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**PROCEEDINGS OF REVIEW WORKSHOP
ON
AQUACULTURE TECHNOLOGY**

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1. INTRODUCTION

Aquaculture is considered to be one of the major components in farming system in Bangladesh because of the potential role it can play to combat protein malnutrition, employment generation, poverty alleviation and foreign exchange earnings. However, proper identification of the problems faced by the farmers as well as selection of appropriate technology and its transfer to the farmers is a must to make the aquaculture practices effective and sustainable. ICLARM (International Center for Living Aquatic Resources Management) in collaboration with different GOs and NGOs has been trying to develop sustainable aquaculture practices for the resource poor farmers of Bangladesh for more than a decade. Many of the farmers reported that they are becoming perplexed as different research and development organizations approach them with different recommendations for the same aquaculture technology.

In view of the above a workshop was organized jointly by ICLARM and BFRI on 25- 26 January 2000 at BFRI, Mymensingh as a routine task of the Sustainable Aquaculture Project of ICLARM to review the aquaculture technologies that are being developed and practiced by different research and extension organizations. The workshop was planned to rationalize the available aquaculture technologies and to develop a strategy for the research and development projects/organizations in Bangladesh.

2. OBJECTIVE

The broad objective of the workshop was to identify suitable, transferable and researchable low cost aquaculture technologies for accelerating fish production in Bangladesh. Specific objectives were as follows :

1. To determine the legitimacy of the recommendations based on research and practical experience ;
2. To seek agreement among various parties providing information to users of the information ;
and
3. To identify priority topics for further research.

3. WORKSHOP PLANS

Considering the above the workshop was organized with the following plans :

Focus : The focus was on fresh water aquaculture systems appropriate to the rural circumstances of Bangladesh. The biological and production aspects were the areas of major concern rather than the public policy or administration.

Participants : Both national and expatriate aquaculture scientists as well as experienced professionals involved in GOs, NGOs, universities and fisheries research institutes were the participants. List of participants is furnished in Appendix 1.

Output : The end product as an output of the workshop provided a set of guidelines for on-station/of-farm research and extension programs.

Organizational structure : In addition to a brief inaugural session, the workshop was organized into four technical sessions each was assigned with the responsibility of addressing some specific themes as outlined in the guidelines for that group. Participants were divided into 4 or 5 working groups to review and discuss the theme assigned to them and bring their recommendations back to a plenary session for presentation and further discussion for adoption. The workshop program is attached as Appendix 2 while guidelines for the working groups are provided in Appendix 3. What follows is a compilation of each session's recommendations.

4. INAUGURAL SESSION

The inaugural session was presided by Mr. D.K. Chowdhury, Joint Secretary, Ministry of Fisheries and Livestock, Government of the People's Republic of Bangladesh. Eminent Fishery Scientist and former Vice-Chancellor of the Bangladesh Agricultural University, Prof. Dr. A.K.M. Aminul Haque adorned the workshop as Chief Guest. Dr. M.A. Mazid, Director General, Bangladesh Fisheries Research Institute delivered the welcome address. Dr. Paul Thompson, Officer-in-Charge, ICLARM Bangladesh Office and Prof. Dr. John H. Grover, Senior Aquaculture Scientist and Project Leader, Development of Sustainable Aquaculture Project of ICLARM Bangladesh also addressed the inaugural session.

The Chief Guest, Prof. Dr. A.K.M. Aminul Haque in his speech gave a resume of the development of Fisheries Sector vis-à-vis Professional Fisheries Education and Research activities in Bangladesh. He stressed the need for the development of different technical packages for different aqua-ecological regions of the country as well as dissemination of uniform technical message to the end users by all the research, development and extension agencies. The Chairman, Mr. D.K. Chowdhury in his address reviewed the fisheries resources of Bangladesh and the potential role they can play in combating protein malnutrition, poverty alleviation, employment generation and foreign exchange earnings in Bangladesh. He further requested the professionals and scientists to play their due role for the development of the Fisheries sector. Dr. M.A. Mazid in his welcome address gave an overview of the fisheries research activities that are being carried out in Bangladesh and their resultant impact in increasing the fish production in Bangladesh. He emphasized the need for conducting further research to make the available fish production technologies suitable for more effective dissemination. Dr Paul Thompson in his address gave a brief outline of the role of aquaculture and open water fisheries management in fish production in Bangladesh. He requested the scientists to conduct research on community based fisheries management practices and on socio-economic aspects of the fisher folk along with biological research to make the fish production technologies sustainable. Prof. Dr. John H. Grover in his address mentioned that Bangladesh is blessed not only with vast and rich fisheries resources as well as excellent environmental conditions for conducting aquaculture activities almost round the year but also a group of compatible carp species which do not compete seriously with each other for food and space. They are responsive to minor management practices and are very suitable for polyculture. He stressed on the need to understand the fish production technologies, how they are working in the field ? and attached more emphasis on continuation of research programs to

address the field problems with a view to making the aqua cultural technologies suitable for different aqua-ecological regions of Bangladesh as well as for different categories of farmers. He further hoped that the Bangladeshi aqua culturists would adopt quickly the modern aquaculture technologies if uniform technical messages were delivered to them by different research and development organizations.

5. TECHNICAL SESSIONS

The different technical issues set for the workshop were discussed in four technical sessions by different groups of experts/scientists /researchers/development workers as follows :

5.1 Technical Session I : Induced Breeding and Hatchery Management

Chairman : William J. Collis
Reporters : A. N. Hasna Banu Hossain
Hasan Ahmmed Chowdhury
Chief Moderator : M. G. Hussain

5.1.1 Working Group 1 of Technical Session I

**Induced Breeding Technique
(Brood fish selection, ovulation, fertilization, incubation, etc.) and
role of hatcheries in fish seed production**

Moderator : Md. Anwar Hossain
Members : Md. Fazlul Awal Mollah, Gias Uddin Ahmed, Anwara Begum
Shelly, Md. Fazlul Huq, Md. Shamsul Islam, Md. Abdul Mannan
Mian, Md. Abul Hossain Miah and G.C. Halder

This group reviewed the prevailing induced breeding practices, the constraints encountered and recommended strategies for management of the constraints and for appropriate skill development.

GENERAL RECOMMENDATIONS

- Quality brood fish should be maintained to produce quality fish seed.
- Proper brood fish maintenance and their gentle handling are of course the major criteria for breeding success.
- In all the steps in hatchery operations, aseptic method is of prime importance to prevent infection and larval mortality.
- Iron free quality water should be used in hatchery operations.
- Unplanned/negative selection of brood fish for hypophysation should be avoided.
- Standard hormone doses as recommended by BFRI should be used to verify how much it reduces breeding mortality and larval deformity.
- Promulgation and proper implementation of a Code of Practice for fish hatchery establishment, operation and maintenance should be done to overcome the inbreeding problem and to make the hatchery operation sustainable.
- Private hatcheries should be registered with the DoF.

SPECIFIC RECOMMENDATIONS

Brood fish selection criteria

Milt oozing male of carps, barbs and catfishes, and females having smooth rounded abdomen, red swollen vent should be selected for breeding.

Suitable brood fish size (kg)

Catla >3.0, rohu/mrigal/common carp>2.0, grass carp/big head carp>3.0, silver barb>0.3, ghannya>0.5, bata/bhagan>0.15, pabda/gulsha/koi>0.06, pangus>3.0, local magur>0.07 and shingi>0.06 should be the suitable size for breeding.

