP takes into account the relevant legislation, policies, and strategies on marine and coastal fisheries. The suggested guidelines and procedures of the PMP would adhere to the due diligence principles, especially it will ensure compliance with the World Bank's environmental and social safeguard policies and the relevant provisions under the related policies of GoB, and associated rules, regulations and procedures.

This PMP will also serve as the guideline for the staff designated by the implementing agencies - the DoF to oversee and monitor the PMP compliance of the project components coming under their implementation responsibility. Therefore, this PMP would be used as the template and guideline to ensure diligent pest and pesticides compliance of the planning and implementation of the activities envisaged under the BSCMF project. However, all processes described in the PMP can be adjusted based on implementation experience. The PMP will be a living document and will be reviewed and updated periodically as needed.

According to Annex C of BP 4.01, a PMP is a comprehensive plan, developed when there are significant pest management issues such as:

(a) new land-use development or changed cultivation practices in an area,

(b) significant expansion into new areas,

(c) diversification into new crops in agriculture/aquaculture e.g. cage culture,

(d) intensification of existing low-technology systems,

(e) proposed procurement of relatively hazardous pest control products or methods, or

(f) specific environmental or health concerns (e.g., proximity of protected areas or important aquatic resources; worker safety).

A pest management plan is also developed when proposed financing of pest control products represents a large component of the project.

With respect to its objectives and execution, BP 4.01 - Annex C stipulates that: "A pest management plan reflects the policies set out in OP 4.09, Pest Management. The plan is designed to minimize potential adverse impacts on human health and the environment and to advance ecologically based Integrated Pest Management (IPM). The plan is based on on-site evaluations of local conditions conducted by appropriate technical specialists with experience in participatory IPM".

The sub-activities to be implemented under the DoF are expected to involve use of agrochemicals and fish/shrimp farmers may expand the use of pesticides more than the recommended dosage in anticipation of higher yields. Therefore, as a matter of precaution to address any potential and unforeseen issues of pest and pesticide management, a Pest Management Plan (PMP) is being prepared. The goal of preparing the PMP is to promote the use of IPM measures which is expected to reduce reliance on chemical pesticides.

1.5 Nature of the PMP

The PMP for the BSCMFP is prepared with the aim of standardizing a comprehensive plan for the management of pests without causing any harmful effect to the existing environmental conditions prevailing in the Project Area. Special efforts will be made to improve the current pest management practices in vogue to decrease harmful effects of aquaculture chemicals causing negative impacts due to sub-activities implementation. IPM system will be encouraged in the pest and disease prevention measures of aquaculture commodities to decrease economic loss and to ensure environmental and health safety for the surrounding populations. The nature of actions will be:

1. Prevention and control of pests and diseases below the level of economic loss instead of removing them totally,
2. Dependence on non-chemical measures to maintain the amount of harm caused by pests and diseases at a low level,
3. If pesticide use is imperative, special care will be suggested to select appropriate pesticides having the least harmful effects as well as the appropriate application methodologies with relatively small negative impact on the biological environment, flora and fauna as well as the health of the person employing the pesticide in the field and in the store room, and finally,

4. The fish farmers involved in the sub-activities will be taught that pesticide application should be employed as a last resort following the four "R"s:

    (a) right pesticide,

    (b) right dose,

    (c) right time, and

    (d) right method of application.

1.6 Promotion of Safer Pesticides Management

For promoting safer chemicals/ pesticide and fertilizer management it is proposed to: (i) Create awareness among the farmers about the dangers related to pesticides and the necessity to learn about their potential harm. (ii) Impart training on appropriate methods of storage, handling and application procedures, (iii) To teach preventive measures as well as actions that might be necessary in case of accident, (iv) Impart training on application of balanced fertilizers for various crops and fish, and (v) Provide easy-to-follow handbooks for following the above principles

1.7 PMP Preparation Approach

The present PMP has been prepared following the standard methodology consisting of the steps listed below:

- Review of the program details and meeting/discussions with the DoF team;
- Reviewed and evaluated the pest problems, disease and pest attack in major coastal aquaculture, and reviewed various methods and techniques currently in use for pest control in Bangladesh;
- Review of the policy and regulatory requirements related to aquaculture production or use of pesticides in Bangladesh, rules/ guidelines of WHO, World Bank and other organizations on pest management;
- Reconnaissance field visits by DoF team and initial scoping and screening to determine level of use and extent of the project activities involving use of chemicals in aquaculture practices, and describing what the nature of the usage would be (high, low, moderate) as caused by the project and the kinds of chemical that would be used;
- Reviewed the IPM measures and determined (a) the extent to which current practices are consistent with IPM, including the policy framework and incentive structure; (b) problems and opportunities for improvement;
- Consultations with the stakeholders including beneficiary/ affected communities and developing the consultation process;

1.8 Most Relevant Project Components Those Requires PMP

BSCMFP has four components (see ESMF), out of which Component 2: **Improving Infrastructure and Production Practices**. It again includes two relevant sub-components **2.2 Value chain and food safety**, and **2.3 Boosting Coastal Aquaculture Productivity**, those may have requirement of PMP implementation. Other components especially relevant to infrastructure development might also need to follow the PMP framework during construction phase. Brief descriptions of the above-mentioned sub-components are given below:

- **Sub-component 2.2: Value chain and food safety** will focus on capacity measures for increasing post-harvest value of catch and compliance with food safety standards, including adoption of good aquaculture practices (GAP) that are critical to sustaining the value of capital infrastructure improvements. Project support will be provided for (i) seafood safety and competitiveness; (ii) research and innovation, and (iii) boosting coastal aquaculture productivity.

- Under item (i) technical assistance and services will be provided to bridge the regulatory capacity and skill gaps. Project funds will be provided for seafood safety needs assessment, for example, through a hazard analysis and critical control points (HACCP) for fish/ shrimp processing plants; training in food safety (for factory workers and industrial trawlers and large mechanized boats); a sensitization and promotion campaign for seafood safety consumers' awareness; GoB staff's international and domestic food safety inspection training; support for seafood safety policy implementation including a food safety pilot for Domestic Markets (Sampling and Analysis). In parallel, the sub-component will finance the introduction of a robust e-traceability system in line with current US and EU import requirements, including system design and equipment.
- Learning opportunities will be provided through a 'training of trainers' (ToT) model on best-practices for the enforcement of handling and safety regulations. The model will help train fishers as well as port and landing site and market operators in best practices for fish handling and food safety. Concurrently, a longer-term capacity solution will be sought in partnership with the MFA and major Bangladesh universities. Training support will be extended to cover a wide range of practices and topics critical to maintain post-harvest quality and food safety.
- Activities under item (ii) will provide support for expanding Bangladesh's marine science and technology capacity by strengthening the government-academia-industry interface. The project will support the preparation of comprehensive marine spatial plan to allow for scaling-up of mariculture in Bangladesh and help initiate targeted mariculture research in partnership with Bangladesh Fisheries Research Institute (BFRI). The sub-component will facilitate partnerships on R&D through the National Skills Development Council (NSDC) and other capacity development institutions and universities for delivery of vocational training programs on topics such as aquaculture, fishing, post-harvest practices (including food safety and quality), marketing, environmental safeguards, and social and business skills of direct relevance to the long-term development of the fisheries and aquaculture sectors.
- **Sub-component 2.3: Boosting Coastal Aquaculture Productivity** will (i) leverage private sector initiative to pilot and commercialize mariculture in Bangladesh and for boosting export earnings from aquaculture, and (ii) support strengthening DoF capacity to monitor and sanction bio-security compliance.
- Specifically, the sub-component will establish a DoF-managed *challenge grant facility* with two dedicated windows for mariculture (including cage culture) piloting and commercialization, and one dedicated grant window for mobilizing private sector solutions to address the poor growth performance and disease burden attributable to wild brood stocks sold currently and used by a large portion of the aquaculture farmers. The grant facility will leverage private sector finance targeting the implementation of a discrete set of climate-smart aquaculture investments to improve bio-security and increase productivity, while also reducing juvenile fish mortality in the coastal zone. The mariculture windows will support applied mariculture research, technology innovation, market studies, and production piloting, while aquaculture one will focus on piloting domestic mud crab and fin-fish hatcheries and on the commercialization of Specific Pathogen Free (SPF) Black Tiger shrimp (BTS) hatcheries/ multiplication facilities enhancement, targeting the introduction of up to 10 new SPF hatcheries in the country. This pilot work in mariculture, hatchery technology, and disease control will reveal adaptation to the on-going sea-level rise and salinity regimes change, for subsequent scaling-up in Phase II.
- The sub-compact will also support the construction and equipment of dedicated SPF brood stock facility as well as *quarantine and food security laboratories* for shrimp and fish products. In conjunction with *safety and value chain* enhancement measures under sub-component 2.2 above, this will strengthen the GoBs regulatory and oversight capacity in the monitoring and

control of infectious crustacean diseases. Investments will target: a) up-grading of lab facilities for polymerase chain reaction (PCR) and other relevant testing; b) training of laboratory and field staffs in sampling protocols and handling; c) establishing a routine inspection and monitoring system; d) establishing an early warning system (EWS) for disease outbreaks; and e) establishing and introducing a functioning private hatchery certification program.

1.9 Composition of Study Team

The ESMF and PMP study team was led by Mr. Mohammad Shahad Mahabub Chowdhury, Team Leader, and a DoF team of 5 members namely Dr. Zillur Rahman, District Fisheries Officer, Rangpur; Mr. Md. Kamruzzaman Hossain, Chief Fisheries Extension Officer, Iftekharul Alam, Senior Upazila Fisheries Officer, Fakirhat, Ayesha Siddiqa, Assistant Director, and Shafaet Alam, Deputy Assistant Director, DoF. The DoF team collected baseline information and collated the findings of the stakeholder consultations assisted by DoF field officials.

Chapter 2: Regulatory Framework for Pest Management

2.1 International Legislation and Policies

2.1.1 World Bank Operational Policy on Pest Management, OP 4.09 (1998)

The Bank uses various means to assess pest management in a country and support IPM and the safe use of agricultural/aquaculture chemicals/ pesticides. It also supports economic and sector work, sectoral or project-specific environmental assessments, participatory IPM assessments, and adjustment or investment projects and components aimed specifically for supporting the adoption and use of IPM.

In Bank-financed agriculture operations, the Bank advocates pest populations reduction through IPM approaches such as biological control, cultural practices, and the development and use of fish varieties that are resistant or tolerant to the pests.

According to the Bank, rural development and health sector projects have to avoid using harmful pesticides. A preferred solution is to use IPM techniques and encourage their use in the sectors concerned.

If pesticides have to be used for fish protection or in the fight against vector-borne diseases, the Bank-funded projects should include a Pest Management Plan (PMP), prepared by the borrower, either as a stand-alone document or as part of an Environmental Assessment.

The procurement of any pesticides in a Bank-financed project is contingent on an assessment of the nature and degree of associated risks, taking into account the proposed use and the intended users. With respect to the classification of pesticides and their specific formulations, the Bank refers to the World Health Organization's (WHOs) Recommended Classification of Pesticides by Hazard and Guidelines to Classification (WHO 2009). The following criteria apply to the selection and use of pesticides in Bank-financed projects:

a) They must have negligible adverse human health effects;
b) They must be shown to be effective against the target species;
c) They must have minimal effect on non-target species and the natural environment;
d) The methods, timing, and frequency of pesticide application must aim to minimize damage to natural enemies; and
e) Their use must take into account the need to prevent the development of resistance in pests.

At a minimum, pesticide production, use and management should comply with FAO's Guidelines for:

i. Packaging and storage;
ii. Good labeling practice; and
iii. Disposal of waste pesticide containers on the farm.

The Bank does not finance formulated products that fall in WHO classes Ia (extremely hazardous) and Ib (highly hazardous); or formulations of products in Class II (Moderately hazardous), if (a) the country lacks restrictions on their distribution and use; or (b) they are likely to be used by or are accessible to lay personnel, farmers, or others without training, equipment, and facilities to handle, store, and apply these products properly.

The proposed project will trigger OP 4.09, considering that the proposed program targets to increase extension services in aquaculture and mariculture production, and also operation of small- to medium-scale construction sites, laboratories which may involve usage of chemicals and fertilizers. Specifically,

processing facilities as well as feed storage areas may need to control pests as well utilizing pesticides or rodenticides.

A separate PMP prescribed to prepare during EISA following this PMP framework by DoF and once the project activities are delineated with quantification of use of chemicals and or pesticides.

2.1.2 International Plant Protection Convention of FAO (1952)

The International Plant Protection Convention (IPPC) is an international treaty to secure action to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control. It is governed by the Commission on Phytosanitary Measures (CPM) which adopts International Standards for Phytosanitary Measures (ISPMs).

2.1.3 World Food Security and the Plan of Action of November 1996

This declaration seeks to secure effective prevention and progressive control of plant and animal pests and diseases, especially those which are of trans-boundary nature, such as rinderpest, cattle tick, foot-and-mouth disease and desert locust, where outbreaks can cause major food shortages, destabilize markets and trigger trade measures. It promotes regional collaboration in plant pests and animal disease control; and widespread development and use of integrated pest management practices.

2.1.4 OIE World Animal Health Organization

OIE World Animal Health Organization is an equivalent of WHO in the human field which sets international standards for animal health and welfare, monitor world animal disease notification and strengthens veterinary services when engaging in international trade which includes residue monitoring of which some of the residues emanate from animal pesticides.

When it comes to Standard setting, the OIE Specialist Commissions and Regional Representatives regularly commit time to and participate in sessions to raise Delegate's (OIE delegates are in most country directors of veterinary services who are veterinarians) awareness of when and how to participate effectively in the standard setting process. They also encourage dialogue between delegates and promote closer regional collaboration among them by sharing their individual national positions on standards being developed or reviewed.

