PACKAGE OF PRACTICES
ON
FISHERIES AND AQUACULTURE IN ASSAM

DEVELOPED BY

ASSAM AGRICULTURAL UNIVERSITY
JORHAT- 785013

PUBLISHED BY

DIRECTORATE OF FISHERIES, GOVT. OF ASSAM

IN COLLABORATION WITH

ARIAS SOCIETY, GOVT. OF ASSAM

Package of Practices on Fisheries and Aquaculture in Assam: *A complete guide on 'Fisheries and Aquaculture in Assam' for the fish farmers, fisheries entrepreneurs, NGOs, Govt. Agencies, Academicians and students of Assam.*

Developed by:
Assam Agricultural University
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Directorate of Fisheries
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Khanapara, Guwahati-22

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सत्यमेव जयते

Chief Minister, Assam
Guwahati

Dispur
05.02.2018

MESSAGE

I am glad to know that Assam Agricultural University and the Department of Fisheries, Assam is publishing the Package of Practices (PoP) for fisheries sector of the State.

Fisheries sector has immense potential for enhancement of productivity, rural employment generation and expansion of related businesses. I hope the PoP being published under Assam Agribusiness and Rural Transformation Project would be highly useful document for all stakeholders.

I convey my best wishes to Assam Agricultural University and Department of Fisheries, Assam and all those who directly or indirectly contributed to the preparation of the PoP all success in their endeavour.

(SARBANANDA SONOWAL)

Parimal Suklabaidya
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Dated, Dispur 17/01/2018

MESSAGE

I am very happy to learn that College of Fisheries, Raha under the aegis of Assam Agricultural University in collaboration with Department of Fisheries, Government of Assam, is bringing out a Package of Practices (PoP) on Fisheries and Aquaculture exclusively for the State of Assam. I hope this PoP would be a highly useful document specially for fish and fish seed farming communities of the State. It is fact that due to the initiative of the concept by the Fishery Department **"Ghare Ghare Pukhuri Ghare Ghare Mach;"** most of the people are coming forward in this sector and this PoP will definitely be helpful for enhancement of productivity of fish as well as the socio economic development of the rural population of the State.

I thank the AIRAS Society, Government of Assam for extending financial support under the proposed World Bank financing "Assam Agribusiness and Rural Transformation Project (APART) for publishing this valuable document.

I extend my heartiest congratulation for those who are directly and indirectly involved themselves towards this great endeavour and to publish this diverse Package of Practices on Fisheries for the benefit of all the stakeholders of the State.

(Parimal Suklabaidya) 17/1/18

DR. K. M. BUJARBARUAH,
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(Recipient of Sarder Patel Outstanding Institution Award)

MESSAGE

I am very happy to note that our Fisheries college, Raha and the Department of Fisheries, Assam are bringing out the latest version of Package of Practices for Fishery sector soon. This PoP was the need of the hour since the now available PoP was prepared way back in 1997 and had become almost obsolete considering the changes in science and technology, eco-system and even in the resource base for aquaculture. Improving the livelihood benchmark of the poor and ultra-poor engaged in fish farming through fishery centric policy and technology intervention has never before been as important as it is today mainly because of the environment and other biotic and abiotic vulnerabilities confronting the sector of late. The often asked question as why the state is not self sufficient in fish production despite the enviable water resources it has, has to be answered now providing appropriate technology backstopping and delivering the deliverables through a well laid out policy support. For the former i.e technology backstopping, the 'to be released PoP' is expected to serve the purpose and for the later i.e policy backing, Assam Agricultural University is already on the job of framing the needed policy for the state.

The PoP is expected to facilitate doubling fish production and thus the farmers' income within a reasonable time frame and if it does not, it will be necessary to reframe it, through experimentation, again and again taking into research fold the surfacing issues, from climate change impact to disease and water quality management, which might demand a business in unusual manner approach encompassing innovations in pond handling to breeding, hatchery and sale management. I am sure the actors responsible for fishery sector growth and development in the state will keep on taking the call of the time through 21st century PoP development to keep the sector vibrant, paying and enjoying - no matter whatever the challenges are.

I congratulate all those involved in drafting the PoP and bringing it out in its present form and hope that it will be well received by the stakeholders engaged in fish farming and trade in the state.