Brood fish transportation and handling

For long distance transportation of brood fish in containers, the stocking density of fish should be @1.0kg/4 liters of water, the temperature of water should be lowered to 25°C. 0.1- 0.3% salt solution may be used as disinfectant. MS222 @ 0.1g/4 liters of water may be used to keep fish drowsy and gentle for subjecting them to less stress to achieve more success in spawning

Hatchery preparation and brood fish care

Brood fish tanks, buckets, brushes and other materials used in the hatchery should be disinfected with sodium hypo chloride, potassium permanganate, etc.

Water of brood holding tanks should be maintained at a suitable level with flow.

Aeration is of essential to minimize oxygen deficiency.

Males and females should be segregate M before hypophysation.

Brood fish should not keep in a crowded condition.

Hypophysation

Standard hormone dose and breeding protocol as recommended by BFRI should be followed.

Excessive dose should be avoided to prevent larval deformity and mortality

Spawning, Fertilization and Incubation

Ovulated eggs should be collected through stripping by pressing the gently from anterior to posterior direction. Milt should be added and mixed gently but thoroughly with dry bird feather in small batches adding 0.86% saline solution.

Cool and fresh water should be added slowly and gently for repeated washing of egg mass.

Eggs should be incubated in circular tank @500/l, in funnel @ 1000-5000/l, in jar @5000/l of water. Sufficient aeration should be provided for hatching success.

One chicken egg yolk should be provided to 100,000 larvae at 2-4 hour interval, frozen/live rotifers should be administered, if possible.

5.1.2 Working Group 2 of Technical Session I

Development of brood stock collected from natural sources

Moderator : Mahbubur Rahman Khan

Members : Begum Awari, Md Jahangir Alam and Md. Abdul Wahab

This group will assess the need for the collection and development of pure line brood stock from natural sources and suggested probable natural sources for the collection of brood stock of different species in Bangladesh. This group also recommended techniques for the collection and selection of brood fishes from different sources and methods of their handling and transportation.

RECOMMENDATIONS

Significance of brood fish collection

For the establishment of brood bank/gene bank from the best stock of the gene pool.

For quality seed production.

For stock improvement and for minimizing the chance of inbreeding.

Identification of natural sources

Brood stock of cultivable fish species should be collected from the Jamuna, the Brahmaputra, the Halda and the Arialkha rivers.

Techniques for brood fish collection

Spawn collection

Spawn can be collected during June-July and shifted carefully to stocked in nurseries for proper care and management

Juvenile collection

Juvenile should collected during September-January for the improvement of brood stock quality and BFRI should play the key role in maintaining improved brood stock of different cultivable species.

Evaluation of stocks collected from different rivers/sources should be undertaken. In addition to major rivers emphasis should be given to collect brood stocks from floodplains like Sylhet basin. Mechanism to be developed to differentiate brood stocks collected from different sources.

Long-term research intervention should be done to improve brood stock management techniques and to formulate breeding strategies to avoid genetic stock deterioration.

Efforts should be made to establish sanctuaries to protect natural habitat & breeding ground.

5.1.3 Working Group 3 of Technical Session I

Inbreeding, measures to avoid inbreeding and genetic deterioration of brood stock in hatcheries

Moderator : Md. Shahidul Islam
Members : Lutfun Hussain, Md. Akhtar Hossain Rana, Md. Naim Uddin, Alan Brooks, Md. Serajul Karim, Md. Kamal, Noor-e-Elahi, Saleh Uddin Ahmed, A.N. Hasna Banu and Nasiruddin Md. Humayun

This group assessed the extent of genetic deterioration, types of genetic deterioration, causes behind them and suggested remedial measures to overcome genetic deterioration.

RECOMMENDATIONS

Impacts and risks of genetic deterioration in hatchery population

Over 700 hatcheries in both public and private sectors presently contributing over 98% of the total spawn production in Bangladesh. Each hatchery has become a genetically closed unit because of using its own reared brood stock without recruiting individuals from outside that caused retarded growth, less reproduction performances deformities, incidence of diseases and mortalities of the spawn. Therefore, survival, growth, production of fish from ponds/flood plains, etc. are being affected adversely.

Measures to avoid inbreeding

Germplasm should be collected from natural sources (i.e. wild stock from rivers and other sources).

Pedigree records should be maintained following the proforma evolved by BFRI for natural and hatchery population and preserved separately or in pool by marking/ tagging.

Genetic selection protocol should be followed for best individuals at maturing stages for several generations.

At least 3000-5000 individuals of brood stock should be utilized for an ideal breeding program.

Culling of brood fish should be done when their reproductive performances start to deteriorate.

Exchange of brood stock should be done between/among hatcheries, growers and brood banks of GO's and NGOs.

A well-planned short and long-term selective breeding program should be undertaken for stock improvement.

Gene Bank should be established at BFRI and Brood Bank should be established by public and private sectors.

Genetically improved breeds (Foundation Seeds) should be distributed to private hatchery operators through GOs/NGOs.

Periodic regional workshops/training should be organized for private hatchery and nursery operators.

Genetic stock improvement program of BFRI should be expanded in collaboration with regional and international institutions.

Proper quarantine measures should be taken to allow introduction of any exotic fish genetic materials for research or development purposes.

5.1.4 Working Group 4 of Technical Session I

Brood stock management for quality seed production

Moderator : Md. Monzurul Haque
Members : Md. Nurullah, Masud Ahmed, Md. Sirajul Islam, M.C. Nandeesh, A.K.M. Ashraf-ul Alam and John H. Grover

This group reviewed the prevailing brood stock management practices and evaluated the quality of fish seed produced as a result of these management practices.

RECOMMENDATIONS

Diseases free healthy fishes that attain gonadal maturity should be used as brood fishes.

Age should be 2-3 years with body weight of 2-3 kg for rohu, mrigal and silver carp; 3-5 kg for catla and grass carp. Selection should be based on best performance with respect to growth, disease resistance capability and reproduction success. Genetically improved fish should be identified and selected.

Feeding up to satiation level should be done with diets complete with nutrients for gonadal development.

Extra effort to rush maturation process should be avoided.

Care should be taken to protect brood fishes from any type of stress through use of anesthetics, avoiding rough handling, acclimatize slowly to newer environments, etc.

Physical, chemical and biological conditions of the brood fish rearing tanks should be maintained at optimum levels.

Disease prevention and control measures should be taken.

5.2 Technical Session II : Nursery management and quality seed production

Chairman : Md. Fazlul Awal Mollah
Reporters : Md. Zaher
Md. Akhtar Hossain Rana
Chief Moderator : A. K. M. Ashraf-ul Alam

5.2.1 Working Group 1 of Technical Session II

Present practice of nursery operation (site selection, pond preparation, stocking density, post stocking management etc.) for finfish seed production

Moderator : Md. Abul Hossain Miah
Members : Md. Idris Miah, Gias Uddin Ahmed, Andras Woynarovich, Md. Abdul Khaleque, Shamsun Nahar, G.C. Halder and Md. Wajed Ali Shah

This group reviewed the prevailing nursery practices for carps and catfishes as well as the constraints encountered and suggested ways to overcome them.

RECOMMENDATIONS

Nursery preparation should be done through draining and drying of water rather than using any chemicals.

Lime should be applied judiciously depending on the soil and water quality and the rate of liming should be standardized.

Organic manure and inorganic fertilizers should be used to ensure production of sufficient natural food organisms in the nurseries. At the same time balanced feed supplemented with minerals and trace elements be formulated and administered for mass production of healthy fish seed.