In terms of Animal Disease Notification, the OIE has made extensive improvements to the World Animal Health Information System (WAHIS). It also continues to assist member in meeting their obligation to notify animal disease occurrences. OIE staffs conduct regular training sessions, at regional level for designated national focal points for disease information. This has certainly significantly improved the quality of and responsiveness to notifications of disease outbreaks.

An effective and credible Veterinary Service is one of the most critical elements for fair and safe international trades in animals and animal products. Without a strong Veterinary Service and a robust international certification programme, member states will continue to experience trade restrictions. The OIE therefore places great emphasis on building the capacity and quality of Veterinary Services.

2.1.5 WHO Classification of Pesticide by Hazard and the Guidelines to Classification, 2009

The WHO Recommended Classification of Pesticides by Hazard was approved by the 28th World Health Assembly in 1975 and has since gained wide acceptance. When it was published in the WHO Chronicle, 29, 397-401 (1975), an annex, which was not part of the Classification, illustrated its use by listing examples of classification of some pesticides active ingredients and their formulations. Later suggestions were made by Member States and pesticide registration authorities that further guidance should be given on the classification of individual pesticides. Guidelines were first issued in 1978, and have since been revised and reissued every few years.

Revised criteria for classification (introduced for 2009 update): The Table 2.1showsthe Recommended Criteria for Classification. WHO now uses the Acute Toxicity Hazard Categories from

the GHS[1] as the starting point for classification. This change is consistent with the 1975 World Health Assembly Resolution which envisaged that the WHO Classification would be further developed with time in consultation with countries, international agencies and regional bodies. The GHS meets this requirement as a classification system with global acceptance following extensive international consultation.

Table 2.1: GHS Classification.

WHO Class		LD_{50} for the rat (mg/kg body weight)	
		Oral	Dermal
Ia	Extremely hazardous	<5	<50
Ib	Highly hazardous	5-50	50-200
II	Moderately hazardous	50–2000	200–2000
III	Slightly hazardous	Over 2000	Over 2000
U	Unlikely to present acute hazard	5000 or higher	

2.1.6 FAO Definition of Pesticide

The Food and Agriculture Organization (FAO) of the UN has defined pesticide as:

Any substance or mixture of substances intended for preventing, destroying, or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals, causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances that may be administered to animals for the control of insects, arachnids, or other pests in or on their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant, or agent for thinning fruit or preventing the premature fall of fruit. Also used as substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport.

2.2 International Treaties Signed by the GoB

Bangladesh has signed most international treaties, conventions and protocols on environment, pollution control, hazardous chemical transportation and use, bio-diversity conservation and climate change, including the Ramsar Convention, the Bonn Convention on migratory birds, the Rio de Janeiro Convention on biodiversity conservation, and the Kyoto protocol on climate change. An overview of the relevant international treaties signed by GoB is shown in Table 2.2.

Table 2.2: Treaty or Convention and Responsible Agency.

Treaty	Year	Brief Description/ Relevance to the BSCMFP	Relevant Department
Protection of birds (Paris)	1950	Protection of birds in wild state Broadly applicable for birds in and around the project influence area;	DoE/ DoF
Ramsar Convention	1971	Protection of wetlands. Broadly applicable for wetlands in and around the project influence area;	DoE/ DoF
Protocol on Waterfowl Habitat	1982	Amendment of Ramsar Convention to protect specific habitats for waterfowl. Broadly applicable for wetlands in and around the project influence area;	DoE/ DoF

[1] http://www.unece.org/trans/danger/publi/ghs/ghs_rev03/03files_e.html

Treaty	Year	Brief Description/ Relevance to the BSCMFP	Relevant Department
World Cultural and Natural Heritage (Paris)	1972	Protection of major cultural and natural monuments. Not applicable since no major cultural or natural monuments are known to exist in the project influence area.	DoArch
CITES convention	1973	Ban and restrictions on international trade in endangered species of wild fauna and flora. Not directly relevant to the BSCMFP since the project does not involve in any international trade of endangered species of wild fauna and flora. General restrictions have however been included in the Environmental Code of Practice.	DoE/ DoF
Bonn Convention	1979	Conservation of migratory species of wild animals. Broadly applicable to the migratory birds in and around the project influence area. Project activities are not likely to have any significant impacts on these species;	DoE/DoF
Prevention and Control of Occupational hazards	1974	Protect workers against occupational exposure to carcinogenic substances and agents. Broadly applicable to the construction and O&M activities under the project.	MoH
Occupational hazards due to air pollution, noise & vibration (Geneva)	1977	Protect workers against occupational hazards in the working environment. Broadly applicable to the construction and O&M activities under the project.	MoH
Occupational safety and health in working environment (Geneva)	1981	Prevent accidents and injury to health by minimizing hazards in the working environment. Broadly applicable to the construction and O&M activities under the project.	MoH
Occupational Health Services	1985	To promote a safe and healthy working environment. Broadly applicable to the construction and O&M activities under the project.	MoH
Convention on oil pollution damage (Brussels)	1969	Civil liability on oil pollution damage from ships. Not applicable since no oil carrying cargos are involved in the proposed project.	DoE/MoS
Civil liability on transport of dangerous goods (Geneva)	1989	Safe methods for transport of dangerous goods by road, railway and inland vessels. Broadly applicable to transportation of substances such as fuels during the project construction phase.	MoC
Safety in use of chemicals during work	1990	Occupational safety of use of chemicals in the work place.	DoE

Treaty	Year	Brief Description/ Relevance to the BSCMFP	Relevant Department
		Broadly applicable to the construction and O&M activities under the project.	
Convention on oil pollution	1990	Legal framework and preparedness for control of oil pollution. Broadly applicable to the construction and O&M activities under the project.	DoE/ MoS
UN framework convention on climate change (Rio de Janeiro)	1992	Regulation of greenhouse gases (GHGs) emissions. Broadly applicable to the construction and O&M activities under the project.	DoE
Convention on Biological Diversity (Rio de Janeiro)	1992	Conservation of bio-diversity, sustainable use of its components and access to genetic resources. Broadly applicable to the construction and O&M activities under the project.	DoE
International Convention on Climate Changes (Kyoto Protocol)	1997	International treaty on climate change and emission of greenhouse gases. Broadly applicable to the construction and O&M activities under the project.	DoE
International Tribunal for Laws of the Sea	1982 formation of the Convention, 2011 (ratified by GoB)	The United Nation Convention on the Law of the Sea (UNCLOS) of 1982 is a document, which has taken almost a decade for its completion. Unlike the past four UN Conventions on the Law of the Sea, this Convention is much broader in scope and governs use of the world's oceans, especially establishing ground rules for everything from navigation to deep-sea mining. The Law of the Sea Convention protects its members' navigation rights to the oceans. It establishes limits for marine boundaries and rules for extracting resources among states and preserving the health of the seas. And it sets up a way to resolve disputes about these issues. Bangladesh ratified the UNCLOS in 2001.	MoFA
Strategic Action Plan for Bay of Bengal	2012 endorsement ; 2016 signed by MoFL/ MoEF of GoB	This Strategic Action Programme (SAP) is based on the Transboundary Diagnostic Analysis (TDA) which was endorsed in March 2012 by the eight countries of the BOBLME. The TDA draws on over ten years of studies, reviews and analyses. It identifies the main transboundary issues and their causes, and it reviews the driving forces at work in the BOBLME, such as the socio-economic, institutional, legal and administrative circumstances and the projected impact of climate change on the	MoFL/ MoEF

Treaty	Year	Brief Description/ Relevance to the BSCMFP	Relevant Department
		region. These forces all pose a range of constraints and challenges and have the potential to influence the success of actions implemented to address the main areas of concern. The SAP is a negotiated policy document that sets out a programme of actions which address the causes of the major fisheries, environmental and social and economic issues. The development of the SAP has been guided by the BOBLME Project Steering Committee which comprised senior-level government officers from the fisheries and environmental agencies in each country. This SAP is the 2015 versions, expanded with the signatures of 16 government partner institutions, endorsing it for the implementation of the 2nd phase.	

2.3 National Legislation and Policies

Laws/ Regulations relevant to environmental issues with respect to Pesticide Management in Bangladesh include:

- National Agriculture Extension Policy (NAEP) 1996, 2006 and 2012
- National Agriculture Policy, 1999
- National Integrated Pest Management Policy, 2002

All these documents contain recommendations for using safer methodologies for utilizing pesticides, including use of IPM methods in one way or the other. The components of the IPM policy include:

- Maintenance of ecological balance,
- Executing appropriate actions on pesticides,
- Operating an effective system for implementing IPM program.
- Developing human resources as the core of IPM
- Conducting research on IPM

TheNationalAgriculturalPolicy(NAP),1999stipulatedthatIPMwillbethemainpolicy for controlling pest and diseases. The NAP has given importance to the following activities for the pest control.

a) Farmers will be motivated to use more pest resistant varieties of crop;
b) Modern cultivation practices will be followed to reduce incidence of pest infestation;
c) Use of mechanical control measures such as light trap, hand net, etc. will be increased and popularized. Biological control measures (e.g. pheromone traps) will be used to destroy harmful insects and preserve the useful ones;

d) Regular training and discussion programs on IPM will be conducted among the farmers under the supervision of Union Agricultural Development Committee for successful introduction and popularization of the method at the farmers' level; and
e) Pest surveillance and monitoring system will be strengthened.

The IPM Policy advocated among others:

a) Growing a healthy crop through proper management of soil, water, fertilizers, pests, etc.;
b) Conservation of biological control agents by avoiding or reducing the use of toxic pesticides;
c) Augmentation of biological control agents;
d) Use of pest tolerant crop varieties;
e) Use of cultivation practices that can minimize pest populations;
f) Mechanical control of pests;
g) Monitoring of field by the farmer on a regular basis;
h) Build up farmers as experts in their own fields in taking Pest Management decisions; and
i) Income generated activities such as growing of 'ail' (border) crops, fish culture in the rice field, etc.

Use of pesticides that are not harmful to the environment as a last resort The National Integrated Pest Management Policy (NIPMP) includes the following number of specific actions regarding the use of pesticides in addition to some others:

a) New proposal for registration of any pesticide will be declined if it falls under WHO class 1A and 1B pesticide compounds;
b) Experimental toxicity data on beneficially insects, fish and other aquatic animals in Bangladesh must be taken into consideration before registering any pesticide;
c) GoB will provide support and incentives to the private sectors for producing bio-control agents (parasitoids, predators and insect pathogens such as fungi, bacteria and viruses) and botanical pesticides locally;
d) GoB will monitor any misleading advertisement toward using pesticides and will initiate appropriate legal actions against such malpractices;

There is no specific rule or regulation on pest management in the fisheries sector in Bangladesh but different fisheries and environmental policies/ rules/ Acts are relevant to pests, drugs, food safety of fishes are existing. Relevant policies/ rules/ Acts are follows:

Bangladesh Environmental Conservation Act (ECA), (Amendments) 2010

The ECA, 1995 was amended in 2010, which provided clarification of defining wetlands as well as Ecologically Critical Areas (ECAs) and included many important environmental concerns such as conservation of wetlands, hill cutting, ship breaking, and hazardous waste disposal. This amendment empowered the Government to enforce more penalties than before. Moreover, affected persons were given provision for putting objections or taking legal actions against the polluters or any entity creating nuisance to affected person.

Bangladesh Environmental Conservation Rules (ECR), 1997

The Environment Conservation Rules, 1997 were issued by the GoB in exercise of the power conferred under the Environment Conservation Act (Section 20), 1995. Under these Rules, the following aspects, among others, are covered:

- Declaration of ecologically critical areas (ECAs)
- Classification of industries and projects into four categories

- Procedures for issuing the Environmental Clearance Certificate
- Determination of environmental standards

The Rule 3 defines the factors to be considered in declaring an area 'ecologically critical area' (ECA) as per Section 5 of ECA'95. It empowers the Government to declare an area 'ECA', if it is satisfied that the ecosystem of the area has reached or is threatened to reach a critical state or condition due to environmental degradation. The Government is also empowered to specify which of the operations or processes shall not be carried out or shall not be initiated in the ECAs

National Environmental Policy, 1992

The National Environment Policy (NEP) is one of the key policy documents of the Government. The policy addresses 15 sectors in all, in addition to providing directives on the legal framework and institutional arrangements. Marine environment is one of the key sectors covered in this policy. Regarding fisheries resource sector, the policy seeks to:

- ensure conservation of fisheries and livestock, mangrove forest and other ecosystems and prevention of activities that diminish the wetlands and natural habitats for fishes are the basic objectives in this sector;
- ensure that Coastal and marine eco-systems are identified as potential areas for intervention, where all internal and external polluting activities should be stopped. Fishing in coastal and marine environment within regeneration limits is recommended;
- keep the rivers, canals, ponds, lakes, haors, baors and all other water bodies and water resources free from pollution;
- ensure sustainable, long-term, environmentally sound and scientific exploitation and management of the fisheries resources;
- ensure environmentally-sound utilization of all fisheries resources;
- ensure that water development activities and canal networks for aquaculture do not create adverse environmental impact;
- ensure that all steps are taken for construction of embankments, dredging of rivers, digging of canals, etc., be environmentally sound at local, zonal and national levels;
- ensure mitigation measures of adverse environmental impact of completed water resources development projects; and
- conduct environmental impact assessment before undertaking projects for fisheries resources development and management, as appropriate level.

National Environmental Management Action Plan, 1995

The National Environment Management Action Plan (NEMAP, 1995) identifies the main national environmental issues, including those related to the fisheries sector. The main fisheries related national concerns include environmental degradation of water bodies, increased water pollution, shortage of aquaculture water and drainage congestion; various specific regional concerns are also identified.

National Fisheries Policy, 1998

The National Fisheries Policy (NFP), 1998 recognizes that fish production has declined due to environmental imbalances, adverse environmental impact and improper implementation of fish culture and management programs. The policy particularly focuses on aquaculture and marine fisheries development.