(K. M. Bujarbaruah)

M. C. Jauhari, IAS
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MESSAGE

I am very happy to learn that the College of Fisheries under Assam Agricultural University and the Department of Fisheries, Assam are going to publish the Package of Practices (PoP) for fisheries sector based on the agro-climatic condition for the State. It is true that with its vast water resources suitable for pisciculture, the Fishery sector is considered as an important economic activity in the socio-economic context in the State of Assam. It provides rural livelihood to a large section of the rural population besides providing gainful employment and affordable nutrition. Considering the potential of the fishery sector in rural employment, income and livelihood, Government of Assam has been making a number of interventions for sustainable development of the sector and to meet the ever increasing demand for fresh fish as well as production of quality fish seed. Though the various organisation like Ministry of Agriculture, Government of India, National Bank for Agriculture and Rural Development (NABARD), World Bank are coming forward to invest in this sector, up-to-date Package of Practice is much needed for benefit of the farmers as the present PoP was prepared long back and had become almost redundant in view of farmers need, climate change and technological advancement.

I hope, the PoP, being published with financial support from ARIAS Society, Government of Assam, under World Bank financed Assam Agribusiness and Rural Transformation Project (APART) would be a highly useful document for all the stakeholders and specially for the fish and fish seed farming communities of the State for years to come. I would like to congratulate all those who directly or indirectly contributed for preparation of this PoP in a single window.

(M.C. Jauhari, IAS)
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Siddharth Singh, IAS
Secretary to the Government of Assam and
State Project Director, ARIAS Society

MESSAGE

I am very glad to learn that the College of Fisheries, Raha (Assam Agricultural University) in collaboration with the Directorate of Fisheries, Govt. of Assam are bringing out the 'Package of Practices' (PoP) very shortly for management of culture and capture fisheries including fish processing for the state of Assam . This was long due as the earlier package was introduced way back in 1997. Further, the advanced version on management of aquatic resources was an urgent need for enhancement of productivity on a sustainable basis and for overall development of the fishery sector in the State.

The Fishery sector in Assam with vast resources needs technology up-gradation through experimentation on periodical basis in order to harness the potential for increasing productivity and production and also to meet the growing demand of fish in the State. The fishery sector is considered as a sunrise sector for production increase, livelihood enhancement, employment generation and socio-economic development of rural masses in Assam. The farming community as well as the State can be highly benefitted through adoption of improved technology and restrict the flow of scarce money being drained out year after year in the procurement of large quantity of fish from other states.

I hope, the PoP, being published with financial support from ARIAS Society, Govt. of Assam, under the proposed World Bank financed Assam Agribusiness and Rural Transformation Project (APART) would be a highly useful document for all stakeholders and specially the fish and fish seed farming communities of the State for years to come.

(Siddharth Singh, IAS)
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24th December, 2017

Message

Assam is rich in both water resources as well as in aquatic biodiversity with vast potential for development of fisheries sector. In the context of state economy, 'Fisheries' has been regarded to be an important activity for food &nutritional security besides livelihood and employment generation. Considering the prospect and potential, both Central and State government have laid emphasis on Fisheries sector for increasing production and farmers' income. During the last few years, farmers and entrepreneurs are also increasingly coming forward for adopting fish culture as a major income generating activity. With the combined efforts of all the stake holders it is expected that the state will attain self sufficiency in terms of fish within a short span.

Although technologies have been developed on scientific fish culture practices, lack of a state-of-the-art Package of Practices on different technological innovations suitable for local condition and considering aspects like best management practices, climate resilience, hazard mitigation etc have been long felt by the farmers of the state. The last package of practices on fish culture was published long back in 1997-98 by the Assam Agricultural University which has now become outdated.

I am indeed happy that the College of Fisheries, Raha under Assam Agricultural University in association with Department of Fisheries, Assam is bringing out a 'Package of Practices on Fisheries and Aquaculture' keeping in view the needs of the fish farmers, fisheries entrepreneurs, NGO's, Government Agencies, academicians and students of the state covering aquaculture, integrated farming, fish seed production, fisheries management, post harvest technologies and related matters. It is also a matter of immense pleasure that few packages have been contributed by the Central Inland Fisheries Research Institutes, Department of Fisheries, Assam and Fisheries Research Centre, Jorhat which has definitely made the PoP richer and diverse. I have no doubt that this PoP would definitely be of practical utility for all the deserving users. I sincerely hope that utmost care will be taken for filling up the gaps and adding up more farmers' friendly technologies in the subsequent updated versions of the PoP on a regular time period in the coming days.