Water quality parameters desirable for the nurseries should be determined and measures to be taken for proper water quality management should be followed.

BFRI model for one and two steps rearing of fry (to fingerling) may be adapted for wide scale dissemination.

Health condition of seed should be monitored every five days during nursery operation and techniques of health management practices should be adopted as a part of nursery operation.

Recommendations for better transportation of seed of carps and catfishes should be made available to the farmers in package form for pilot scale testing.

Techniques for concurrent and alternate fish seed raising and paddy cultivation should be made available to the farmers in package form for pilot scale testing.

5.2.2 Working Group 2 of Technical Session II

Present status of freshwater prawn nursery practices for quality seed production (pre-stocking, stocking and post-stocking management)

Moderator : Md. Wahed Ali Pramanik
Members : Md. Fazlul Awal Mollah, Saleh Uddin Ahmed, Md. Jahangir Alam,
A.N. Hasna Banu, Md. Anwar Hossain and Md. Akhtar Hossain

This group reviewed the present nursery practices of freshwater prawn (*Macrobrachium resenberglia* or *golda*) and the problems encountered by the nursery operators as well as suggested ways to overcome them.

RECOMMENDATIONS

Sites where there is demand for *golda* juveniles, PL and other production inputs are easily available, soil and water quality parameters as well as prevailing socio-economic conditions are favorable should be selected for the establishment of fresh water prawn nurseries.

Undesirable aquatic animals should be eliminated through dewatering or by using rotenone (60-100 g/dec/m of water depth). Biocides must not be used in prawn nursery preparation, it should be filled up with at least 3 feet of quality water to get rid of growth of undesirable aquatic weeds. Liming should be done @ 1-4 kg/dec (depending on soil pH)

Fertilization should be done as follows :

Cow dung @ 10 kg/dec + Urea and TSP (100-200 kg/dec).

Sources of PL

PLs should be collected from hatcheries. In case of collection from natural sources care should be taken to protect the stock from over exploitation and other aquatic lives from indiscriminate destruction.

Handling and transportation of PL

Stocking density should be 100-300 PL/L of water (in any container) without oxygenation with periodical partial water exchange while it should be 1000-1500 PL/L of water in oxygenated bags with ice for transportation for 24 hours.

Stocking Density

Stocking density should be 100-300/m² in hapas in pond, 750-1000/m² in cemented tanks with periodical water change, while 300-500/m² in earthen ponds.

Post stocking management

Feed

Farm made or commercial nursery feed having 35-40% protein content should be used in PL nursery.

Fertilization

25g urea + 50g TSP per dec should be used at weekly intervals depending on plankton growth.

Feeding Schedule

Supplemental feed should be administered two times daily at dawn and dusk at the rate following rate :

- 20 - 25% of body weight - 1st week
- 10 - 15% of body weight - next two weeks
- 10% of body weight - rest of the rearing period

Growth and health monitoring

Growth and health conditions should be monitored every week and daily respectively using the feeding tray. Quantity of supplemental feed to be administered should be adjusted on the basis of average body weight and the ability of the stocked individuals to consume the feed through daily monitoring of the feeding trays.

Harvesting and handling schedule of the seeds for marketing

Harvesting from hapa is not a problem but it is difficult to harvest all the juveniles from nursery ponds without dewatering the pond. Handling of shrimp seed during harvesting and marketing should be done by very carefully to avoid any injury.

Feasibility of using rice fields for nursing of shrimp PL/juveniles

Rice fields are very good nursery grounds for *golda* PL but recovery of shrimp juveniles from the rice field is unpredictable. Ways and means to increase the recovery should be developed through research.

5.2.3 Working Group 3 of Technical Session II

Problems/constraints in nursery operation, transportation and marketing and their remedies.

Moderator : Md. Abdul Mannan Mian
Members : William J. Collis, Md. Scrajul Islam, Md. Nuc-E-Elahi, Md. Mahbubur Rahman Khan, Begum Anwari and Md. Monzurul Haque

This group reviewed the constraints in nursery operation, transportation and marketing of fish and shrimp seed and suggested ways of overcoming them.

RECOMMENDATIONS

Fish spawn is available but its quality in many cases is a problem. Steps should be taken to ensure supply of quality fish spawn to the nursery operators. Access to *golda* PL is a problem in many areas, steps should be taken to make the *golda* PL available to the nursery operators.

Availability of feed ingredients especially animal protein supplement (fish meal), *Artemia* cysts, etc. is a problem. Steps should be taken to make the feed ingredients and formulated feed available at a reasonable price.

Both short-term and long-term research should be conducted to update and develop sustainable fish fry/fingerling and *golda* juvenile production technologies.

Comprehensive institutional credit systems should be introduced to encourage mass production of fish fry/fingerling and *golda* juveniles at all the potential areas.

Training should be provided to the nursery operators on conditioning and handling of fish and *golda* seeds for medium to long distance transportation.

Some essential materials/facilities like poly bags, gunny bags, oxygen cylinders, ice, aerators, water holding tanks (fiber glass), etc. should be provided to the small-scale nursery operators at a reasonable price.

Appropriate and cheap transportation materials/facilities should be developed for small-scale nurseries.

5.2.4 Working Group 4 of Technical Session II

Establishment of quality fish/shrimp seed bank, distribution and marketing

Moderator : Md. Lutfur Rahman

Members : A.K.M. Ashraf-ul Alam, Anwara Begum Shelly, Md. Serajul Karim, Nasiruddin Md. Humayun, Md. Shahidul Islam, John H. Grover and Hasan Ahmmed Chowdhury

This group assessed the necessity of establishment of fish/shrimp seed bank for availability of quality seed for aquaculture purposes.

RECOMMENDATIONS

Uncertain availability of quality fish spawn and *golda* in many areas necessitates the establishment of fingerling bank in some strategic areas.

Timely supply of stress free and quality fingerlings of different species at a reasonable price to the fish farmers could only be ensured through establishment and successful operation of fingerling banks in some potential areas.

For successful operation of the fingerling bank, strategic planning and continuous information flow with respect to demand, supply, timing, price, etc. are essential. Training for successful management of the fingerling bank should be provided to the GO, NGO and private entrepreneurs.

GOs will provide training to the NGO trainers and in turn they will train the private entrepreneurs.

GOs should be given the responsibility of certifying the seed quality on the basis of species, origin, age, disease resistance, genetic potential for growth and production, etc.

5.3 Technical Session III Aquaculture Practices for Small-scale Farming

Chairman : John H Grover
Reporters : Md. Jahangir Alam
Chief Moderator : Md. Serajul Karim

5.3.1 Working Group 1 : Aquaculture in seasonal water bodies

Moderator : Nasiruddin Md. Humayun
Members : Anwara Begum Shelly, Md. Mahbubur Rahman Khan, Begum Anwari, A.N. Hasna Banu and Md. Kabir Ekramul Haque

This group reviewed the present aquaculture practices in seasonal water bodies as well as the prospects and constraints to aquaculture practices in seasonal water bodies in Bangladesh.

RECOMMENDATIONS

The existing technological packages for seasonal water bodies should be evaluated and appropriate measures should be taken to develop sustainable aquaculture technological packages suitable for different aqua-ecological zones of Bangladesh.

Fast growing, disease resistant and compatible fish species with better market price should be selected for polyculture rather than monoculture. The fresh water prawn may be an important option.

Women particularly the poor and destitute should be given preference and engaged in production activities.