The policy suggests following actions:

- Enhancement of the fisheries production

- Poverty alleviation through creating self-employment and improvement of socio-economic conditions of the fishers
- Fulfill the demand for animal protein
- Achieve economic growth through earning foreign currency by exporting fish and fisheries products
- Chemicals harmful to the environment will not be used in fish shrimp farms
- Environment friendly fish shrimp culture technology will be used
- Expand fisheries areas and integrate rice, fish and shrimp cultivation
- Control measures will be taken against activities that have a negative impact on fisheries resources and vice-versa
- Laws will be formulated to ban the disposal of any untreated industrial effluents into the water bodies.

The Protection and Conservation of Fish Act (1950)

This Act provides power to the government to: make and apply rules to protect fisheries; prohibit or regulate erection and use of fixed engines; and construction of temporary or permanent weirs, dams, bunds, embankments and other structures. The Act prohibits: destruction of fish by explosives, guns, and bows in inland or coastal areas; destruction of fish by poisoning, pollution, or effluents. The Act prescribes the seasons during which fishing is allowed, prohibits fishing during spawning periods, and specifies officials having authority to detect breaches of this Act.

East Bengal Protection and Fish Conservation Act (1950) and Amendments

The East-Bengal Protection and Fish Conservation Act (1950), as amended by the Protection and Conservation of Fish (Amendment) Ordinance (1982) and the Protection and Conservation of Fish (Amendment) Act (1995), provides for the protection and conservation of fish in inland waters of Bangladesh. These instruments define a relatively non-specific framework that simply provides a means for Government to introduce rules to protect inland waters not in private ownership. Among other things, this Act allows rule making regarding destruction of, or any attempt to destroy, fish by poisoning of water or depletion of fisheries by pollution, industrial effluent, or otherwise.

Protection and Conservation of Fish Rules (1985)

These Rules are in line with the overall objectives of the Fisheries Act and its amendments. Section 5 of the Rules states that, “No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters”. Section 6 states, “No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters’’.

Fish Feed and Animal Feed Act 2010

This Act has been promulgated to ensure quality of feed using in fisheries and livestock sub-sectors and came into effect in 2010. This Act also incorporated ban of adding antibiotic growth promoter (AGP) in the feeds to highlight the food safety issues.

Chapter 3: Current Pest Management Practices in Bangladesh

3.1 Existing Pest Management Practices in Aquaculture/ Fisheries Sector

3.1.1 Necessity of Pest Management

Aquaculture is a rapid growing sector in Bangladesh. Over the last decade the rapid expansion of shrimp culture in coastal areas has drawn an outstanding development in the country's fisheries sector. In recent years most of the farmers in coastal areas culture both shrimp and prawn in the same gher or pond. On the other hand, inland fisheries is also expanding rapidly having new aquaculture techniques with improved extensive and semi-intensive culture systems. For successful aquaculture, technology is most needed as well as the application of different aqua-drugs and chemicals which enhance the production, preventing from disease or create immune system or antibody against diseases (Subasinghe et al., 1996 and Akhter et al., 2010).

There is a long history behind the using of drugs and chemicals in aquaculture. A variety of aqua-drugs and chemicals use in both inland and coastal aquaculture, that can be classified according to the purpose of use, types of organisms under culture, life cycle stage for which they are used, culture system and intensity of culture and the type of farmers who use them (Subasinghe et al., 1996). The purposes of using chemicals and antibiotics are to:

- improve health condition of aquatic animal,
- aquatic productivity,
- feed formulation,
- growth promotion,
- manipulation of production,
- transportation of live fish,
- pond construction, and
- overall the management of natural pond environment and water quality.

3.1.2 Use of Drugs and Chemicals in Aquaculture

In the past, farmers used only some traditional chemicals like Lime, Salt, Potassium permanganate, Copper sulphate, Formalin and Bleaching powder(Hasan and Ahmed, 2002 and Plumb, 1992) but in recent years several pharmaceutical companies are playing a vital role in producing various types of commercial aqua-drugs (Faruk et al., 2008). There are about 33 pharmaceutical companies within 18 branded antibiotics and 23 pharmaceutical companies are active for producing and marketing aqua-drugs in greater Khulna region(Akhter et al., 2010). The common commercial chemicals used by the rural farmers are Geotox, Geolite, Benzo, Ammonil, Megageo, EDTA, Timsen, BKC, Microdine iodine, Oxyflow, Oxymax, Oxy-plus, Oxy-gold, Eco-solution, Melathion, Sumithion, Dipterex, Virex, Malachite green, Spa, Oxytetracycline, Renamycine, Renamox, Bactitab, Bactrol, Vitamin, Cevit vet, Growmax, Panvit aqua, Aquamin, Aqua boost and Acimix supper-fish (Faruk et al., 2008) (Table 3.1).

According to the purposes, of aqua-drugs and chemicals can be categorized into pond preparation drugs, gas removal drugs, oxygen supplier drugs, disinfectants, growth promoter drugs, probiotics, antibiotics and disease treatment drugs. For health management of fish and shrimp several types of antibiotics and probiotics are used by farmers. The antibiotics are being used in aquaculture for over fifty years for treating bacterial infection in fish and shrimp. The common antibiotics are Oxytetracycline, Chlorotetracycline, Amoxicilin, Co-trimoxazoie, Sulphadiazine and Sulpha

methoxozole (Plumb, 1992). Some common chemicals[2] used for health management[3] include Sodium chloride, Formalin, Malachite green, Methyl blue, Potassium permanganate and Hydrogen per-oxide (Plumb, 1992).Table 3.1: Common Aqua drugs and their producing companies in Bangladesh (Hasen, 2014).

Potassium permanganate is the most widely used chemical for treating external protozoa and external bacterial infection. For treating fungal infection, external parasites on fish and fish eggs as flush, prolonged or indefinite treatment or fungal control sodium chloride and formalin is an old treatment used by the farmers (Plumb, 1992). Recently some farmers use probiotics[4] such as Aqua gold, Aqua photo, Bio-zyme, Mutagen, pH fixer, Supper PS and Zymtine for fish growth and health management (Shamsuzzaman and Biswas, 2012). Figure 3.1 highlights a scenario of chemical use (%) in different regions of Bangladesh.

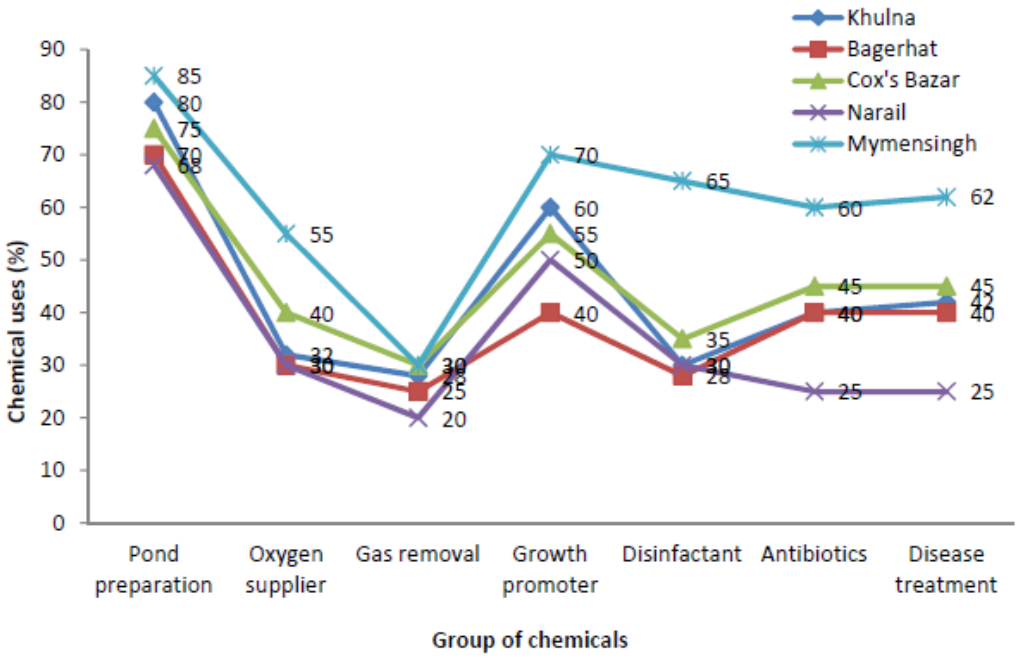

Figure 3.1: Aqua-drugs and chemicals used by regionsin Bangladesh (Hasen, 2014).

[2] Leading Aquaculture experts (personal communication with Dr. S. A. Shameem Ahmad, Solidaridad International, Khulna) advice farmers not to use any kind of insecticides (such as Melathion, Sumithion), fungicide (Malachite Green, Renamycine) and antibiotics (Oxytetracycline, Chlortetracycline, Amoxicilin etc.). Some of the disinfectants and antibiotics are though allowable but as farmers cannot maintain the right dosage, therefore highly discouraged to use those in the farm.

[3] Farmers are advised to use Lime, Geolite, Tea Seed Cake or Rotenone (if Tea Seed Cake is unavailable), good quality Probiotics, compost made of molasses, rice Bran and yeast etc.

[4] Pond Cure (SKF), Bio-Prob (UniBiocare), Shrimp Shield (ACI), Bio-guard (RIMS) etc. are some of the quality probiotics as per fish farmers' practical experience.

Table 3.1: Common Aqua drugs and their producing companies in Bangladesh

SL. NO.	Aqua drugs producing companies	Products
01	Acme Laboratories Ltd	Acme's zeolite, Oxy A, Vitamix F aqua and Tetravet 200 WSP
02	ACI Animal Health Ltd	Mega Zeo, Bio care, Bio-Ox, Acimox (Vet.) Powder, Bactitab, Acimix super-fish, AC mix super fish, AQ cell, AQ grow-G, AQ grow–L, AQ grow-P, Aqumin, Ayumin powder, Calfostonic powder, Oxy dox-F and Virex
03	Al Madina Pharmaceuticals Ltd	Pure oxy
04	Annexvet (Pvt.) Ltd.	Zeonex and Diginix aqua
05	Aqua marketing Companies	Shrimp safe powder and Aqua-z gold
06	Avon Animal Health Ltd	Bis zeolite, Supure Zeolite and Oxygen plus
07	Biotic Corporation Ltd.	Biolite plus and Aquamin
08	Bismillah Enterprise Ltd.	Fish grow
09	Biswas Agrovet Ltd.	Alpha zeolite
10	Century Agro Ltd.	Oxygrow
11	CP Aquaculture	C-150, Mutagen, pH fixer, Super Biotic, Super PS and Zymetine
12	Ellwellas	Protacide
13	Eon Animal Health Product Ltd	JV Zeolite, Bio Aqua, Timsen, Efinol, Oxymax, Aqua savor and Fibosole
14	Fish World Ltd	Geo top and Aqua cleaner plus
15	Fishtech Ltd	Oxy-Gold, Deletix and Chargergel
16	Lion Overseas Trading Company Ltd.	Aquazet, Omicide and Machalemen
17	M.R. Food and Protein Industries	Fish Curepas
18	M/S Shinzon Traders Ltd.	Nature's gift liquid gold
19	National Agricare Ltd.	Zeolite
20	Nature Care	Zeocare, Lenocide, O-plus and Nature care GP
21	Navana Animal Health	Oxy plus and Oxin WS
22	Novartis Pharmaceuticals	Geotox, Oxyflow, Oxysentin 20%, Chlorsteclin, Aquaboost, Classic aqua-Z plus powder and Ammonil
23	Nutria Health Ltd.	Aqua-Z powder and Oxy top
24	Organic Pharmaceuticals Ltd	Green Zeolite, Bio-Tuff, Water clear, O_2-Marine, Quick oxygen, Orgamycin 15%, Orgacycline 15%, Orgavit aqua, Aqua gold, Eco marine and Ecomax
25	Penta Agrovet Ltd.	Pathocide, Oxy-plus, Zeolite plus and Growmax
26	Rals Agro Ltd.	Pontox plus, Microdine Iodine 20%, Oxysun, Fish cure, Fish vita plus, Grow fast and Procon-PS
27	Renata Pharmaceuticals Ltd.	Renamycin and Renamox
28	S.S.S Agro Care Ltd.	Fish care powder
29	SK+F Bangladesh Ltd.	Well Zeolite, Emsen and Oxy more
30	Speed Care Ltd.	Fish safe
31	Square Pharmaceuticals Ltd.	Contrim vet Bolus, Otetra vet powder, Sulfatrim, Cevit ver, Vitamin premix, Gas trap, Oxy life, Penamin, Aqua clean, Panvit aqua and Square aqua mix
32	Syngenta	Benzo, Albez and Spa
33	Tushin Agro Pharma Ltd.	Diamond fish
34	Univet Ltd.	Best oxygen, Major zeolite and Golden Bac

Table 3.2: Purpose of aqua-drugs and chemicals and theireffectiveness (Hasen, 2014).