I take this opportunity to thank and congratulate all those who directly or indirectly contributed towards this endeavour and bringing in diverse packages in a single anthology. I also express my gratitude to ARIAS Society for support in publishing the PoP.

(S.K. Das)

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FORWORD

Assam is endowed with vast fishery resources in the form of rivers, pond, and derelict water bodies and *Beels* covering total water spread area of over 2.85 lakh excluding 4820 KM riverine fisheries. Fishery is an important sector in the State of Assam that provides employment opportunity to large numbers of people besides providing nutritional and livelihood to them and more than 90 percent of total population of the State consumes fish. There are about 3 lakh fish farmers engaged in fish culture and about 10 lakh fishermen population involved mainly in capture fisheries in the State. Though the state has ample water resources, production from the resources are very low in comparison to its potential. Therefore, it needs technology up-gradation in order to harness the potential for increasing productivity and production and also to meet the growing demand of fish in the State.

In the ICAR 21st Regional Committee meeting (Region III) held at Assam Agricultural University, Jorhat in April, 2013 there was a discussion on Package of Practices on Animal Husbendry & Vety as well as Fishery sector and Director of Research (Vety) was entrusted with the responsibility to make it happen. Although, the first package on Fisheries was prepared on 1997 by Assam Agricultural University, considering the changes in science and technology, eco-system and necessity for climate resilience technology, it was due to develop a fresh Package of Practice (PoP). The College of Fisheries, Raha under Assam Agriculture University has developed the PoP for management of culture and capture fisheries including fish processing for the State of Assam. Apart from the scientists from College of Fisheries, Raha, the scientists from Central Inland Fisheries Research Institute (CIFRI), Guwahati centre, Fisheries Research Centre, AAU, Jorhat and the State Fisheries Departmental Officers have contributed the packages. There are total eight packages including fish seed production and management, culture of carps and barbs, diversified aquaculture, integrated aquaculture, integrated animal-fish farming systems, *beel* fisheries management, fish health management and preparation of value added fish products. The photographs of cultivable fish species of Assam and model bankable projects are also included as Appendix.

I hope the fish farmers as well as the entrepreneurs in this sector will be highly benefitted through adoption of improved technology incorporated in this PoP and it would be a highly useful document for all stakeholders.

24/5/18

(Apurba Ckakraborty)

CONTENTS

PACKAGE -1

FISH SEED PRODUCTION AND MANAGEMENT

1.01 CARP SEED PRODUCTION AND MANAGEMENT

Carp seed production in commercial scale is one of the economically promising enterprises for the North East Region. With the growing requirement for quality carp seed, there is increasing need for establishment and expansion of fish seed production farm in the region to meet the demand. Proper planning along with calculative step for scientific designing and construction of a fish seed production farm is very important for developing it as a productive and economically sustainable enterprise.

1.01.01 Components of a seed production farm

A self-sufficient carp seed production farm includes facilities not only for induced breeding of fish but also for raising of hatchlings from spawn to fry stage and fry to fingerling stage as well as marketing of the fish seed at different stages.

1.01.02 Basic components-

- Hatchery proper with overhead tank and running water facility
- Different ponds viz. nursery, rearing and brooders' pond
- Store house
- Working shed
- Cement cisterns
- Inter farm road
- Watchman shed etc.

1.01.03 Characteristics of different types of pond:

Types of pond	Targeted culture	Area(ha)	Depth (m)
Nursery pond	Rearing of spawn to fry size upto 25-30mm	0.01-0.05	1.0-1.5
Rearing pond	Rearing of fry to fingerling stage upto 100-150mm	0.05-0.10	1.5-2.0
Brooders' pond	Rearing of brood fish	>0.15	2.5-3.0

1.01.04 Other requirements

- A reliable and continuous source of water of proper quality and quantity should be available in accordance with the cycle of breeding operation and hatchery management.
- Farm implements viz. water pump, balance, different nets (fry, fingerling, brooders dragnet, hand net, scoop net etc.), hand cart, buckets, hapa, transportation bag for brooders, oxygen packing implements including oxygen cylinder, standard measuring cup etc.
- Other facilities like boundary wall/fencing, electricity, transportation, market linkage, input availability, security etc.