Production inputs like low cost indigenous feed ingredients, quality fingerlings of desired species and size should be made available at cheaper price.

Extension and training programs should be arranged for the operators.

Regular sharing of the experiences, problems and needs of the farmers should be done through strengthening of GO-NGO coordination at different levels.

Research should be undertaken on environment related aspects.

5.3.2 Working Group 2 of Technical Session III

Polyculture of carps/catfishes/shrimps in perennial ponds

Moderator : Md. Lutfur Rahman

Members : Alan Brooks, Shamsun Nahar Irene, M.G. Hussain, Saleh Uddin Ahmed,
Md. Monzurul Haque and Md. Anwar Hossain

This group reviewed the existing technical packages for polyculture of carps/catfishes/shrimps in perennial ponds as well as the constraints encountered during implementation of the technological packages and suggested remedial measures.

RECOMMENDATIONS

The existing BFRI/DoF carp polyculture technologies should be updated to suit different agro-ecological regions of Bangladesh.

For extension of carp-prawn polyculture system, supply of fingerlings/PL of prawn should be ensured.

More applied research on *Macrobrachium* backyard hatchery should be conducted to ensure supply of golda PL to the rural farmers.

Research on polyculture of shrimp with brackish water fin fishes should be conducted for standardizing stocking density, feed application and other management aspects.

GOs and NGOs should provide training in different geographic areas to fry traders, farmers and extension workers on different aspects of good quality fish seed production, handling, conditioning, marketing and stocking.

Diminishing availability of seed from nature, cost of live feed (especially *Artemia*) is the major constraints to mass supply of seeds of *Macrobrachium* and pangus. Steps should be taken to make the *Artemia* cysts available at a cheaper price.

On farm resources should be used efficiently to produce fish.

5.3.3 Working Group 3 of Technical Session III

Integrated aquaculture practices (rice cum fish culture, integrated poultry cum fish cultures and horticulture with fish)

Moderator : Md. Serajul Karim

Members : Md. Nur-E-Elahi, G.C. Halder, V.R.P.Sinha, Md. Serajul Islam and
Md. Wajed Ali Shah

This group overviewed the existing integrated aquaculture practices as well as their problems and prospects and suggested measures to improve them.

Identification of resource potentials

Ponds and ditches, paddy fields, roadside canals, irrigation canals and borrow-pits, wet lands and oxbow lakes, and selected floodplain areas are the potential resources for integrated aquaculture practices.

Review of technological packages

Technically and economically viable technologies

Rice-fish farming (concurrent and sequential) and integrated poultry (chicken and duck) – fish farming are the technically and economically viable existing integrated aquaculture technologies.

Technologies yet to be developed

Fish-vegetable/horticulture farming and fish-cattle farming.

Limitations

Lack of policy issues for government support and certain information gaps in technical, financial, social and ecological aspects.

Lack of effective coordination and feed back among GOs (Fisheries, Livestock and Agriculture) and NGOs at field level.

Timely availability of quality and cost-effective inputs (fish fingerlings, poultry birds, poultry feed, medicine, etc.).

Lack of operational skills of farmers in integrated farming.

Damage caused by calamities like floods, cyclones, social security, etc.

RECOMMENDATIONS

Development and dissemination of appropriate technology and farmer's motivation should be done through strengthening of extension services.

Government should intervene with appropriate policy and implementation strategy.

Flood prone areas should be avoided or measures taken to minimize damages from floods or cyclones.

Strategies

Appropriate technologies and inputs should be made available at end users level.

Integrated health management for fish-livestock farming should be ensured.

Integrated pest management for fish-horticulture/vegetable farming should be ensured.

Role of GOs and NGOs

Role of GOs and NGOs should be further strengthened as has been done for polyculture of carps and hatchery management.

GOs and NGOs should intensify their efforts for integrated farming technology dissemination.

Adoption of legal and social security

On the basis of policy research results, policy guidelines should be formulated for government intervention.

5.3.4 Working Group 4 of Technical Session III

Culture feasibility of commercially important small fish species

Moderator : M.A. Wahab
Members : A.K.M. Ashraf-ul Alam, Andras Woynarovich, Md. Abdul Khaleque, Md. Abdul Mannan Mian, Md. Abul Hossain Miah, Md. Shahidul Islam and Md. Akhtar Hossain Rana

This group assessed the present status of small indigenous fish species in Bangladesh and their culture feasibility. It also overviewed the existing technological packages and their limitations and suggested ways to overcome them. for govt. extension

RECOMMENDATIONS

To minimize the information gap on different aspects of the existing technological packages, the existing technologies should be reviewed and upgraded to include some of the desirable and complimentary SIS (small indigenous species) in polyculture of carps.

Technology should be perfected for mass production of SIS seeds.

Steps should be taken for proper dissemination of the technology of seed production, culture and management practices for SIS to the farmers. Suitable extension materials on carp-SIS culture technology should be developed for different categories of farmers.

Only harmful (e.g. *Chanda* spp.) and predatory species should be eradicated from the culture ponds during pond preparation.

Policy research should be initiated for developing guideline information for government and extension agents.

5.3.5 Working Group 5 of Technical Session III

Weed based aquaculture in ponds and rice fields

Moderator : Mohammad Zaher
Members : Anne Van Dany, Md. Abdul Khaleque, Md. Kamal, Md. Shahidul Islam and John H. Grover

This group reviewed the present status of weed based aquaculture in ponds and in rice fields in Bangladesh and the limitations of the present practices with a view to recommend appropriate remedial measures.

RECOMMENDATIONS

Use of "weeds" for aquaculture has interest because under utilized vegetation is accessible to the low income groups may be used as important inputs for fish production but the weed based technology is still in experimental state, attempts should be made to develop complete weed based aquaculture technology packages for different aqua-ecological regions through on farm trials.

Of the many possibilities, *Azolla* based carp polyculture appears to have the maximum potential.

Problems include lack of vegetation in the dry season, pond space for growing duck weed or *Azolla*, getting farmers to follow directions for on-farm trials need to be resolved.

5.4 Technical Session IV : Aquaculture technology transfer and socio-economic issues

Chairman : Md. Abdul Mazid

Chief Moderator : Md. Abdul Khaleque

5.4.1 Working Group 1 of Technical Session IV

Role of extension agencies (GO/NGO) in existing technology transfer system

Moderator : Begum Anwari

Members : Alan Brooks, Md. Mahbubur Rahman Khan , A.N. Hasna Banu and Md. Aminul Islam

This group reviewed the existing technology transfer systems and evaluated the technical messages perceived by the end users. It also made an attempt to identify the limitations of the existing technology transfer mechanisms and suggested ways and means to overcome them.

RECOMMENDATIONS

Role of extension agencies

Extension agencies should provide training, credit and important production inputs to ensure successful implementation and sustainability of the program.

The training may be in the form of awareness building, enhancement of the knowledge base, skill development and technology transfer.

Review of existing technology transfer mechanism

Present technology transfer mechanisms include residential training with or without follow-up, pond side method demonstration to large groups, result demonstration, farmers' fair and open days, farmer exchange programs and through mass media like Radio, TV, Newsletters, etc. One to one direct contact or motivational visit.

Limitations of existing technology transfer mechanism:

Inadequate funds and resources of the implementing agencies.

Insufficient in-service training of staff.

Low skill levels of AFOs and FAs working in DoF.

Low rate of perception of technical messages by the ill educated farmers.

Weak networking and information exchange among research, development and extension agencies.

Shortage of technically qualified and skilled manpower in most of the NGOs.