Category	Drugs/Chemicals/ Trade name	Dose	Purpose of use	Effectiveness (%)
Pond preparation, gas removal & water quality management	Acme's Zeolite	7kg/ 33 dec. every 15 days	To improve soil & water quality	65-70
	Agricultural lime	6-10 ppm	To maintain pH	60-65
	Bio-tuff	Pond preparation & culture 15-20kg & 7-10kg/acre	To improve soil & water quality	65-70
	JV Zeolite	Pond preparation & culture 7 kg/33dec & 3.5Kg/33 dec.	To improve soil & water quality	65-70
	Lime	1-1.5 kg/dec	To maintain pH and water quality	95-97
	Urea	100-150g/dec	Proliferation of algae	95-97
	Zeolite plus	20-30 kg/acre	To improve soil & water quality	70-75
Oxygen suppliers	Bio-ox	2.50-5g/acre	Oxygen supplementation	60-65
	O_2 marine	33-40 tab/33dec	Oxygen supplementation	60-65
	Oxymax	250-500g/acre	To increase DO	72-75
	Oxy-flow	250-350g/acre	Oxygen supplementation	75-80
	Oxy-gold	250-350g/acre	To increase DO	75-80
Disinfectants	BKC	0.5 ppm	Disinfection	85-90
	Bleaching	250-350g/acre	Disinfection	90-95
	Emsen	20g/33 dec	Disinfection	85-90
	Timsen	20g/33 dec	To kill microbes	90-95
Growth promoters	Aqua boost	500g/mt feed	To increase organic acid in feed composition, β-glucan	75-80
	Aqua savor	2-3 kg/mt feed	To increase protein % in feed	68-70
	Aquamin	200g/100kg feed	Used in vitamin deficiency	75-78
	Cevit vet	25mg/kg feed	Used in vitamin C deficiency	75-80
	Growmax	2.5 kg/ton feed	Used in vitamin, mineral & protein deficiency	65-70
	Megavit aqua	100g/kg feed	Vitamin, mineral & protein supplementation	75-80
Probiotics	Mutagen	5g/kg	For better health	80-82
	Super PS	4-6 L/ acre	To improve soil quality and reduce toxic gas from bottom.	80-82
	Zymetine	5g/kg	To inhibit pathogen	80-85
Antibiotics	Bactitab	50g/ kg body weight	To inhibit pathogenic bacteria	65-68
	Cotrim Vet	.5g/kg feed	To inhibit pathogenic	60-65
	Oxytetracycline	1g/kg feed	To increase resistance capacity	65-70
	Renamox	30g	To increase resistance capacity	65-70

Table 3.3: Impact of aqua-drugs on shrimp health and disease (Hasen, 2014).

Study area	Disease name	Disease symptoms	Drug and dose	Recovery (%)
Khulna and Bagerhat regions	White Spot Disease (WSD)	White spots or patches, on the inside of the shell and carapace.	Malachite green 10g/dec Methylene blue 10g/dec Bleaching powder 60ppm $KMnO_4$ 0.1-0.2 ppm	------
	Yellow Head Disease (YHD)	Pale bodies, a swollen cephalothorax with a light yellow to yellowish hepatopancreas.	$KMnO_4$ 0.1-0.2 ppm Eco solution 0.1-0.2 ppm Methylene blue 10g/dec Basudin 150g/33dec Timsen 80 gm/33 dec	20-25
	Vibriosis	Reddish discoloration of juvenile shrimp, black spots, chronic soft shelling.	Renamycin 5g/kg feed Oxytetracycline 1g/kg feed Lime 0.5-1kg/dec Salt 0.5-1kg/dec $KMnO_4$ 0.1-0.2 ppm	50-55
	Black Gill Disease	Brownish to blackish discoloration on the gills of juvenile shrimp.	Formalin 100-200 ppm Oxolinic acid 0.6 ppm Sarafloxacin 5 mg/kg feed Timsen 80 gm/33 dec	-----
	Cotton shrimp disease or Milk shrimp disease	Infected shrimps appear opaque and cooked. Gradual and low levels of mortalities are observed.	Renamycin 5g/kg feed Oxytetracycline 1g/kg feed Lime 0.5-1kg/dec Salt 0.5-1kg/dec $KMnO_4$ 0.1-0.2 ppm Eco solution 0.1-0.2 ppm	25-30
Cox'sBazar region	Monodon Baculovirus (MBV)	Lethargy, anorexia, poor feeding, dark coloration and reduced growth rate.	Eco solution 0.1-0.2 ppm Methylene blue 10g/dec Basudin 150g/33dec Timsen 80 gm/33 dec	15-20
	White Spot Disease (WSD)	White spots, on the inside of the shell and carapace,	Malachite green 10g/dec $KMnO_4$ 0.1-0.2 ppm Timsen 80 gm/33 dec	---
	Vibriosis	Reddish discoloration of juvenile shrimp, black spots, chronic soft shelling.	Renamox 5g/kg feed Oxytetracycline 1g/kg feed Salt 0.5-1kg/dec $KMnO_4$ 0.1-0.2 ppm Formalin 100-200 ppm	25-30
	Surface Fouling Diseases	Infected shrimps show black/ brown gills or appendage discoloration or cottony appearance.	Renamycin 5g/kg feed Oxytetracycline 1g/kg feed Lime 0.5-1kg/dec Salt 0.5-1kg/dec $KMnO_4$ 0.1-0.2 ppm Eco solution 0.1-0.2 ppm	40-45

Table 3.4: Impact of aqua-drugs on fish health and disease (Hasen, 2014).

Study areas	Species	Diseases	Drugs/chemicals with dose	Recovery (%)
Trishal	Pangus	EUS	Zeolite 200g/dec Gastab 2-3g/dec Timsen 0.6g/dec Cotrimvet 2g/kg feed	75-80
		Edwardsiellosis	Renamycin 5g/kg feed Timsen 80 gm/33 dec Ossi-C 3 gm/kg feed Polgard plus 5 ml/decimal	75-80
		Fin root	Lime 0.5-1 kg/dec Salt 0.5-1 kg/dec	60-65
	Tilapia	EUS	Renamycin 50mg/kg body weight Polgard plus 500 ml/acre Ossi-C 3 g/kg feed	80-85
		Dropsy	Aquamycine 1-2 g/feed Ossi-C 3 g/kg feed	80-85
	Koi	Edwardsiellosis	Renamycin 5g/kg feed Ossi-C 3 gm/kg Polgard plus 5 ml/decimal	65-70
		EUS	Aquamycine 1-2 gm/feed Ossi-C 3 g/kg feed Polgard plus 5 ml/decimal	80-85
Bhaluka	Pangus	EUS	$KMnO_4$ 3kg/dec Renamycine 5g/kg feed Cotrimvet 2g/kg feed Revoflavin 50 tab/kg feed Tetravet 5g/kg feed Fish curapus 20g/dec	80-85
		Edwardsiellosis	Renamycin 5g/kg feed Ossi-C 3 g/kg feed Polgard plus 5 ml/decimal Geolite gold 200-250 g/decimal	75-80
		Fin rot	Lime 0.5-1 kg/dec Salt 0.5-1 kg/ dec	70-75
		Pop eye	Renamycine 5g/kg feed	70-75
		Fat deposition	Livabid 10ml/kg feed Cholin chloride 10ml/kg feed	50-55
	Tilapia	EUS	Renamycin 50 mg/kg body weight Ossi-C 3 g/kg feed	75-80
		White spot	Lime 0.5-1kg/dec Salt 0.5-1kg/dec Aqua mix 5g/kg feed Vita mix-F-Aqua5g/kg feed	75-80
	Koi	Edwardsiellosis	Renamycin 5g/kg feed Ossi-C 3 g/kg Polgard plus 5 ml/decimal	75-80
		White spot	Lime 0.5-1kg/dec Salt 0.5-1kg/dec Aqua mix 5g/kg feed Vita mix-F-Aqua5g/kg feed	70-75

3.1.3 Impact of Using Chemicals and Aqua-drugs in Aquaculture

The impact of using chemicals and drugs, improve the growth and disease resistance capacity of fish and shrimp (Ahmed et al., 2014). The production of Thai pangus in chemically treated pond is 8,100 kg/acre and the non-treated pond is 4,800 kg/acre (Ahmed et al., 2012). Histology of fish skin-muscle, gill, liver and kidney and shrimp muscles differentiates the chemically treated and non-treated through the remarkable pathological changes like necrosis, vacuums, pyknotic cell (Ahmed et al., 2014).In most of the cases the farmers do not maintain the appropriate dose of drugs for pond and disease treatment. As a result, the chemicals have some negative impact on fish production and also human health through consumption. The rough handling of chemicals often leads to problems like drug resistance, tissue residue, and adverse effect on species biodiversity (Spanggaard et al., 1993 and Herwing and Gray, 1997). Sometimes the chemicals can be found in the sediment at least six months such as the antimicrobials, notably Oxytetracycline, Oxolinic acid and Flumequine (Weston, 1996). There is a lack of information and proper knowledge about the impact of using aqua-drugs and chemicals in Bangladesh. So, the following tables highlight some investigated impacts of aqua-drugs and chemicals on fish and shrimp health and production through clinical, histological and overall field observation of both inland and coastal aquaculture. (Table 3.2, Table 3.3 and Table 3.4).

3.2 Farmers Preference of aqua-drugs and chemicals in Bangladesh

Shrimp and fish farmers of different regions use different categories of aqua-drugs and chemicals to serve various purposes. It can be mentioned that farmers of different regions use drugs and chemicals in different categories and percentages. The farmers of greater Khulna region use 80% and 60% chemicals during pond preparation and growth promotion of shrimp. Farmers of Bagerhat region use 70%, 40% and 40% chemicals during pond and water quality management, antibiotic and disease treatments respectively. Whereas in Cox's Bazar region farmers use 75%, 30% and 35% chemicals during pond and water quality management, as oxygen suppliers and disinfectants respectively. Recently Narail district have gathered attention on the production of prawn and 50% and 33% farmers use chemicals as growth promoter and oxygen supplier. In case of inland aquaculture, such as in Mymensingh region 85%, 70% and 62% farmers use chemicals during pond preparation, growth promotion and disease treatment respectively.

3.3 Commons Diseases of Fish and Shrimp in Bangladesh

In coastal regions of Bangladesh, the recorded diseases of shrimp are WSD, YHD, External Fouling, MBVD, Black gill disease and Bacterial diseases. And common fish diseases are EUS, Fin rot, Dropsy, White Spots, Pop eye and Edwardsiellosis. However, a list of common diseases in Bangladesh and those cause symptoms, reason for infection, action to be taken and treatment including using aqua-drugs and chemicals are furnished in Table 3.5.

3.4 Integrated Pest Management and Its Advantages

IPM fundamentally differs from the traditional pest control programs in that IPM emphasizes the growth of a healthy crop and livestock with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms (FAO, 2014) while conventional pest management basically relies on chemical pesticides only.

The advantages of IPM are:

- Environmentally friendly
- Reduces human health risks (exposure to chemical pesticides)
- Relatively cheaper
- IPM is more effective in controlling pests over long periods.

IPM requires wider knowledge unlike traditional programs. Managing pests with less pesticide requires a strong working knowledge of pest biology and behavior, current pest control technologies and practices, climate and its effects on pest proliferation, greenhouse and storage structural

characteristics and staff behavior. Without this knowledge, it will be difficult, if not impossible, to prevent infestations.

Investing in IPM programs may initially cost more than traditional methods but for the long-term; IPM is analogous to preventive health maintenance. IPM is more cost-effective in terms of time, personnel and materials to prevent pest problems than the practice of remediating the same problem again and again.

Table 3.5: Common disease of fishes in Bangladesh and remedial measures.

Disease and Causes	Symptoms	Reason for Infection	Action	Treatment
Ulcers Caused by species of *Pseudomonas* and *Aeromonas* bacteria	Pinky-white open wounds, often with a white edge and sometimes secondarily infected by fungi and other bacteria.	Very poor water quality or an excessively high pH level. Minor scratches can become infected if conditions are poor. Also, commonly affects newly imported Koi and goldfish.	Test the water for signs of ammonia and nitrite. Conduct a large water change to reduce pollution levels.	Fish lose salts quickly through open wounds, so add aquarium salt at a dose of 1-3 g/liter. Use an anti-ulcer treatment. If treatment fails, a vet can prescribe stronger antibiotics.
Cloudy eye Caused by poor water quality, poor diet, eye flukes, corneal damage, bacterial infection.	Entire surface or lens of eye takes on a cloudy, opaque appearance. There may be a build-up of mucus on the outer surface.	Most commonly caused by poor water conditions. A lack of vitamins in the diet may also cause clouding. On rare occasions digenetic flukes, such as *Diplostomum*, can cause problems.	Improve water conditions. Use a good quality food containing added vitamins.	Improving water conditions usually cures cloudy eyes. Eye flukes are uncommon and can be difficult to accurately diagnose and treat.
Dropsy Usually caused by bacterial infection. Viral infection, nutritional, metabolic and osmo-regulatory problems can also be responsible.	Swelling of the body cavity due to a buildup of fluid. Scales become raised giving a pine cone-like appearance. One or both of the eyes maybe protruded.	Usually triggered by poor water quality, especially the presence of ammonia and nitrite. Often confined to individual fish.	Test water and improve water conditions immediately. Aquarium salt at a dose of 1- 3 g/liter can help to prevent salt loss.	Can be difficult to treat. A broad spectrum antibacterial treatment is the best option in most cases.
White spot Caused by *Ichthyophthirius multifiliis* parasite	Small white spots, about the size of a salt grain, on the skin, fins and gills.	Stress related. Usually a consequence of poor or incorrect water conditions, fluctuating temperature and general poor husbandry. Sensitive species may develop white spot as a result of being introduced to a new aquarium.	Ensure the water is free of pollution and isolate cause of stress.	Treat promptly with an anti-parasite medication. It may be necessary to raise the water temperature to improve the effectiveness of the treatment. Wounds left by parasites may become secondarily infected.
Bacterial infections	Reddening of the skin or fins; ragged fins with signs of infection, open	Poor water conditions, especially the presence of ammonia and nitrite. Wounds	Improve water conditions, and treat promptly.	Use a proprietary treatment as soon as possible. Aquarium salt at a dose of 1-3 g/liter can help

Disease and Causes	Symptoms	Reason for Infection	Action	Treatment
Caused by species of *Aeromonas* and *Pseudomonas* bacteria	sores. Common on many newly imported fishes. Often accompanied by other diseases, including fungi.	resulting from poor handling, transport or fighting may become secondarily infected by these bacteria if conditions are poor.		prevent salt loss. Severe infections may require prescription medications from a vet.
Fungal infections Caused by species of *Saprolegnia* and *Achlya*	Fluffy growths affecting wounds on the skin and fins of freshwater fishes.	Usually a secondary infection that Invades wounds left by ulcers and parasites, including white spot. Rarely a problem in tanks with good water quality.	Improve water condition and treat promptly.	Standard antifungal medications, such as methylene blue, are usually very effective, but may affect filtration and water quality. When the disease occurs on open wounds, aquarium salt at a dose of 1-3 g/liter can help reduce salt loss. Cotton-wool disease (*Flexibacter*) looks similar but is caused by bacteria and may require a different treatment.
Fin-rot Caused by species of *Aeromonas*, *Pseudomonas* or *Flexibacter* bacteria	Frayed fins, often with a pale pinky white edge and some blood in the fin tissues.	The bacteria are present on most fish. Stress from poor water conditions usually triggers an infection. Nipped fins may become secondarily infected if water is polluted. Some wounds may also be attacked by fungus.	Improve water conditions. Isolate nippy fishes.	Treat promptly with a fin-rot or anti-bacteria treatment to prevent the further spread of the disease. Consider adding salt (1-3 g/liter) to reduce the loss of salt by the fish. Ensure that water stays free of pollution during treatment.
Swim bladder disorder Caused by bacterial infection, incorrect diet, trapped gas, physical deformities.	Fish have difficulty swimming to the surface, or to the lower levels of the tank. Commonly affects eggs of fancy goldfish.	Sometimes caused by poor water quality. Genetic problems in selectively bred goldfish.	Improve water conditions. Feed less dried foods, or pre-soak pellets and flakes so they don't swell the gut. Feed *Daphnia*, which acts as a laxative.	Change diet and improve water conditions. Treat with a specialist antibacterial treatment. Fancy goldfish suffering from physical deformities will not recover.