1.01.05 Selection of site

- A suitable site is one that provides optimum conditions for seed production of the desired species at the targeted production level with and economically viable cost benefit ratio, given an effective hatchery, pond design and support facilities.

Following aspects need to be considered for site selection-

1.01.05.01 Feasibility of production

- Whether the targeted seed production of the proposed species is really profitable in that locality.
- Whether the farm management and marketing is within the reach of the fish farmer

1.01.05.02 The economy factor

- How about the cost of production
- How about marketing and input availability

1.01.05.03 Steps for site selection

1) **A preliminary contour survey –**
   Topography, Area available, Accessibility

1.01.05.03.01 Area available

- For a self sufficient composite fish culture farm, the ratio of nursery, rearing and stocking ponds should be 1:10:26.25 respectively, considering stocking density of 6 million spawn ha^{-1} with 50% survivability, 0.3 million fry ha^{-1} with 70% survivability from fry to fingerling stage and 8000 fingerlings ha^{-1}.

1.01.05.03.02 Topography

A gently sloping site is preferable to facilitate drainage. Plain type layout is also suitable.

1.01.05.03.03 Soil characteristics for construction of ponds

1.01.05.03.03.01 Types: Alluvial, having high amount of mud.

1.01.05.03.03.02 Texture: Impervious soil such as heavy clay, silty clay and clay loam. A percolative soil with high ground water table is also suitable.

1.01.05.03.03.03 Soil fertility: Organic carbon must not exceed 1%. Available nitrogen (N) should be more than 3-5 mg $100g^{-1}$ soil. Available phosphorous (P_2O_5) should be 6-16 mg $100g^{-1}$ soil.

1.01.05.03.03.04 Soil pH: The optimum range is 6.5-8.5. In case of acidic soil, the pond should be treated with lime as corrective measure.

1.01.05.03.03.05 Water table: In case of percolative soil, water table should be high so that the pond can be dug below the water table. Porous soil with low water table is avoided particularly for rearing and brooders' pond. However, nursery ponds (Fig.1) may be constructed in such areas for seasonal seed raising from spawn to fry stage.

1.01.05.03.04 Sources of water

a) Rainwater
b) Underground water
c) River or canal water etc.

Ground water table: Ground water may be the chief source of water. In case of percolative soil where the water table is high, the pond is dug below the water table.

1.01.05.03.05 Legal matter

Land should be free from any legal dispute.

1.01.05.03.06 Flood level

There should not be any flood risk.

1.01.05.03.07 Availability of inputs

Availability of all the inputs including required inputs such as brood fish, inducing hormone, feed, medicine, oxygen cylinder, packing material, farm implements etc. should be easily available.

1.01.05.03.08 Manpower

Availability of skilled labours and trained manpower is a prerequisite for successful operation.

1.01.05.03.09 Road and transport

There should be good communication for transportation.

1.01.05.03.10 Demand and Market

Consumers' preference, elasticity of demand, future price trends and comparative costs, competition, marketing infrastructures and growth of auxiliary enterprises should be considered.

1.01.05.03.11 Power supply

Availability of power supply is another prerequisite for the selection of site.

1.01.05.03.12 Market promotion

Facilities for market promotion through different media as well as through visibility and person to person extension is an added advantage for successful operation.

1.01.05.03.13 Productive water conditions

The productive biological and physico-chemical parameters of pond water are as follows-

Parameters	Tentative values
Plankton production	10-20ml m^{-3} of water
pH	6.5-8.5
Free Carbon-di-oxide (FCO_2)	1.5ppm is best, never > 15ppm
Dissolved oxygen (DO_2)	5-10ppm
Plankton Turbidity	>20ppm
Nitrate (NO_3)	0.2-0.5ppm
Phosphate (PO_4)	0.2-0.5ppm
Hardness	<20ppm
Temperature	26-32°C

Other factors like probability of pollution, security problem etc. should also be considered.