Ways and means to overcome the limitations

Appropriate farmer led technology and production strategies need to be developed.

Effective extension model (s) should be developed.

Improved linkage, networking and information exchange mechanism among agencies (extension and research), should be developed through holding of regular meetings, seminars, workshops, etc., and through using Fax, e-mail, internet, etc.

The present extension wing of DoF should be upgraded as a separate extension department/Division within DoF with sufficient funds, faculties, and professional staffs.

Subject matter specialist (SMS) from Livestock services, agriculture and water management need to be based at DoF HQ.

Mechanisms need to be developed to organize regular refreshers training courses for DoF staff.

NGOs should recruit more technically qualified staff and maintain effective linkages with public fisheries R & D agencies.

5.4.2 Working Group 2 of Technical Session IV

Transfer of aquaculture technologies through farming systems

Moderator : Md. Noor-E-Elahi

Members : Md. Lutfur Rahman, Md. Ataur Rahman, Shamsun Nahar Irene, M.G. Hussain, Saleh Uddin Ahmed, Md. Kabir Ekramul Haque, Md. Anwar Hossain and Hasan Ahmmed Chowdhury

This group reviewed the existing technology transfer techniques through farming systems, their problems and prospects and suggested measures to overcome them.

RECOMMENDATIONS

Background of existing farming system

Existing farming system in Bangladesh is integrated. Crop sub-component is dominating as a whole but fish has been emerging as an important component as it has been identified as the simplest way of generating income in the entire farming community.

Components of farming system

The major components are crops, fisheries, livestock, agro-forestry in the crop fields and in the homestead.

Role of components

Income generation, creation of employment opportunities, poverty alleviation, food security, etc. All components are complementary each other.

Methods

Farmers' needs should be assessed through PRA and priorities should be fixed through participatory approach.

Farmers should have orientation about their real resources/potentials and needs through training and field demonstration.

Technology should be made available at the farmer's level.

Available technologies should be improved further getting feedback from the farmers about the problems in implementing them and the technologies after modification should be taken back to the farmer for field trial.

Farmers rally should be organized to demonstrate the results obtained through adoption of the new technology.

Training to the extension people (GOs/NGOs) should be organized to strengthen their capacity.

Limitations and remedial measures of the technology transfer methods

Lack of coordination among the extension agencies at grass root level is the major limitation, mechanisms should be developed for strengthening the coordination of technology transfer.

The communication and language to the farmer should be very simple and in farmers language.

Technology transfer in the existing methodology emphasizes only on a component of whole integrates system, more integrated approach should be made to maximize

exploitation of the resources. Necessary research works should be undertaken to address them.

Role of GOs/NGOs for aquaculture technology transfer

Coordination between GOs/NGOs should be strengthened for implementation of the FSR technology package.

More training should be given to the NGOs on FSR technologies for capacity build up as NGOs have greater network in the country.

Fishery/livestock extension services should be expanded like the crop sub-sector.

Regular national workshops with GOs/NGOs should be held on FSR (fisheries) on the latest technologies developed by different research and development agencies.

Trainers should be developed locally to train farmers on the FSR technology particularly on fish component for sustainable aquaculture practices.

5.4.3 Working Group 3 of Technical Session IV

Socio-economic improvement through transfer of aquaculture technology

Moderator : Anwara Begum Shelly

Members : Md. Serajul Karim, Md. Kamal, G.C. Halder, Muhammad Zaher and Md. Wajed Ali Shah

This group reviewed the socio-economic improvements that have taken place through the transfer of aquaculture technologies to the resource poor farmers as well as their problems and prospects.

RECOMMENDATIONS

Polyculture of carps in seasonal and perennial ponds, integrated rice-fish/vegetable/poultry farming, pen and cage culture and fish seed production technologies are the technologies that improved the socio-economic conditions of the rural poor farmers should be promoted.

Through assessment and reports of GOs and NGOs, socio-economic impact of aquaculture has been reported and has been reflected in the government policy .

The major impact of aquaculture technology transfer has been reflected in the form of socio-economic upliftment of the people engaged in the activities, improvement of their nutritional status, accelerated status of their health management and child education, increase in off-farm income, etc.

Participatory on-farm adaptive research and technology demonstration, motivation and training, and involvement of women in the technology transfer programs and research will help the technology transfer process.

5.4.4 Working Group 4 of Technical Session IV

Socio-economic impact of small-scale aquaculture system

Moderator : Md. Serajul Islam
Members : Andras Woynarovich, Md. Abdul Mannan Mian, Nasiruddin Md. Humayun, Ramesh Chandra Mondal, V.R.P. Sinha and Md. Akhtar Hossain Rana

This group has made an attempt to define the small scale aquaculture system and reviewed the socio-economic impacts of small scale aquaculture system in Bangladesh.

RECOMMENDATIONS

Small-scale aquaculture should be viewed more as a subsistence level activities, dependant by and large on institutional support, but with a potential to become entrepreneur in course of time.

To measure the impact of small-scale aquaculture, a few case studies should be done on small scale aquaculture projects already implemented and analyze the impacts compared to the set objectives. It is important to identify quantifiable indicators and parameters to assess the impact of small-scale aquaculture. In depth studies need to be made to assess the role and contribution made by small-scale aquaculture systems (on the basis of project completed) in terms of involvement of women, food security, nutritional security and employment generation to small fishermen and farmers.

On the basis of results of the above studies, the specific system of small aquaculture should be identified to give the maximum socio-economic benefits to the rural poor.

5.4.5 Working Group 5 of Technical Session IV

Future strategies for aquaculture technology development and transfer through GO/NGO extension agencies

Moderator : M C Nandeesha
Members : Anne Van Dam, Md. Abdul Khaleque, Md. Abul Hossain Miah, Md. Abdul Wahab, Saleh Uddin Ahmed, Md. Monzurul Haque, Md. Wahed Ali Pramanik, Md. Shahidul Islam and John H. Grover

This group reviewed the existing process of aquaculture technology development and transfer through GO/NGO agencies and suggested future strategies for the development of sustainable aquaculture technology and transfer mechanisms.

RECOMMENDATIONS

Social scientists should be given the responsibility of conducting social research with adequate funding and coordination with aquaculture scientists. Socio-economic division of BFRI should be strengthened with skilled manpower and facilities to take the leadership.

Technical people (aqua culturists) should have a clear understanding of the social issues in aquaculture technology transfer. Beneficiaries need to be involved in identification and evaluation of research needs in aquaculture technology development and dissemination.

The role of NGOs in TT process should be recognized but motives and capabilities of some of the NGOs are not always positive.

Community organizations should be strengthened as they have the promise to facilitate technology assimilation and generation.

Coordination within and between institutions needs to be strengthened.

Adequate incentives and opportunities should be given to ensure quality human resources with specific reference to women for technology transfer.

Aquaculture subjects (social and biological technology) should be included in basic school curricula.

Political advocacy is needed for changes in policy and support.

SUMMARY RECOMMENDATIONS

Small scale aquaculture should be viewed as a subsistence level activity, dependant by and large on institutional support, but with a potential to become entrepreneur in course of time. Specific systems of small aquaculture should be identified to give the maximum socio-economic benefit to the rural poor.

Both short term and long term research should be conducted to update and develop sustainable fish fry/fingerling and *golda* juvenile production technologies in ponds and in paddy fields. Fingerling banks should be established at potential locations to ensure availability of quality fish seed.