Disease and Causes	Symptoms	Reason for Infection	Action	Treatment
Lymphocystis Caused by an *Iridovirus*	The virus causes crusty grey-white lumps to develop on the skin and fins. These may affect freshwater or marine fishes, and sometimes take on the colour of the underlying skin. These lumps are clusters of enlarged cells.	The disease is viral, but maybe triggered by stress, poor handling or poor water. Some fish may carry the virus without showing symptoms.	The disease rarely kills, although lesions may become secondarily infected. Ideally, infected fish should be isolated.	There is no known treatment. Some vets recommend the surgical removal of the lesions.

3.5 Currently Available Pest Management Technologies in Agricultural Sector

Insect Control

The Current IPM Technologies for controlling insects of rice, vegetables and fruits differ according to the commodities and the types of insects and diseases. These are:

- Perching for attracting insect-eating birds.
- Use of sex Pheromone trap.
- Use of light traps.
- Use of tolerant/ resistant varieties.
- Picking/ catching by hand net or mosquito net and destruction of eggs, nymphs& adults.
- Burning or mixing the debris and left-over rice straw under soil.
- Delaying pesticide spray to help parasitic (friendly) insects in eating eggs of destructive insect pests.
- Removing water from the field and drying the soil temporarily.
- Increasing planting space of seedlings to allow increased light penetration through the canopy.
- Using balanced fertilizer.
- Pulling out of affected plants & burying under the soil.
- Collection and destruction of infested leaf (with egg mass and grub).
- Application of ash on the plants.
- Practicing clean cultivation.
- Using yellow sticky trap.
- Cultivating trap crops like okra or mustard between rows and around the field.
- Spraying bio-pesticides.
- Destruction of infested flower pods and fruits regularly.
- Treating seeds with insecticides before planting in seedbed.
- Covering seedbeds with fine nylon net.
- Irrigation of field during infestation with very low quantity of kerosene oil.
- Use of poison bait (broken rice husk + gur +Carbarin insecticide).
- Using approved insecticide as a last resort

Disease Control

A number of IPM measures are used in disease control:

- Using tolerant varieties
- Using Light trap and hand net
- Using balanced fertilizer, urea application in three installments
- Withholding irrigation for 7-8 days & applying 5 kg potash fertilizer per bigha (0.33 acres) of land
- Collecting floating debris along the field borders and burying under soil
- Using crop rotation
- Using seed collected from healthy plants
- Using seed treatment measures
- Using organic manure
- Keeping standing water in the field (depending on the disease)
- Keeping the land dry for some time in case of leaf scald attack
- Burning out the affected straw

- Keeping grass-type weeds under control
- Not to use same land for seedbed continuously
- Using purified seed by soaking in fungicide-mixed water
- Using soft seed bed and keeping it moist all the time (depending on the disease)
- Drying land immediately after disease appearance (depending on the disease)
- Throwing disease affected seedlings
- Burning out the disease affected plants
- Growing different varieties of rice at interval
- Using balanced fertilizer
- Mixing rice bran with seed bed soil (depending on the disease)
- Covering seedbed with polythene sheets during cold spells
- Prompt destruction of infested plant material to reduce initial inoculums
- Weed control (solanaceous weeds) such as nightshades
- Removal and destruction of the affected plant parts
- Application of neem cake at 250 kg/ha
- Using yellow sticky traps
- Field sanitation by burning of crop debris
- Avoiding crowded planting of seedlings
- Maintaining field sanitation
- Using virus tolerant varieties
- Using of disease free seeds
- Use of high land and well-drained soil (for vegetables & fruits)
- Use of fungicide as a last resort

3.6 Non-chemical Methods of IMP in aquaculture sector of Bangladesh

Some of the main features of IPM involve the use of non-chemical methods of pest control which include the following:

Biological Control Agents

Biological control means use of living organisms to suppress pest populations and damage. These living organisms can be parasitoids, predators and use of sterile males during breeding or pathogens. Environmentally friendly chemical interventions such as the use of semio-chemicals (e.g. pheromones and Para-pheromones), bio-pesticides and relatively less toxic insecticides can be used together with biological control agents.

Cultural Control Practices

Cultural control means use of usual fish species production practices to suppress pest population and damage in the pond. These practices include ploughing/ digging/ leaching to expose and kill soil pests, using pest and disease-free fingerlings, stocking in time, inter-cropping, natural feeding, timely harvesting in time to minimize exposure of the pests, practicing rotational crops, selection of brood stock, and practicing all in all out modern and hygienic fish production systems.

Mechanical control methods

Mechanical control means using manual devices to suppress pest population and damage. This involves hand picking, netting and encircling of ponds and use of traps.

Physical control methods

Physical control means killing pests or suppressing their population by modifying physical factors of their environment to their detriment. This involves techniques such as irradiation, heat treatment, cold treatment, ultrasonic vibrations and drying.

Legislative measures

This involves setting up and effecting acts and regulations which help in pest management. Examples are quarantine services, seed (fry) certification, produce inspection, etc.

Genetic control measures

They involve production and use of fish species or brood stocks which are resistant to pests and/or diseases. These include insect and disease resistant varieties/ brood stock and fry's.

3.7 Chemical Pesticide Use Challenges in Bangladesh

During consultations by DoF at field level, it was revealed that there are some challenges as perceived by fish farmers. Some of the general challenges are that some of the pesticides are not manufactured in Bangladesh and in addition, Bangladesh does not have ultimate pesticides disposal facilities (such as pesticide incinerators). Other observed challenges are summarized as follows:

3.7.1 Use of Unregulated Pesticides

Bangladesh shares borders with India and Myanmar and this geographical proximity to these countries facilitates both trade and accessibility to unregulated and illegal chemical pesticides (not approved by the GoB) especially for the districts close to these bordering countries. Negative effects of the prevalent supply of un-screened chemicals include:

- A threat of the introduction of highly toxic substances into the environment, putting human beings, plant and animals at risk.
- Development of pest resistance and economic loss on the part of the farmers for using sub-standard chemicals.
- Incessant expansion of Bangladesh government's regulatory duties and responsibilities; stretching its finances and resources too thin and seriously diluting its role and capacity of chemical pesticide regulation; and rendering it ineffective.

3.7.2 Use of expired pesticides

Indiscriminate use of expired chemical pesticides by farmers is a problem emanating from shared negligence between the farmers and chemical pesticide marketers. Both parties contribute to the situation partly due to ignorance. Unlicensed chemical pesticide marketers also contribute to the proliferation of expired chemicals.

3.7.3 Lack of appropriate skills

Implementation of an effective pest management plan requires an interdisciplinary approach, due to the breadth and depth of the subject. DoF's field extension officer and other staff usually lack appropriate training in pesticides management.

3.7.4 Inadequate protective gear

A combination of ignorance of the potential risks associated with chemical pesticides, with the lack of sufficient funding, imposes formidable strains on the safety methods of chemical pesticide application.

3.7.5 Inadequate policy, acts and rules

Most of the fisheries and aquaculture policy, acts and regulations do not have sufficient coverage on the use of pesticides, drugs and chemicals in fish ponds. However, some rules include restriction of using chemical fertilizers. But there is no such PMP plan from GoB for fisheries sector.

3.7.6 Fish farmer's attitude

A mis-informed approach amongst farmers is their chemical remedies for pests are sought in the first instance. It has happened due to improper advocacy on IPM.

3.8 Banned Drugs/Chemicals in Fish and Animal Health Sector in Bangladesh

Food safety is a term broadly applied to food quality that may adversely affect human health. There are major areas of concern over the presence of residues of antibiotics in animal-derived foodstuffs with regard to human health. The term "antibiotic growth promoter" (AGP) is used to describe any medicine that destroys or inhibits bacteria and is administered at a low, sub-therapeutic dose. The use of antibiotics for growth promotion has arisen with the intensification of fish farming. APG's are restricted to avoid residual effect of antibiotics in fishes subsequently in human.

Locally and globally banned steroid hormones Decason, Oradexon, Prednisolon, Betnenal, Cortan, Steron and Adam-33 are often found in the local market in the name of remedial medicines for fish/ and or shrimp diseases. These are bannedin the country according to the Fish and Animal Feed Act, 2010. Besides those, Nitrofurans (Furazolidone, Furaltadone, Nitrofurantoin, Nitrofurazone) Chloramphenicol, injectable Dichlofenac sodium are also banned in the country (Table 3.6).

Table 3.6: List of Banned Pesticides and Chemicals in Bangladesh.

SL	Trade name of Products	Registration Number	Name of Company
1	Diazinon 14G	AP-08	Shetu Coporation Limited
2	Bizguard 2P	AP-09	Ciba-Geigy (Bangladesh) Limited
3	Roxion 40EC	AP-11	International Services (BD) Limited
4	Dankavapon 100EC	AP-13	Shetu Corporation Limited
5	Damfin 2P	AP-19	Ciba-Geigy (Bangladesh) Limited
6	Diazinon 90L	AP-20	Ciba-Geigy (Bangladesh) Limited
7	Danmfin 950EC	AP-25	Ciba-Geigy (Bangladesh) Limited
8	Dichlorvos	AP-27	Bayer (Bangladesh) Limited
9	Curaterr 3G	AP-30	Bayer (Bangladesh) Limited
10	2,4-D NaSalt	AP-34	Bayer (Bangladesh) Limited
11	Folithion ULVC 98	AP-36	Bayer (Bangladesh) Limited
12	Methybron	AP-38	Excell Trading Company
13	Heptachlor 40WP	AP-39	Krishi Banijya Protisthan
14	Chlordane 40WP	AP-40	Krishi Banijya Protisthan
15	Aerovap 100EC	AP-41	Liza Enterprise Limited
16	Aerodriel 20EC	AP-42	Liza Enterprise Limited
17	Aeromal 57EC	AP-44	Liza Enterprise Limited
18	Padan 10G	AP-52	Data Enterprises Limited
19	Fenitrothion 98	AP-53	Farm Chemical Corporation Limited
20	Carbin 85WP	AP-54	Farm Chemical Corporation Limited
21	Diamal 57EC	AP-55	Farm Chemical Corporation Limited
22	DetiaGas EXT	AP-56	Farm Chemical Corporation Limited
23	Dichlorvos 100EC	AP-57	Farm Chemical Corporation Limited
24	Methyl Bromide 98	AP-57	Farm Chemical Corporation Limited
25	Malathion 57EC	AP-68	BPI Limited
26	Curaterr 3G	AP-69	Bayer (Bangladesh) Limited
27	Dieldrin 20EC	AP-73	Shell Company of Bangladesh Limited
28	Bidrin 24WSC	AP-74	Shell Company of Bangladesh Limited
29	Malathion 57EC	AP-78	Burmah Eastern Limited
30	Vapona	AP-79	Shell Company of Bangladesh Limited
31	Bidrin 85WSC	AP-80	Shell Company of Bangladesh Limited
32	Dieldrin 50WP	AP-82	Shell Company of Bangladesh Limited
33	Dieldrin 40WP	AP-83	Shell Company of Bangladesh Limited
34	Furadan 3G	AP-85	FMC International S.A.
35	Actellic 2% Dust	AP-99	Bangladesh Manufacturers Limited
36	Quickphos	AP-102	Agrani Traders