1.01.06 Scientific pond construction

1.01.06.01 Shape of the ponds-

Rectangular ponds are always preferred over square, circular, oval and irregular shaped ponds. On the other hand, construction of square shaped pond is found to be easier and less cost effective from engineering point of view.

1.01.06.02 Season for pond construction-

November to February are the best season.

1.01.06.03 Method of construction of ponds-

A pond may be constructed in three different ways depending upon the contour of the area, viz.

- By constructing only the embankment in naturally very low lying area
- By constructing the embankment and partially digging the pond bottom up to desired level in areas having slight slope or in medium low lying area
- By complete digging and construction of the embankment in normal upland areas

1.01.06.04 Side slope-

- The slope may vary depending upon the type of soil viz. for clay soil, slope of the embankment in horizontal to vertical axis should be in the ratio of 1.5:1, while for alluvial or sandy soil it should be 2:1 or more (Fig. 2 & 3).

Fig. 1: Nursery ponds

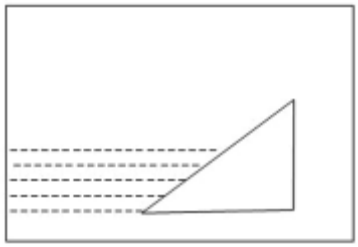


Fig. 2: Slope of embankment

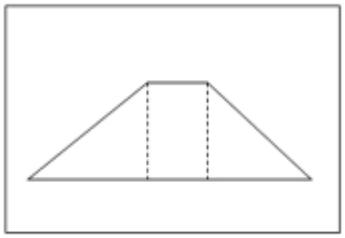


Fig. 3: Slope of the inter pond embankment

1.01.06.05 Construction of a pond embankment-

- Embankments should be compact, solid and leak proof so as to maintain the desired level of water as well as a hygienic pond environment. During digging process, the top layer of the soil i.e. up to the depth of 10-20 cm should be kept separately; the other portions are used for construction of the dyke whereas the top soil is used for the finishing of the same.
- The height of the embankment depends on the annual rainfall and the highest water level of the area. It should always be at least 60 cm more than the highest recorded water level of pond.
- There should always be a 1cm free board for every 2cm annual rainfall.
- The state of Assam receives an annual average rainfall of 120 cm; as such a minimum free board of 60cm should be kept during construction of pond in the state.

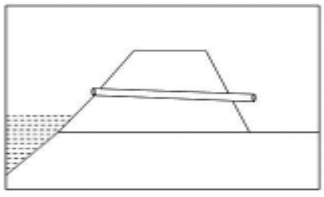


Fig. 4: Construction of pond outlet

- The peak/crest of the embankment should be sufficiently wide. For a pond having the slope of 2:1 and 1m height of the embankment, the peak and base of the pond dyke should be of 1m and 5m respectively. The slope of the pond and width of the base of the dyke are proportionate to each other.
- Outlet pipes of 20-25 cm radius should be provided through the embankment at appropriate height to drain out the excess water (Fig. 4). The opening of outlet pipes should be well guarded with net to avoid escape and entry of fish feed.

1.01.07 Construction of AAU model carp hatchery

This hatchery is suitable for medium scale operation with capacity around 20 lakhs spawn per operation.

Fig-5: AAU model hatchery

1.01.07.01 Detailed specification

In the AAU Model Hatchery (Fig.5), a triple chambered cement circular tank is constructed. The outer chamber serves as the spawning chamber, while the middle and innermost chambers serve as incubation-cum-hatching chamber and waste disposal chamber, respectively (Fig. 6 & 7). The chambers are interconnected and provided with water inlets and outlets for unidirectional water flow in the spawning chamber, tangential flow and discharge through the centre by means of a standpipe in the hatching cum incubation chamber. The hatching chamber is connected to a collecting pool for collection of spawn. A riverine condition during rainy season is artificially created through these water flow systems with the help of showers fitted in the walls of the hatching & breeding chambers.