Recommendations for better handling, conditioning and transportation of seeds of carps and cat fishes for short and long distance transportation should be made available to the nursery operators as well as fry and fingerling traders to minimize loss during transportation.

The existing aquaculture technology packages for perennial and seasonal water bodies as well as for paddy and taro plots should be evaluated and appropriate measures should be taken to make them suitable for different aqua-ecological regions of Bangladesh. Steps should be taken to develop weed based technological packages. At the time of developing aquaculture packages, due considerations should be given to environment related aspects.

Fast growing disease resistant fish species with better market performance should be selected for polyculture of compatible species rather than monoculture. The fresh water prawn (*golda*) may be an important option. Compatible SIS may also be included in carp polyculture models.

A well planned short and long term selective breeding program should be undertaken for stock improvement. Gene bank should be established at BFRI and Brood Banks should be established by private sectors. Genetically improved breeds (foundation seeds) should be distributed to private hatchery operators through GOs and NGOs.

Social awareness of the people engaged in hatchery industries should be build up to arrest genetic deterioration of stocks through inbreeding.

Promulgation and proper implementation of a Code of Practice for the fish hatchery establishment, management and maintenance should be done to overcome the inbreeding problem and to make the hatchery operation sustainable.

Women, particularly the poor and destitute should be given preference and engaged in aquaculture production activities.

Fish production inputs like hormones, piscicides, feed ingredients, quality fingerlings of desired species and size, and small aqua cultural implements should be made available at a reasonable price.

Periodic regional workshops/trainings should be organized for private hatchery and nursery operators to up date their knowledge base and to enhance their professional skill and efficiency.

Regular sharing of experiences, problems and needs of the farmers should be done through strengthening of GO-NGO coordination at different levels.

Comprehensive institutional credit system should be introduced to encourage mass production of fish fry/fingerlings and *golda* juveniles as well as fish production through aquaculture at all the potential areas.

Proper quarantine measures should be taken to allow introduction of any exotic fish genetic material for research or for development and production purposes.

CONCLUSION

Appreciation was expressed to all that participated in this workshop. The recommendations presented by the different working groups need to be given due consideration in planning future research priorities. In many cases the recommendations were not as specific as it was originally hoped. However, there was a common consensus among all the working groups that there is a need for better communication and strategic planning for making the aquaculture research activities more effective and sustainable.

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Program for Aquaculture Technology Review Workshop

Organized by BFRI and ICLARM, Dhaka

25-26 January 2000

Venue: BFRI, Mymensingh

Day 1: 25 January 2000

<i>Hour</i>	<i>Topic</i>	<i>Resource person</i>
09:00 hrs	Registration	Ms. Zebun Nahar, BFRI Ms. Sayeda Sultana, BFRI
Inaugural session		
9:30 hrs	Tilwat-e-Quaran	Imam, BFRI Mosque
9:30 hrs	Welcome address	Dr. M. A. Mazid Director General, BFRI
9:45 hrs	Address by	Prof. John H. Grover Senior Aquaculture Scientist and Project Leader, IAASP, ICLARM
9:50 hrs	Address by	Dr. Paul Thompson Officer-in-Charge, ICLARM
9:55 hrs	Address by Chief Guest	Prof. Dr. A.K.M. Aminul Haque Former Vice-Chancellor Bangladesh Agriculture University, Mymensingh
10:10 hrs	Address by Chairman	Mr. D. K. Chowdhury Joint Secretary, MOL
10:20 hrs	Tea break	

Day 1: 25 January 2000

<i>Hour</i>	<i>Topic</i>	<i>Resource person</i>
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Technical session I : Induced Breeding and Hatchery Management

Chairman : Mr. William J. Collis, Team Leader, MACH Project

Reporter : Dr. A.N. Hasna Banu Hossain, SSO, BFRI
Mr. Hasan Ahmed Chowdhury, ICLARM

Chief Moderator: Dr. M. G. Hossain, CSO, BFRI

10:45 hrs Briefing and working group formation: Prof. Dr. Md. Aminul Islam, ICLARM

11:00-12:15 *Group discussion*

Working Group 1 : Induced breeding technique (Brood fish selection, maturation, incubation, fertilization etc.) and role of hatcheries in fish seed production

Moderator : Mr. Anwar Hossain, SO, FS, BFRI

Working Group 2 : Development of brood stock collected from natural sources
Moderator : Mr. Mahbubur Rahman Khan, PD, DoF

Working Group 3 : Inbreeding measures to avoid inbreeding and genetic deterioration of brood stock in hatcheries

Moderator : Mr. Md. Shahidul Islam, SO, FS, BFRI

Working Group 4 : Brood stock management for quality seed production
Moderator : Dr. Md. Monzurul Haque, SO, FS, BFRI

12:15-12:30 hrs Presentation of recommendations from working group 1, 2, 3 and 4 by Chief Moderator

12:30-13:00 hrs Open discussion by the participants

13:00-13:15 hrs Chairman's remarks and close of Technical Session I.

13:15-14:00 hrs Break for lunch and prayer

Day 1: 25 January 2000

Technical Session II : Nursery Management and Quality Seed Production

Chairman : Prof. Dr. Fazlul Awal Mollah, Dean, Faculty of Fisheries, BAU
Reporter : Mr. Md. Zaher, PSO, FS, BFRI
Chief moderator : Mr. Akhter Hossain Rana, ICLARM
 Mr. A.K.M. Ashraf-ul Alam, UNICEF, Dhaka

14:00-14:15 hrs Briefing and working group formation : Prof. Dr. Md. Aminul Islam, ICLARM

<i>Hour</i>	<i>Topic</i>	<i>Resource person</i>
14:15-15:35		<i>Group discussion</i>
	Working Group 1 :	Present practice of nursery operation (site selection, pond preparation, stocking density, post-stocking management etc.) for fish seed production
	Moderator :	Mr. Md. Abul Hossain, FM, FSMF, DoF
	Working Group 2 :	Present status of freshwater shrimp nursery practices for quality seed production (pre-stocking, post-stocking management)
	Moderator :	Mr. Md. Wahed Ali Pramanik, DD, BFRI
	Working Group 3 :	Problem/constraints in nursery operation, transportation and marketing and their remedies.
	Moderator :	Mr. Abdul Mannan, DFO, DoF, Gazipur
	Working Group 4 :	Establishment of quality fish/shrimp seed bank, distribution and marketing
	Moderator :	Mr. Md. Lutfur Rahman, DFO, DoF, Mymensingh
15:35-15:50 hrs	Tea break	
15:50-16:10 hrs	Presentation of recommendations from working group 1, 2, 3 and 4 by Chief Moderator	
16:10-16:50 hrs	Open discussion by the participants	
16:50-17:00 hrs	Chairman's remarks and close of Technical Session II	

Day 2: January 26, 2000

APPENDIX 2

Hour *Topic* *Resource person*

Technical Session IV : Aquaculture Technology Transfer and Socio-economic Issues

Chairman : **Dr. M.A Mazid, Director General, BFRI**
Rapporteur : **Dr. Wajed A. Shah, ICLARM**
Chief Moderator : **Mr. M. A. Khaleque, PD, MAEP**

14:00-14:10 hrs Briefing and working group formation : Prof. Dr. Md. Aminul Islam, ICLARM