SL	Trade name of Products	Registration Number	Name of Company
37	Torque 550g/l	AP-115	International Services (BD) Limited
38	Ridan 3G	AP-131	Rupali Sangstha Limited
39	Bkzne 14G	AP-135	B. K. Traders
40	Aerocypermethrin 10EC	AP-137	Liza Enterprise Limited
41	Karmex	AP-145	Beximco Agrochemicals Limited
42	Carbaryl 85WP	AP-147	Shetu Corporation Limited
43	Agridan 3G	AP-154	Shetu Pesticides Limited
44	Tecto 2% Dust	AP-157	Alco Pharma Limited
45	Manex-II	AP-163	Shetu Corporation Limited
46	Phytox MZ80	AP-164	Liza Enterprise Limited
47	Uniflow TMS ulphur	AP-167	Shetu Corporation Limited
48	Fenkil 20EC	AP-169	Agrani Traders
49	Sunfuran 3G	AP-171	Shetu Corporation Limited
50	Hekthion 57EC	AP-178	Farm Chemical Corporation Limited
51	Poligor 40EC	AP-180	Farm Chemical Corporation Limited
52	Melbromid 98	AP-185	Horizon Trade Limited
53	Mebrom	AP-186	Bengal Wings Trade Limited
54	Agrine 85WP	AP-187	Edgro (Private) Limited
55	Drawizon 60EC	AP-190	Keeco Pesticides Limited
56	Gastoxin	AP-195	Bright Corporation
57	Cekomethrin 10EC	AP-219	Premier Traders
58	Cythrin	AP-220	Bari & Company Limited
59	Cekuthoate 40EC	AP-225	Premier Traders
60	Arifos 20EC	AP-229	Bari & Company Limited
61	Malathion 57EC	AP-230	Sabrina Trading Corporation
62	Cardan 5G	AP-234	Bari & Company Limited
63	Diazinon 14G	AP-236	Liza Enterprise Limited
64	Rizinon 60EC	AP-239	Bari & Company Limited
65	Zincphosphide	AP-258	Liza Enterprise Limited
66	Davison Glyphosate	AP-266	Shetu Pesticides Limited
67	Morestan 25WP	AP-269	Beximco Agrochemicals Limited
68	Manzate 200	AP-301	Auto Equipment Limited
69	Dimecron 100SL	AP-22&276	Novartis (Bangladesh) Limited
70	Pillarcron 100SL	AP-148	Shetu Pesticides Limited
71	Benicron 100WSC	AP-06	Sabrina Trading Corporation
72	DDVP 100W/V	AP-03	ACI Formulations Limited
73	Chemo DDVP 100EC	AP-245	Chemsfil Bangladesh Limited
74	DDVP 100EC	AP-151	McDonald Bangladesh (Pvt) Limited
75	Nogos 100EC	AP-26&274	Novartis (Bangladesh) Limited
76	Phosvit 100EC	AP-56	Data Enterprises Limited
77	Daman 100EC	AP-325	Petrochem (Bangladesh) Limited
78	Azodrin 40WSC	AP-336	BASF Bangladesh Limited
79	Nuvacron 40SL	AP-18&275	Novartis (Bangladesh) Limited
80	Megaphos 40SL	AP-175	McDonald Bangladesh (Pvt) Limited
81	Phoskil 40SL	AP-339	United Phosphorus (Bangladesh) Ltd
82	Kadette 40WSC	AP-284	Bisco Pesticide & Chemical
83	Monophos 40WSC	AP-328	Alpha Agro Limited
84	Monodrin 40WSC	AP-07	Sabrina Trading Corporation
85	Corophos 40SL	AP-342	Corbel International Limited
86	Luphos 40SL	AP-388	ACI Formulations Limited
87	Amcodrin 40SL	AP-340	Atherton Imbros Company Limited
88	Vitacron 40SL	AP-341	Shetu Marketing Company

SL	Trade name of Products	Registration Number	Name of Company
89	Monotaf 40WSC	AP-331	Auto Equipment Limited
90	Tamaron 40SL	AP-188	Haychem (Bangladesh) Limited
91	Folithion 50EC	AP-32	Haychem (Bangladesh) Limited
92	Macuprax 65%	AP-65	Bayer Crop Science Limited
93	Zithiol 57EC	AP-126	Rhone Poulenc Bangladesh
94	Delapon Na-84	AP-66	Rhone Poulenc Bangladesh
95	Anthio 25EC	AP-64	Rhone Poulenc Bangladesh
96	Zolone 35EC	AP-67	Rhone Poulenc Bangladesh
97	Rentokill CC Type 75%	AP-221	Getco Limited
98	Paramount CC Type	AP-300	BD Associate and Company
99	Darsban 20EC	PHP-5	Auto Equipment Limited
100	Darsban 20EC	PHP-85	Auto Equipment Limited
101	Basudin 10G	AP-23	Syngenta Bangladesh Limited
102	Diazinon 60EC	AP-24	Syngenta Bangladesh Limited
103	Mortin King Mosquito Coil	PHP-54	Reckitt Benckiser Bangladesh Limited
104	Mortin Mosquito Coil	PHP-101	Reckitt Benckiser Bangladesh Limited
105	Sarfium 56%	AP-689	Sar Trade Fertilizer Limited
106	Sicofen 20EC	AP-624	Genetica
107	Cythrine 10EC	AP-310	ACI Formulations Limited
108	Diazonyl T-60	AP-283	ACI Formulations Limited
109	Salmathion 57EC	AP-1066	Agrimax Bangladesh Limited
110	Basamid Granular	AP-205	BASF Bangladesh Limited
111	Ducord 17EC	AP-793	BASF Bangladesh Limited
112	Argold 10EC	AP-409	BASF Bangladesh Limited
113	Dicofol 18.5EC	AP-359	McDonald Bangladesh (Pvt) Limited
114	Carbaryl 85WP	AP-150	McDonald Bangladesh (Pvt) Limited
115	Amitage 20EC	AP-476	McDonald Bangladesh (Pvt) Limited
116	Neoron 500EC	AP-551	Syngenta Bangladesh Limited
117	Anvil 5SC	AP-472	Syngenta Bangladesh Limited
118	Ridomil Gold MZ68 **WG**	AP-377	Syngenta Bangladesh Limited
119	Folio Gold 440SC	AP-1133	Syngenta Bangladesh Limited
120	Dolma 5G	AP-1226	Syngenta Bangladesh Limited
121	Sonne t50SP	AP-1488	Syngenta Bangladesh Limited
122	Basudin 10GR	AP-532	Syngenta Bangladesh Limited
123	Ricon 60EC	AP-533	Syngenta Bangladesh Limited
124	Paprika 50EC	AP-1250	Syngenta Bangladesh Limited
125	Touchdown	AP-404	Syngenta Bangladesh Limited
126	Touchdown HiTech 500SL	AP-873	Syngenta Bangladesh Limited
127	Dual Gold 960EC	AP-1111	Syngenta Bangladesh Limited
128	Lintur 70WG	AP-633	Syngenta Bangladesh Limited
129	Koranda	AP-794	Auto Crop Care Limited
130	Seda 50SP	AP-420	Auto Crop Care Limited
131	Lorsban 15G	AP-371	Auto Crop Care Limited
132	Autoguard 25EC	AP-1147	Auto Crop Care Limited
133	Focus 50SC	AP-828	Auto Crop Care Limited
134	Alert 50EC	AP-648	Auto Crop Care Limited
135	Quinguard 25EC	AP-1106	Auto Crop Care Limited
136	Fendor 5G	AP-279	Auto Crop Care Limited
137	Edfen 50EC	AP-191	SeaTrade Fertilizer Limited
138	Malatox 57EC	AP-286	SeaTrade Fertilizer Limited
139	Edthoate 50EC	AP-307	SeaTrade Fertilizer Limited
140	Metasystox R25EC	AP-493	United Phosphorus (Bangladesh) Ltd

SL	Trade name of Products	Registration Number	Name of Company
141	Sumithion 3% Dust	AP-156	Shetu Corporation Limited
142	Sumibas 75EC	AP-255	Shetu Corporation Limited
143	Arozin 30EC	AP-383	Bayer Crop Science Limited
144	Basta SL15	AP-265	Bayer Crop Science Limited
145	Baycarb EC500	AP-488	Bayer Crop Science Limited
146	Curaterr 5G	AP-490	Bayer Crop Science Limited
147	Cupravit 50WP	AP-489	Bayer Crop Science Limited
148	Hinosan EC50	AP-491	Bayer Crop Science Limited
149	Labaycid 50EC	AP-492	Bayer Crop Science Limited
150	SunriceSuper 315EC	AP-1777	Bayer Crop Science Limited
151	Benefiter 315SC	AP-2105	Bayer Crop Science Limited
152	Thiodan 35EC	AP-1147	Bayer Crop Science Limited
153	Fantush 300EC	AP-2569	Asia Trade International
154	Ultima 40WG	AP-2560	Mimpex Agrochemicals Limited
155	Abate 15G	PHP-118	BASF Bangladesh Limited
156	Fendona 1.5SC	PHP-84	BASF Bangladesh Limited
157	Edfen 50EC	PHP-40	Sea Trade Fertilizer Limited
158	Coopex 25WP	PHP-191	Bayer Crop Science Limited
159	Sislin 2.5EC	PHP-192	Bayer Crop Science Limited
160	Crackdown	PHP-193	Bayer Crop Science Limited
161	Resigen 50E	PHP-194	Bayer Crop Science Limited
162	Resigned OS	PHP-196	Bayer Crop Science Limited
163	Bilshot M46.5EC	AP-586	Pharma & Farm
164	Pharzeb 80WP	AP-784	Pharma & Farm
165	Phartap 50SP	AP-605	Pharma & Farm
166	Cypercid 10EC	AP-523	Pharma & Farm
167	Glyphar 41SL	AP-896	Pharma & Farm
168	Topsin M70WP	AP-193	Data Enterprises Limited
169	Homai 80WP	AP-179	Data Enterprises Limited
170	Padan 50SP	AP-555	Data Enterprises Limited
171	Diazinon 14G	AP-554	Data Enterprises Limited
172	Diazinon 60EC	AP-557	Data Enterprises Limited
173	Diazinon 90ULVC	AP-560	Data Enterprises Limited
174	Trebon 10EC	AP-161	Data Enterprises Limited
175	Bassa 50EC	AP-142	Data Enterprises Limited
176	Elsan 50EC	AP-556	Data Enterprises Limited
177	Elsan 92ULVC	AP-558	Data Enterprises Limited
178	Vitavax 200B	AP-559	Pioneer Equipment & Chemical Co.
179	Pyriba n20EC	AP-381	Agro Development Services Co.(Pvt) Ltd
180	Aimal 57EC	AP-1136	Agro Development Services Co. (Pvt) Ltd
181	Asset	AP-364	Agrodev United
182	Padan 4G	AP-372	Krishi Kallyan Limited
183	Diazinon 10GR	AP-385	Krishi Kallyan Limited
184	Limithion 57EC	AP-264	ACI Formulations Limited
185	Knockout Liquid Insect Sprya	PHP-28	Shetu Pesticides Limited
186	Victor 1G	PHP-340	Shetu Pesticides Limited
187	Night Queen Mosquito Coil	PHP-46	Shetu Pesticides Limited
188	Sovathion 50EC	AP-240	Shetu Pesticides Limited
189	Pillartex 50EC	AP-414	Shetu Pesticides Limited
190	Kap 50EC	AP-216	Shetu Pesticides Limited
191	Dipterex 80SP	AP-561	United Phosphorus (Bangladesh) Ltd
192	Cekufon 80SP	AP-257	Shetu Pesticides Limited

SL	Trade name of Products	Registration Number	Name of Company
193	Palash 57EC	AP-312	Petrochem (Bangladesh) Limited
194	Pounce 1.5G	AP-419	FMC Chemical International AG
195	Acekro 20EC	AP-318	McDonald Bangladesh (Pvt) Limited

Chapter 4: Framework of PMP and Its Implementation Strategies

4.1 Fundamentals of PMP Planning

When developing a pest management plan, it is important to:

- consider why need a plan for BSCMFP
- know what the plan to achieve by the project components
- understand the invasive species and other animals in BSCMFP area
- consider the principles of pest management
- consider other pest management plans
- set achievable objectives through implementation of the PMP.

Before finalizing a pest management objective, it is also important to consider the interaction between pests and other issues such as land, water, vegetation and cultural heritage.

4.1.1 Steps to planning PMP

The following 6 steps will assist in effective pest management planning:

1. Understand the pest issue
2. Develop a draft pest management plan
3. Consultations
4. Finalize and implement the plan
5. Monitoring
6. Evaluate and review the overall results

4.1.2 Principles of Pest Management

Eight principles of pest management are suggested to follow as common basis for the management of pest animals throughout project area of BSCMFP. The consideration of all these principles is critical to the success of any pest management activity, regardless of scope and scale. These are:

1. Integration: Pest management in aquaculture is an integral part of managing natural resources and agricultural systems.
2. Public awareness: Public awareness and knowledge of pest must be raised to increase the capacity and willingness of individuals to participate in control.
3. Commitment: Effective pest management requires shared responsibility, capability, capacity and a long-term commitment by land owners/ managers, the community, industry groups and government. Those that create the risks associated with pest species introduction or spread and those that benefit from the pest management should help to minimize the impacts of pest animals and contribute to the costs of management.
4. Consultation and partnership: Consultation and partnership arrangements among the users, local communities, industry groups, government agencies and local governments must be established to achieve a collaborative and coordinated approach to management.
5. Planning: Planning for pest management should be based on risk management to ensure that resources target the priorities identified at local, regional, and national levels.
6. Prevention and early intervention: Preventive pest management is generally more cost-effective than other strategies and is achieved by: preventing the spread of pest species, and viable parts of these pests, especially by human activity early detection and intervention.
7. Best practice: Pest management must be based on ecologically and socially responsible practices that protect the environment and the productive capacity of natural resources while minimizing impacts on the community. It should balance feasibility, cost-effectiveness, sustainability, humaneness, community perceptions, emergency needs and public safety.

8. Improvement (research, monitoring and evaluation): Research about pest and regular monitoring and evaluation of control activities is needed to make evidence-based decisions and improve pest management practices.

4.2 Steps in Setting up IPM in BSCMFP

4.2.1 Identify the implementation team

Transition to a PMP program requires a diverse, action-oriented PMP Committee. This PMP Committee will be an environmentally conscious committee lead by the Project Director at PMU, DoF. A representative of the District Fisheries Office and Fish Farming Group will be members of this Committee. The leader of this team should be familiar with pests, pesticides and pesticide regulations. This arrangement is appropriate, because implementation of an IPM program can be tracked as a performance indicator.

PMP leadership is guided by pest management principles and environmental issues. Leadership with such academic background and experience qualifies to serve as an authority to supervise PMP implementation. Other team members include Environmental, Agriculture Extension , agronomists, crop protection experts(entomologists, pathologists), aquaculture expert, health officer and Livestock officer.