Inside the main circular tank a middle circular brick wall configures the incubation cum hatching centre. A circular inbuilt iron rod netting partition is provided in the centre of the inner tank to separate the incubation cum hatching chamber from the waste disposal chamber. The construction is done with the following specification:

Outer diameter of the hatchery	6.66 m
Inner diameter of the hatchery	6.06 m
Width of spawning chamber	1.2 m
Depth of spawning chamber	0.85 m
Outer diameter of hatching chamber	3.6 m
Inner diameter of hatching chamber	3 m
Inner diameter of waste disposal chamber	1.65 m
Size of the egg collecting chamber	3.0 m X 2.15 m X 1.0 m
Size of the overhead tank	5.28 m X 3.64 m X 1.38 m

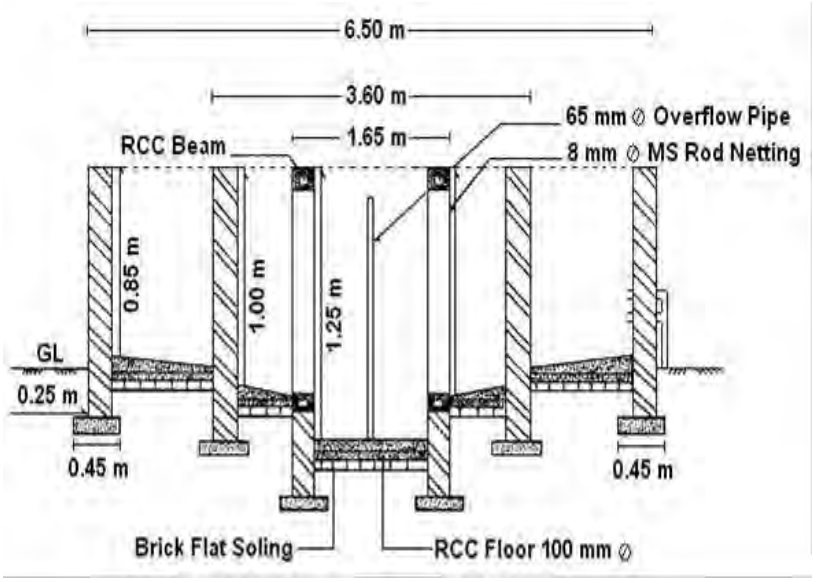


Fig-6: Cross section of the hatchery proper showing different measurements

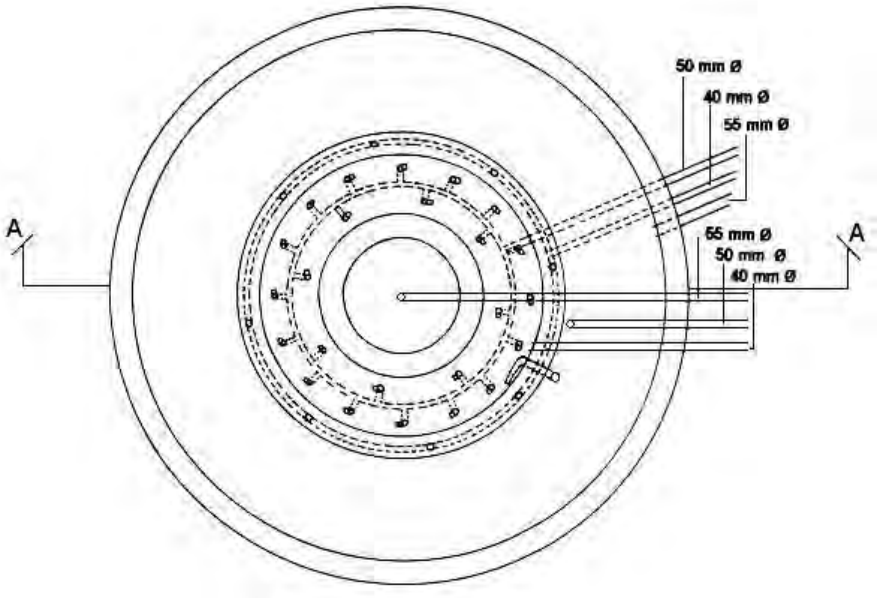


Fig-7: A/A section of AAU model carp hatchery

The spawning tank has a capacity for breeding of 20 kg females in one operation. The incubation cum hatching chamber has the capacity of holding 9.0 cubic meter of water and as such 9 million eggs can be accommodated in this chamber. A passage is provided for automatic entry of eggs from the spawning chamber to the incubation-cum-hatching chamber by fitting a 55mm GI pipe diagonally at the middle wall. The inner end of the egg-passing pipe is jet type. The spawning chamber is connected with the spawn collection tank. There are a total of 24 numbers of water jet (15mm) type inlets (duck mouth) at the bottom of the incubation-cum-hatching chamber. These inlets move the water in a spiral upward direction and keep the eggs gliding in suspended condition. The iron frame of innermost chamber is wrapped with a nylon netting of small mesh that facilitate