14:15-15:20 hrs *Group discussion*

Working Group-1 : **Role of Extension Agencies (GO/NGO) in existing aquaculture technology transfer system**
Moderator : **Begum Anwari, Asstt. Director, DoF**
Working Group-2 : **Transfer of aquaculture technologies through farming system**
Moderator : **Dr. Md. Noor-e-Elahi, CSO & Head. FSR, BFRI**
Working Group-3 : **Socio-economic improvement through transfer of aquaculture technologies**
Moderator : **Ms. Anwara Begum Shelly, Caritas**
Working Group-4 : **Socio-economic impact of small-scale aquaculture system**
Moderator : **Prof. Dr. Serajul Islam, Local Consultant, ARMP, BFRI**
Working Group-5 : **Future strategies for aquaculture technology development and transfer through GO/NGO extension agencies**
Moderator : **Dr. M.C. Nandeesha, CARE**

15:20-15:30 hrs Tea break

15:30-16:00 hrs Presentation of recommendations from working group 1, 2, 3, 4, and 5 by Chief Moderator

16:00-16:40 hrs Open discussion by the participants

16:40-17:00 hrs Chairman's remarks and close to Technical Session IV

17:00-17:10 hrs Concluding remarks : **Prof. John H. Grover, ICLARM**

17:10-17:15 hrs Vote of thanks : **Dr. M. G. Hussain, CSO, BFRI**

GUIDELINES FOR WORKING GROUP SESSIONS

5.1.1 Working Group 1 of Technical Session I

Induced Breeding Technique (Brood fish selection, ovulation, fertilization, incubation etc.) and role of hatcheries in fish seed production

This group will review the prevailing induced breeding practices, the constraints encountered and formulate strategies for the management of the constraints and for appropriate skill development. This group will specifically address the following :

- Criteria followed for the selection of brood fish for induced breeding,
- Hormone schedule followed to ovulate different species of carps and catfishes,
- Techniques followed to fertilize the eggs released by the females, and
- Techniques of incubation of the fertilized eggs : stocking density of the fertilized eggs, water flow, aeration, disinfection and hatchery hygiene, feeding of hatchlings, hatchling collection, packaging, handling and transportation.
- Techniques of incubation of the fertilized eggs: stocking density of the fertilized eggs, water flow, aeration, disinfection and hatchery hygiene, feeding of hatchlings, hatchling collection, packaging, handling and transportation

5.1.2 Working Group 2 of Technical Session I

Development of brood stock collected from natural sources

This group will assess the need for the collection and development of pure line brood stock from natural sources. More specifically the group will address the following :

- Significance of the collection of brood stock from natural sources.
- Identification of the probable natural sources for the collection of brood stock of different species.
- Techniques for the collection and selection of brood fishes from natural sources, methods of their handling and transportation. and
- Regional brood stock exchange for improvement of brood stock quality.

5.1.3 Working Group 3 of Technical Session I

Inbreeding, measures to avoid inbreeding and genetic deterioration of brood stock in hatcheries

This group will assess the extent of genetic deterioration, types of genetic deterioration, causes behind them and suggest remedial measures to overcome genetic deterioration. The group will specifically address the following :

- What are the impacts and risks of genetic deterioration in fish seed industry and aquaculture?
- How do the impacts/risks influence investment and management decision?
- What can realistically be done about them and how can the risks be minimized?
- What intervention/management strategies are appropriate?
- What follow up actions are required at different levels/organizations (GO/NGO/private sector) at national and international levels to overcome the genetic deterioration.

5.1.4 Working Group 4 of Technical Session I

Brood stock management for quality seed production

This group will review the prevailing brood stock management practices and evaluate the quality of fish seed produced as a result of these management practices. More specifically the group will address the following:

- Brood fish rearing techniques - pond selection, pond preparation, water supply, stocking density, management of water quality parameters, feeding schedule and health care practices.
- Techniques of pre-maturation hormone selection and hormone administration.
- Techniques of selection of mature brood fishes for induced breeding, their handling and transportation to hatchery.
- Techniques of conditioning of brood fishes for induced breeding.
- Techniques of recruitment and maintenance of viable brood stock for efficient breeding purposes.

5.2 Technical Session II : Nursery management and quality seed production

5.2.1 Working Group 1 of Technical Session II

Present practice of nursery operation (site selection, pond preparation, stocking density, post stocking management, etc.) for fin fish seed production

This group will review the prevailing nursery practices for carps and catfishes as well as the constraints encountered, and suggest ways to overcome them. Specifically the group will address the following :

- Factors to be considered for site selection for the establishment of nursery for carps and catfishes.
- Biocides used, their doses and adverse effects. if any.
- Liming dose and method of application.
- Techniques of pre-stocking manuring and inorganic fertilizer application.
- Water supply and water quality monitoring techniques.
- Stocking of spawn, fry and fingerling for one step and two step rearing - stocking composition and stocking density.
- Post stocking management - feeding schedule, fertilization schedule, growth and health condition monitoring.
- Hardening of fish fingerling for marketing.
- Feasibility of using paddy fields for nursing of fish spawn and fingerlings - prospects and constraints of using rice fields for nursing of fish seed.

5.2.2 Working Group 2 of Technical Session II

Present status of freshwater shrimp nursery practices for quality seed production (pre-stocking, stocking and post-stocking management)

This group will review the present nursery practices of freshwater shrimp and the problems encountered by the nursery operators as well as suggest ways to overcome them. The group will specifically address the following :

- Factors to be considered for site selection for the establishment of freshwater prawn nursery.
- Methodology to eliminate undesirable aquatic weeds and predatory aquatic animals from prawn nurseries.
- Effect of biocide application in prawn nurseries.
- Pond preparation procedure - liming, pond fertilization, erection of shelters for PL and juveniles, water supply and water quality monitoring.
- Sources of PL, collection, handling and transportation techniques.
- Stocking density and species composition of PL and carp seeds for rearing.
- Post-stocking management - feed formulation, fertilizer and feeding schedule, growth and health monitoring.
- Harvesting and handling of shrimp seed for marketing.
- Feasibility of using rice fields for nursing of shrimp PL/juveniles - prospects and constraints, and ways of overcoming the problems, if any.

5.2.3 Working Group 3 of Technical Session II

Problems/constraints in nursery operation, transportation and marketing and their remedies.

This group will review the constraints in nursery operation, transportation and marketing of fish and shrimp seed as well as suggest ways of overcoming them. The group will specifically address the following :

- Enumerate the constraints faced by the nursery operators in case of carps, freshwater prawn and catfishes - quality seed, feed, chemicals and farm equipment.
- Availability and dissemination of appropriate nursery management technology.
- Materials used in packaging of seeds - constraints and suggestions for improvement.
- Transportation methods and techniques - constraints and suggestions for improvement.
- Present marketing systems - their constraints and suggestions for improvement

5.2.4 Working Group 4 of Technical Session II

Establishment of quality fish/shrimp seed bank, distribution and marketing

This group will assess the necessity of establishment of fish/shrimp seed bank for availability of quality seed for aquaculture purposes. Specifically the group will address the following :

- Enumerate the reasons behind short fall of quality fingerlings of carps and catfishes and juveniles of freshwater shrimp.
- Necessity of establishment of fingerling bank.
- Problems in establishment of fingerling bank and suggestions to overcome the problems.
- Role of establishment of fingerling bank in rural aquaculture.
- Role of GO, NGO's and private entrepreneurs in establishing marketing linkage between fingerling bank operators and fish farmers.
- Assess the institutional support (technical and financial) needed for the establishment of sustainable fingerling banks.