4.2.2 Decide on the scale of implementation

To determine the scale of implementation, a strategic approach will be taken. IPM will be clearly defined and discussed by the PD as is done for all other development projects. A representative of the District Fisheries Offices must attend these meetings to help explain the IPM approach and give examples of similar documented success studies. Through these discussions comprehension will be achieved, and potential objections will be addressed with successful practical examples.

4.2.3 Review and set measures objectives for the PMP

The PMP Committee will set measurable objectives and refine the IPM indicators relevant to their district; and determining factors such as:

- When the IPM program will start
- How much it will cost
- What will be accomplished by choosing IPM
- How success shall be monitored

The determination of above must be done prior to IPM implementation. Additionally, measurable goals will be set, to track:

- Pest management costs;
- Monitoring of pest activity before and after implementation of the IPM program;
- Number of calls related to pest problems and toxic chemical use reduction.

Furthermore, the time when the shift to IPM will occur must be discussed and agreed upon prior to implementation. The initial step will be to establish an implementation timeline that includes time to execute all of the steps outlined in the implementation plan. It is imperative to include time to organize the administration of the IPM and conduct any farmer training as well as manage the IPM process.

The IPM Committee will gather information on previously implemented or currently being implemented IPM programs; the time it took to develop them and how successful they have been. They will obtain the budgetary and any technical information for the previously implemented IPM programs and analyze the elements to establish lessons to learn. Field visits to currently running programmes will be conducted to get a practical insight.

Reduced pesticide use is the substantive yardstick in measuring an IPM's ability to create a safer environment. Baseline study will be conducted and therefore an information database that includes

annual quantities of pesticides used will be designed to enable comparative analysis to the previous years. The goal will be a downward trend over time or ideally, a specific reduction amount, ultimately leading to a scant usage of highly toxic pest control chemicals.

4.2.4 Analysis current housekeeping, maintenance and pest control practices

While preparing to make a transition to IPM, the PMP Committee will familiarize itself with the organization's current policies and practices with respect to structural maintenance, sanitation and pest control. Occasionally, current practice may be consistent with IPM principles. Familiarization will provide the flexibility necessary to adapt to, and prepare for the necessary changes.

Structural maintenance is arguably the most efficient way to keep pests out of a facility because it physically stops pests from entering wherever possible. Structural maintenance will therefore be a regular part of the IPM. Cracks, crevices or other unnecessary openings in the building exterior that can be used by pests as harborage areas or entry points regardless of size, will be sealed appropriately. Sanitation deprives pests of food and water. A sanitation plan must therefore be accounted for in the development of an IPM. Staff must be provided with special sanitation training.

4.2.5 Establish a system of regular IMP inspection

PMP's central focus is regular facility inspections. Such inspections are the "life blood" for a continuous cycle of IPM activities that may or may not include chemical treatments. Activities will include:

a) Routine Inspections
b) Pest Identification
c) Selection of Control Methods
d) Monitoring and Evaluation

IPM inspections must emphasize on the four "zones" of pest activity:

a) Entry points
b) Water sources
c) Food sources
d) Harborage areas.

During inspections, all existing pest issues and potential problem areas, inside and outside, must be noted for follow-up.

For in-house IPM programs, the greatest inspection challenge will be establishing routine, proactive surveillance by trained specialists. To ensure this is done, the EMC or an independent consultant will conduct inspections and audits twice a year.

4.2.6 Define the treatment policy selection

A clear written policy on how the facility will respond to pests, when they appear,must be developed. Included in the policy will be definitions of both non-chemical and chemical treatment options and the sequence or prioritization in which they will be considered. It should be unequivocal on when and where chemical treatments are appropriate. Finally, it should include an "approved materials" list to ensure informed choices when chemical treatments are applied.

The key to an effective IPM is to correctly identify pests that have invaded the area before. Due to pest behavior variations from one species to the other, the appropriate response will vary accordingly.

Once the pest is identified and the source of activity is pin-pointed, the treatment policy will call for habitat modifications such as exclusion, repair or better sanitation. These counter measures can drastically minimize pest presence before chemical responses are considered. Additional treatment options—chemical and non-chemical can then be tailored to the biology and behavior of the target pest.

The final step in the pest response cycle is Monitoring. The information gained through on-going monitoring of the problem will facilitate determination of supplemental treatment options if required.

4.2.7 Establish communication protocols

Communication protocols must be developed to assist environmental services, facility maintenance, facility management and service providers. IPM is a cooperative effort and therefore effective communication between various parties is essential for success. PMP Committee and fish farmers must document pest sightings.

The PMP Committee will make recommendations and notify DFO for pesticide treatments. They will also communicate with the maintenance team to make the necessary repairs.

4.2.8 Develop fish farmer training plans and policies

The Fish Farmer Groups will serve as a pool of "inspectors" charged with reporting pest sightings to expedite response times and help limit the scope of new infestations. Training sessions will be conducted to acquaint farmers with IPM principles and their responsibilities for the success of the IPM program.

4.2.9 Track progress and reward success

Measurable objectives set at the beginning, must be measured against the IPM program's performance at least once a year. Documentation to facilitate the evaluation process is as follows:

a. Detailed description of the parameters and service protocols of the IPM program, stating the ground rules;

b. Specific locations where pest management work was performed;

c. Dates of service;

d. Activity descriptions, e.g., baiting, crack-and crevice treatment, trapping, structural repair; hygiene and

e. Log of any pesticide applications, including:

- Target pest(s);
- The brand names and active ingredients of any pesticides applied;
- PCB registration numbers of pesticides applied;
- Percentages of mix used in dilution;
- Volume of pesticides used expressed in kilograms of active ingredient;
- Applicator's name(s) and certification identity (copy of original certification and re-certification should be maintained);
- Facility floor plan on which all pest control devices mapped and numbered;
- Pest tracking logs (sightings and trap counts);
- Action plans, including structural and sanitation plans, to correct any pest problems;
- Pest sighting memos for IPM Committee to use in reporting pest presence to District Executive Committee (DEC); and
- Using these records, and the goals of the IPM program (increased efficacy, lower costs and reduced pesticide use), the IPM Committee must see:
    - Fewer pest sightings and farmer complaints;
    - Lower monitoring-station counts over time;

- Lower costs after the first 12-18 months, once IPM's efficacy advantage has had time to take effect; and
- Downward trend in volume or frequency of chemical pesticide usage
- Reduced pest infestations on the fishes

IPM is a team effort. Therefore, the PMP Committee will track and report the program's successes following each evaluation; and encourage good practices by recognizing farmers who played a role. Communicating the success of the program in reducing toxic chemical use and exposure, reducing pest complaints and lowering costs will help farmers to understand the purpose of the program and appreciate its success. The more they understand, the more likely they will participate willingly in helping expand and institutionalize the IPMP.

After the program has been in place for long enough to show significant results, it is recommended for the PMP Committee to work with DoF to publicize successes more broadly and to demonstrate the environmentally responsible approach to effective pest management and control. PMP Committee and DoF will lead theexample by sharing success with other stakeholders.

4.3 Principles Governing Selection of Pesticides

Selection of pesticides, under the BSCMFP project will be guided by the consideration of several pest management approaches for cultural, physical and biological measures before resorting to application of chemical pesticides.

The use of pesticides must be guided by the principles of cost efficiency, safety to humans, the bio-physical environment and effectiveness in controlling the pests. Pesticides selection will be made in accordance with the World Bank guidelines for the selection of pesticides (World Bank Operational Manual, Good Practice (GP) 4.03) as follows:

- Pesticides requiring special precautions should not be used if the requirements are not likely to be met;
- Pesticides to be selected from approved list, taking into consideration of: toxicity, persistence, user experience, local regulatory capabilities, type of formulation, proposed use, and available alternatives;
- Type and degree of hazard and availability of alternatives; and the following criteria will be used to restrict or disallow types of pesticides under Bank loans:
    a. **Toxicity**: acute mammalian toxicity, chronic health effects, environmental persistence and toxicity to non-target organisms;
    b. **Registration status** in the country and capability to evaluate long-term health and environmental impacts of pesticides.

4.4 Pesticides to be Acceptable to BSCMFP

The selection of pesticides to be acceptable under the project will be in line with(a) the World Bank Safeguard Policy OP 4.09 on pest management, and will depend on (b) the hazards and risks associated with pesticide use, and (c) the availability of newer and less hazardous products and techniques such as bio-pesticides.

In addition to the toxic characteristics of the pesticide, the hazards associated with pesticide use depend on how the pesticides are handled. Precautions to minimize environmental contamination and excess human exposure are needed at all stages from manufacture, packaging and labeling, transportation, and storage to actual use and final disposal of unused and contaminated containers.

The guidelines in Annex A provide internationally accepted standards on pesticides to minimize the hazards associated with pesticide use.

The use of pesticides under the project will also be guided by the FAO Publication on International Code of Conduct on the Distribution and Use of Pesticides 1991; *FAO Guidelines for the Packaging, Storage, Good Labeling Practice, Transportation and Disposal of Waste Pesticide and Pesticide Containers 1985*.

4.5 Pest Management Plan (PMP)

The Integrated Pest Management and Monitoring Plan (IPMP) is to be developed from the impacts and mitigation measures identified at the implementation stage based on the principles mentioned in this chapter and also the available techniques for aquaculture farms described in Chapter 3. The IPMP should include impacts from application of chemical as well as non-chemical pesticides. The reason why chemical pesticides are included is that in the initial stages of implementation of the IPM, chemical pesticides will still be used but will be gradually phased out as the IPM gets established.

When coming up with the IPMP, the following steps should be considered and documented:

- Identify the main pests affecting fishes in the region, assess the risks to the operation, and determine whether a strategy and capacity are in place to control them.
- Where possible, apply early-warning mechanisms for pests and diseases (i.e., pest and disease forecasting techniques).
- Select resistant varieties and use the cultural and biological control of pests, diseases, and weeds to minimize dependence on pesticide (chemical) control options. An effective IPM regime should:
    - Identify and assess pests, threshold levels, and control options (including those listed below), as well as risks associated with these control options.
    - Rotate crops to reduce the presence of insects, disease, or weeds in the soil or crop ecosystems.
    - Support beneficial bio-control organisms—such as insects, birds, mites, and microbial agents—to perform biological control of pests (e.g., by providing a favorable habitat, such as bushes for nesting sites and other original vegetation that can house pest predators and parasites).
    - Favor manual, mechanical weed control and/or selective weeding.
    - Consider using mechanical controls—such as traps, barriers, light, and sound to kill, relocate, or repel pests.
    - Use pesticides to complement these approaches, not replace them.
    - Prior to procuring any pesticide, assess the nature and degree of associated risks and effectiveness, taking into account the proposed use and the intended users.

The purpose of the IPMP is to ensure that the identified impacts related to application of pesticides are mitigated, controlled or eliminated through planned activities to be implemented throughout the project life. The IPMP also provides opportunities for the enhancement of positive impacts. The IPMP gives details of the mitigation measures to be implemented for the impacts; and the responsible institutions to implement them.

Implementation of the IPMP may be slightly modified to suit changes or emergencies that may occur on site at the time of project implementation. The plan therefore should be considered as the main framework that must be followed to ensure that the key potential negative impacts are kept minimal or under control.

In this regard, flexibility should be allowed to optimize the implementation of the IPMP for the best results in pest management. The IPMP consists of generic or typical environmental impacts that are

derived from the site investigations, public consultations and professional judgment. This is because the specific and detailed impacts cannot be predicted without details for the project design and construction activities as well as the specific project locations. The IPMP will however, provide guidance in the development of more detailed IPMP's, once the project design and construction details are known. Site specific Integrated Pest Management and monitoring plans will depend on the scope of identified major impacts to be addressed in the implementation of the BSCMFP. Presented in Table 4.1 below is a typical environmental management and monitoring plan, which should be updated during implementation of the BSCMFP.

4.6 Pest Monitoring Plan

Successful implementation of the BSCMFP Integrated Pest Management Plan in the project locations will require regular monitoring and evaluation of activities under taken by the farmers to be involved in the project. The focus of monitoring and evaluation will be to assess the build-up of IPM capacity among the fish farmers and the extent to which IPM techniques are being adopted in aquaculture production, and the economic benefits that farmers derive by adopting IPM. It is also crucial to evaluate the prevailing trends in the benefits of reducing pesticide distribution, application and misuse.

Indicators that require regular monitoring and evaluation during the programme implementation include the following:

1. Number of farmers engaged in IPM capacity building in the project locations
2. Number of farmers who have successfully received IPM training in IPM methods
3. Number of trainees practicing IPM according to the training instructions
4. Number of women as a percentage of total participating in IPM and successfully trained
5. Number of youth as a percentage of total participating in IPM and successfully trained
6. Number of farmers as a percentage of total applying IPM
7. Rate of IPM adoption (number of people as a percent of total) every year
8. Improvement in farm production due to adoption of IPM as a percent of production without IPM
9. Increase in farm revenue resulting from adoption of IPM practices, compared with revenue from conventional practices
10. Improvement in the health status of farmers
11. Extent to which crops and livestock are produced using chemical pesticides compared with total crop production
12. Efficiency of pesticide use and handling
13. Reduction in chemical pesticide poisoning and environmental contamination
14. Number of IPM participatory research project completed
15. Overall assessment of activities that are going according to IPMP; activities that need improvement; and remedial actions required

Table 4.1: Integrated Pest Management and Monitoring Plan.

Item No.	Potential Issues/ Concerns	Cause of Concern	Control/ Mitigation Measures	Responsible Person/ Institution and Cost per year per district (Tk.)	Standards/ Regulation	Monitoring Institution	Monitoring Frequency
1.	Increase in fish yield		Implement a long term IPM programme to sustain productivity and combat negative effects of chemical pesticides.	BSCMFP, participating institutions and farmers cost included in the IPMP overall cost	IPMP	PMP Committee lead by PD, BSCMFP	Semi-annually
2.	Soil degradation	Persistent use of chemical pesticides	Apply pond soil conditioning measures which include IPM Train farmers in proper handling and application of pesticides	Farmers	IPMP	PMP Committee lead by PD, BSCMFP, EMC	Quarterly
3.	Poisoning of non-target species including natural biological agents	Lack of knowledge of chemical pesticide potency Equipment malfunction Use of wrong type of equipment Wrong time and method of application (spraying)	Supervise and control use of chemical pesticides so that only approved and recommended ones are used Provide PM equipment Regularly maintain and clean equipment as recommended by supplier Dispose old equipment as recommended by manufacturer Provide recommended protective gear Use recommended and appropriate protective gear Conduct trainings in IPM	BSCMFP and participating farmers Cost: As estimated for capacity building	IPMP	PMP Committee lead by PD, BSCMFP, EMC, DoF	Quarterly
	Health and safety risks	Exposure to pesticides	Provide protective clothing and ensure it is used. Train farmers in proper pesticides handling. Routine medical examination	Agro-dealers, Transporters and Farmers	Labor regulations DoE regulations	Min. of Labor, DAE, DoF and PD, BSCMFP	Semi-annually

4.	Air pollution and contamination	Exposure of pesticides to air. Disposal of pesticides remains in the open Disposal of pesticides containers and equipment in the open air	Store pesticides in closed containers Dispose chemical remains according to supplier recommendations. Train farmers in appropriate spraying techniques to avoid chemicals being blown away by wind Train farmers to maintain spray equipment in efficient operational order	Pesticides Suppliers, Farmers	Pesticides and equipment manufacturer's recommendations. Air pollution standards.	DoE, BSCMFP	Quarterly
		Illegal disposal of pesticides	Prohibit disposal of pesticides wastes into open dumps where they will be blown away by wind	Agro-dealers AGCOM	EMC ECR of DoE	EMC, City/District authority, DoE	Half-yearly
5.	Pest resistance	Lack of appropriate knowledge in pesticides application	Train farmers on correct application of pesticides	Farmers, BSCMFP	Different Laws	BSCMFP	Half-yearly
6.	Reduced environmental and health risks		Initiate education programmes Establish demonstration plots to disseminate information on environmental and health benefits of biological control agents to the communities for them to appreciate the advantages	BSCMFP	EMC	MoEF, DoE, DoF	Half yearly

4.7 Estimated Costs for Pest Management and Monitoring

Estimated costs for managing and monitoring plan provided in Table 4.1 need to be developed during implementation period. A sample of cost estimation format is provided in Table 4.2.

It is assumed that some of the PMP measures will be part of the normal responsibility of the respective government ministries, agro-dealers, transporters, fish farmers and other relevant stakeholders, within their institutional mandates and budgets.

It is important to appreciate that some of the stakeholder institutions may not have sufficient capacity to manage environmental and social impacts of pesticides and to adequately monitor implementation of the enhancement and mitigation measures. Therefore, it is necessary to train them. The cost of training for the managing impacts is necessary to build it within the BSCMFP budget. The table also include costs for conducting awareness and sensitization campaigns on pesticides application, management and adoption of IPM in the project areas. Costs for setting-up, adoption and use of IPM by fish farmers are also necessary to consider. The costs for managing and monitoring various mitigation and enhancement measures indicated in Table 4.1 should be estimated for throughout the project period i.e. 5 years.

Table 4.2: Example Format of Management and Monitoring Costs of PMP.

Impact/Measures	Management Cost (BDT)	Monitoring Cost (BDT)
Provide PM equipment (sprayers)		
Provide recommended protective gear		
Pesticide inspection, sampling and testing		
Routine medical examination		
Rehabilitation of laboratories		
Construct pond, draining channels and draining dams.		
Disposal of chemical pesticides remains according to supplier recommendations		
Enforce regulation prohibiting importation of banned chemical pesticides		
Grand Total =		

4.8 Training and Capacity Building to Implement PMP Effectively

Training programs on various aspects of the pest and disease management and judicious use of chemical pesticides have to be organized by the BSCMFP for the members of the fish farmers groups, pesticides dealers and retailers. It would be the responsibility of the EMC to train the relevant staff in the BSCMFP. Resource persons from relevant projects of DAE, DLS and DoF should be enlisted well ahead of time, contacted beforehand and requested to prepare lecture notes keeping the educational and other qualifications of the trainee farmers in view. Training modules for pest management in ponds, hatcheries and nurseries should be developed. Following training programs will be provided under BSCMFP:

- Fish farmers' training
- Pesticides dealers' training
- Aquaculture extension personnel including BSCMFP staff training
- Local service providers training

4.8.1 Fish farmers' training

The goal of fish farmers' training is to strengthen safety of farmers and let them master skill on biological control of ordinary pest, strengthen the ability for economically and effectively controlling

pest, including: how to identify pest, how to adopt correct prevention and control measures and how to adopt appropriate prevention and control measures to the fish and shrimp farms.

Fish farmers should be trained up on various aspect of pond management, environmental bio-security, endo- and ecto- parasitism and their control measures. Training in dormitories is a more formal avenue of training which is often not popular with smallholder fish farmers who have various family and community obligations. It may be more appropriate for training of trainers (ToT).

Training on IPM would be conducted through "farmer to farmer" approach. For this, a group of core trainers among the Fish Farmer's Groups will be developed.

4.8.2 Pesticide Dealer's Training

An exact training program will be organized for the dealers/ retailers/ pharmacist of pesticides/ medicine to make them aware about toxicity of pesticides/ drugs and rules of use so that they can disseminate this information to the farmers. This is needed because, in practice, the dealers/retailers while selling pesticideshelpthefarmersinselectingtheappropriatepesticideforspecificinsector disease, give guidance to dose determination, dilution ratio, frequency of application, etc. Their training curricula may be prepared by actual experts in the fields of disease and insect control for crops, livestock and fisheries. The best practice, of course, would have been to give dealership/ retailership license to only those candidates having diplomas in crops, pharmacist for livestock and fisheries sectors.

4.8.3 Training of aquaculture extension personnel including BSCMFP staff

Training programs for grass root-level workers should be organized to improve their knowledge on PMP. The contents of training include:

e) Features of pests
f) Harm of all kinds of pests
g) The natural enemies of all kinds of pests
h) Method of field investigation
i) Prevention and control index
j) Control measures including IPM method; safely store, manage, and process pesticide wastes and packaging containers.
k) Using method and protection requirement of chemical pesticide

At the end of the training programs, a field day should be organized at the fish and shrimp farms to create awareness about IPM activities. Aquaculture extension personnel are very closer and core actors to fish farmers. They can help the farmers to boosting up the knowledge on parasitic problem and management aspect. Intensive pest management training should be effective along with training on pond management and extension.

4.8.4 Training of local service providers

Local service providers such as fish nutritionist, veterinarian, sub-technical staff, fish health practitioner, pharmacist, etc. are directly or indirectly involved in treating the fishes and fish ponds. Most of the cases proper selection, actual doses (avoid under/over dose), safety margin, toxic effect, withdrawal period, residual effect, etc. of anthelmintic can be maintain with the specific training of the personnel. Sometime agricultural pesticide or insecticide have been used for insect or arthropods control for aquaculture management, those are somewhat new arena for fish technical personnel, in this reason specific training on those chemicals use, toxic action, residual effect, contamination etc., should be highlighted in training module.

4.9 Awareness building

To initiate the promotion of IPM and sound pesticide use, will be effective by organize awareness program involving Fish Farmer's Groups and different stakeholders. Awareness will be raised through demonstrations, discussion meeting, dissemination of information about pest arrival, distribution of leaflet, booklet, etc.

4.9.1 Discussion meetings

Discussion meetings of the Fish Farmer's Groups among themselves on regular basis will help dissemination of the IPM techniques and their benefits and aware all farmers.

4.9.2 Demonstrations

Demonstration of the improved technologies has become one of the most effective strategies for dissemination of useful technologies to the fish farmers. Therefore, extreme care should be taken from the beginning to the end of conducting demonstration on various IPM techniques.

4.9.3 Dissemination information about pest arrival

Arrangements should be made to disseminate information on pests that pose a threat to fish and shrimps and public health especially at the beginning of the season. Additionally, information on control programs already in operation should also be made public in appropriate manner.

Annex A: Pest Management

When coming up with the IPMP, the following steps should be considered and documented:

- Identify the main pests affecting crops/ fishes/ shrimps in the region, assess the risks to the operation, and determine whether a strategy and capacity are in place to control them.
- Where possible, apply early-warning mechanisms for pests and diseases (i.e., pest and disease forecasting techniques).
- Select resistant varieties and use the cultural and biological control of pests, diseases, and weeds to minimize dependence on pesticide (chemical) control options. An effective IPM regime should:
    - Identify and assess pests, threshold levels, and control options (including those listed below), as well as risks associated with these control options.
    - Rotate crops to reduce the presence of insects, disease, or weeds in the soil or crop ecosystems.
    - Support beneficial bio-control organisms—such as insects, birds, mites, and microbial agents—to perform biological control of pests (e.g., by providing a favorable habitat, such as bushes for nesting sites and other original vegetation that can house pest predators and parasites).
    - Favor manual, mechanical weed control and/or selective weeding.
    - Consider using mechanical controls—such as traps, barriers, light, and sound—to kill, relocate, or repel pests.
    - Use pesticides to complement these approaches, not replace them.
    - Prior to procuring any pesticide, assess the nature and degree of associated risks and effectiveness, taking into account the proposed use and the intended users.

Pesticides Use and Management

Where pesticide use is warranted, in order to prevent, reduce, or control the potential contamination of soils, wildlife, groundwater, or surface water resources caused by accidental spills during the transfer, mixing, storage, and application of pesticides, they should be stored, handled, and applied in a manner consistent with the recommendations for hazardous materials management presented in the General EHS Guidelines.

A pesticide management plan (PMP) that includes procedures for the selection, procurement, storage, handling, and ultimate destruction of all out-of-date stocks should be prepared in accordance with FAO guidelines and should be consistent with country commitments under the Stockholm, Rotterdam, and Basel Conventions.

The PMP prescribes the type of pesticides to be used, as well as the purpose of their use, and outlines best practice for the procurement and storage of all pesticides. Personnel must have appropriate training—including certification, where relevant—to handle and apply pesticides safely. In particular:

- Ensure that any pesticides used are manufactured, formulated, packaged, labeled, handled, stored, disposed of, and applied according to the FAO's International Code of Conduct on Pesticide Management.
- Do not purchase, store, use, or trade pesticides that fall under the World Health Organization's (WHO) Recommended Classification of Pesticides by Hazard Classes 1a (extremely hazardous) and 1b (highly hazardous), or Annexes A and B of the Stockholm Convention.
- Do not use pesticides listed in WHO Hazard Class II (moderately hazardous), unless the project has appropriate controls established with respect to the manufacture, procurement, or distribution and/or use of these chemicals. These chemicals should not be accessible to personnel without proper training, equipment, and facilities in which to handle, store, apply, and dispose of these products properly.

- Preferentially, use selective pesticides with low environmental impact quotient (EIQ) where appropriate, rather than broad-spectrum products, to minimize impacts on non-target species.

Storage

Recommended pesticide storage practices include:

- Store all pesticides in a lockable, bundled container or store that has sufficient space in which to capture any spills without contaminating the environment. Stores should be set away from water sources, residential and built-up areas, as well as livestock and food storage areas.
- Procure spill kits and institute suitable control measures in case of accidental spillage.
- Store all pesticides in their original, labeled containers, and ensure that storage instructions are followed.
- Keep a register of all pesticides procured, recording when they were received, the amount used, the amount remaining in store, and their location.
- Keep SDS at appropriate locations in storage facilities.
- Warehouses must have appropriate ventilation, secondary containment, and emergency showers and kits.

Handling

- Operators must read, understand, and follow product label directions for safe mixing, application, and disposal; use trained personnel for critical operations (e.g., mixing, transfers, filling tanks, and application).
- Insist that correct PPE (e.g. gloves, overalls, eye protection) for each exposure route16 listed in the SDS be worn at all times when handling and applying pesticides.
- Mandate that any mixing and filling of pesticide tanks occur in a designated filling area.
- This should be set away from watercourses and drains.
- If on concrete, water should be collected in a separate sump and disposed of as a hazardous waste.
- Ensure that spills are cleaned up immediately using appropriate spill kits; spills should not be washed away into watercourses or drains.

Application

- Give preference to the application method with the lowest EHS risk and ensure non-target organisms are not affected.
- Select pesticide application technologies and practices designed to minimize off-site movement or run-off (e.g., low-drift nozzles, using the largest droplet size and lowest pressure that are suitable for the product).
- Establish buffer zones around watercourses, residential and built-up neighborhoods, as well as livestock and food storage areas.
- For the aerial application of pesticides, the boundaries of target areas should be clearly demarcated and all possible nearby communities, livestock, and rivers should be identified in the flight plan.
- The aerial application of pesticides should not be conducted where there is potential for contamination of organic or otherwise certifiable production.
- Ensure that all equipment is in good condition and properly calibrated to apply the correct dosage.
- Insist that applications occur under suitable weather conditions; avoid wet weather and windy conditions.

Disposal

- Any unused dilute pesticide that cannot be applied to the crop—along with rinse water, and out-of-date or no-longer approved pesticides—should be disposed of as a hazardous waste, as per FAO guidelines.
- Empty pesticide containers, foil seals, and lids should be triple rinsed, and washings used in the pesticide tank should be sprayed back onto the field or disposed of as hazardous waste in a manner consistent with FAO guidelines and according to the manufacturer's directions. Containers should be stored safely and securely under cover prior to their safe disposal; they should not be used for other purposes.