5.3 Technical Session III Aquaculture Practices for Small-scale Farming

5.3.1 Working Group 1 of Technical Session III

Aquaculture in seasonal water bodies

This group will review the present aquaculture practices in seasonal water bodies, the prospects and constraints to aquaculture practices in seasonal water bodies in Bangladesh. This group will particularly concentrates on the following :

- Review the available technical packages for the seasonal water bodies - pre stocking, stocking and post-stocking management practices.
- The advantages and disadvantages of the existing technical packages.
- Identification of the seasonal water resources, assessment of their biological productivity and selection of appropriate low cost and environment friendly technical packages for them.
- Recommend ways and means to enhance biological productivity of the seasonal water bodies.
- Role of GOs and NGOs to provide institutional support needed for the development and dissemination of low cost aquaculture technologies.
- Recommend future strategies for the development and transfer of sustainable aquaculture technologies for seasonal water bodies.

5.3.2 Working Group 2 of Technical Session-III

Polyculture of carps/catfishes/shrimps in perennial ponds

This group will review the existing technical packages for polyculture of carps/catfishes/shrimps in perennial ponds as well as the constraints encountered during implementation of the technical packages and will suggest remedial measures. Particularly this group will concentrate on the following :

APPENDIX 3

- Overview the technical packages that are in practice for the polyculture of carps/catfishes/shrimps in the perennial ponds in Bangladesh.
- Identify the limitations of the existing technical packages - technical, financial, social, input availability, transportation and marketing facilities.
- Recommend ways and means to overcome the stated limitations, strategies for the development, and transfer of sustainable aquaculture practices for perennial water bodies
- Role of NGOs and GOs to provide institutional support for the development and dissemination of low cost aquaculture technologies for perennial water bodies.
- Adoption of the legal policies for the protection and conservation of aquaculture industries.
- Adoption of social security measures to safeguard the interests of fish farmers.

5.3.3 Working Group 3 of Technical Session III

Integrated aquaculture practices (rice cum fish culture, integrated poultry cum fish cultures and horticulture with fish)

This group will overview the existing integrated aquaculture practices as well as their problems and prospects and suggest measures to improve them. This group is expected to concentrate on the following :

- Identify the resource potential for integrated farming in Bangladesh.
- Review the existing technical packages and their production economics.
- Identify the limitations of the existing technical packages - technical, financial, social, input supply, ecological appropriateness, etc.
- Recommendation of ways and means to overcome the above limitations.
- Formulate strategies for the development of sustainable integrated farming technologies.
- Role of NGOs and GOs to provide institutional support for the development and dissemination of sustainable integrated farming practices.
- Adoption of legal and social security measures to safeguard the interests of the integrated farmers.

5.3.4 Working Group 4 of Technical Session III

Culture feasibility of commercially important small fish species

This group will assess the present status of small indigenous fish species in Bangladesh and explore their culture feasibility. More particularly this group will concentrate on the following :

- Identify the small indigenous fish species that are suitable for aquaculture in Bangladesh.
- Overview the technical packages that are in practice for monoculture and polyculture of SIS as well as their composite culture with other fishes or shrimps.
- Identify the limitations of the existing technical packages - technical, financial, social, availability of inputs (seed, feed, manure, etc.), harvesting, handling and preservation and marketing.
- Recommend ways and means to overcome the limitations.
- Suggest strategies for the development and transfer of sustainable SIS culture technologies.

5.3.5 Working Group 5 of Technical Session III

Weed based aquaculture in ponds and rice fields

This group will review the present status of weed based aquaculture in ponds and rice fields in Bangladesh and will identify the limitations of the present practices with a view to recommend appropriate remedial measures. This group will particularly concentrate on the following :

- Enumerate the significance of weed based system for the development of low cost environment friendly sustainable aquaculture practices.
- Identify the resource potentials for weed based aquaculture in ponds and in rice fields.
- Review the existing technical packages and their production economics.
- Identify the limitations of the existing packages specially *Azolla* based, duck weed based and external weed based practices - technical, social, input availability, appropriate aqua-ecological conditions, etc.
- Recommend ways and means to overcome the above limitations.
- Suggest strategies for the development and transfer of technologies for the sustainable production of *Azolla* and duck weed vis-a-vis weed based aquaculture technologies for ponds and rice fields.

5.4 Technical Session IV : Aquaculture technology transfer and socio-economic issues

5.4.1 Working Group 1 of Technical Session IV

Role of extension agencies (GO/NGO) in existing technology transfer system

This group will review the existing technology transfer systems and evaluate the technical messages perceived by the end users. More specifically they will concentrate on the following :

- Enumerate the role of extension agencies (GOs/NGOs) in transfer of aquaculture technologies.
- Review the existing technology transfer mechanism of the GOs and NGOs in Bangladesh.
- Identify the limitations of the existing technology transfer mechanisms and the causes behind them.
- Suggest ways and means to overcome the above limitations.
- Role of GOs and NGOs to provide institutional support needed for the transfer of aquaculture technologies and for establishment of linkages among the technology developing institutions, extension agencies and end users.
- Recommend follow up action/s needed by GOs/NGO/private sectors at national, regional and international levels including capacity building, policy development, research, etc.

5.4.2 Working Group 2 of Technical Session IV

Transfer of aquaculture technologies through farming systems

This group will review the existing technology transfer techniques through farming systems and evaluate their problems and prospects. The group is requested to concentrate specifically on the followings :

- Overview the existing farming systems and identify the different components as well as their role in the farming systems.
- Review the existing aquaculture technology transfer methods through farming systems in Bangladesh.
- Identify the limitations of the existing methods and recommend measures to develop sustainable aquaculture technology transfer mechanism through farming systems.
- Identify the role of GOs and NGOs to provide institutional support needed for transfer of aquaculture technologies through farming systems.

5.4.3 Working Group 3 of Technical Session IV

Socio-economic improvement through transfer of aquaculture technology

This group will assess the socio-economic improvements that have taken place through the transfer of aquaculture technologies to the resource poor farmers as well as their problems and prospects. More particularly they are expected to concentrate on the followings :

- Review the transfer of aquaculture technologies, which have improved the socio-economic conditions of resource poor farmers.
- Is the socio-economic impact recognized and reported? How are they reported ?
- What impact does aquaculture technology transfer have on other development efforts?
- Are participatory processes actually utilized and effective?
- What research would help the transfer process?

5.4.4 Working Group 4 of Technical Session IV

Socio-economic impact of small-scale aquaculture system

This group will review the socio-economic impact of aquaculture system in Bangladesh. More particularly, this group is expected to concentrate on the followings :

- Definition of the goal and the expected impact, expectation vs. reality.
- Describe the ways of measuring and reporting the impact of small-scale aquaculture.
- Definition of small-scale aquaculture systems. What information is required for justifying the role of small-scale aquaculture system and socio-economic system ?
- What type of small-scale aquaculture system gives the better impact ?

5.4.5 Working Group 5 of Technical Session IV

**Future strategies for aquaculture technology development and transfer
through GO/NGO extension agencies**

This group will review the existing process of aquaculture technology development and transfer through GO/NGO agencies and will suggest future strategies for the development of sustainable aquaculture technology and transfer mechanisms. More particularly, they are requested to concentrate on the following :

- Who is responsible for social research?
- What role universities, research institutes, extension organizations should play for future technology transfer?
- What mechanism would attract young scholars to study and work with technology transfer issues?
- Are there ways to influence fundamental education systems to make the aquaculture technology development process more effective?
- Who speaks for fish and who speaks for fish farmers? How can we influence the political process?
- How can we assure long-term support and participatory approaches at all levels for technology development and transfer?