sieving out the excess water from the spawning chamber (Fig. 8). There is a provision of 8 numbers of vertically fitted showers on the middle wall. The excess water goes out through a standpipe of 65mm diameter fitted at the centre of the inner chamber, which maintains the required water level in the incubation cum hatching chamber.

Fig. 8: Nylon netting in the innermost iron

An RCC overhead tank (Fig: 9) of about 16,000 litres capacity is constructed and is connected with the piping system of the hatchery for continuous supply of water. For this an overhead tank of 5.28m length, 3.64m width and 1.38m depth is constructed at around 2.25m height with fitting for water supply to the hatchery proper.

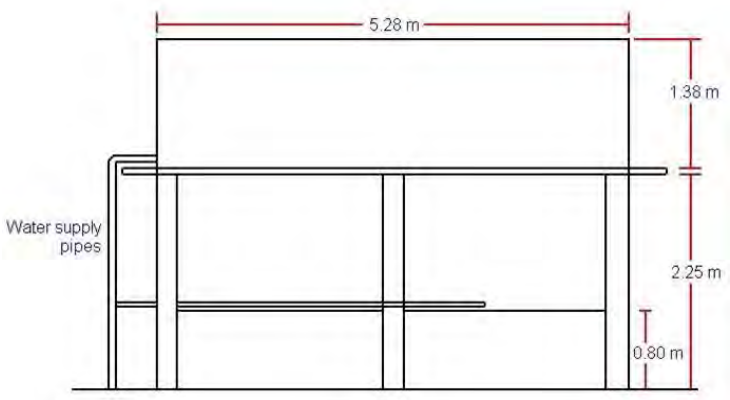


Fig-9: Overhead water reservoir

As one breeding operation requires 3-4 days for completion, there is a break of 3-4 days between two operations in this hatchery system. For continual operation, additional hatching pool has been constructed outside the system, with same specification and measurements as in the hatchery proper, connecting to the spawning pool of the hatchery proper through inlet pipes

(55mm GI pipe) in one side and to the collecting chamber through an outlet on the other side (Fig 10 & 11). A shed constructed over the hatchery proper, protects it from direct impact of rainfall and sunlight. Similar shed is provided to the additional hatching pool also.

Fig 10: Additional hatching pool

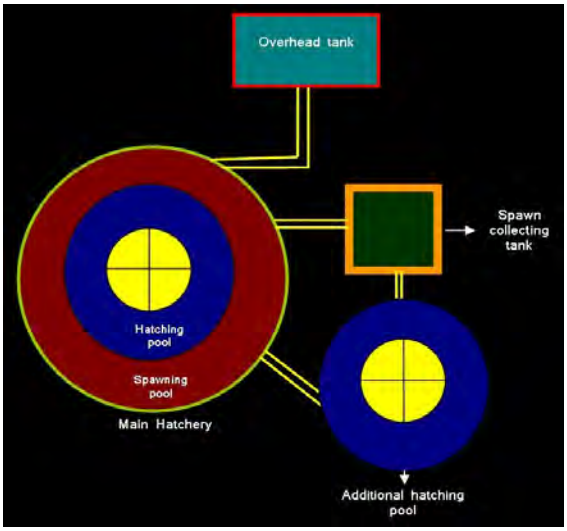


Fig-11: Interconnection of components of the AAU hatchery model

1.01.07.02 Economics of AAU Model hatchery (For production of carps spawn)

A. Capital Cost

Item	Cost(Rs.)
1. Construction of eco hatchery complex including- i. Circular breeding pool of 6.66 m diameter ii. 2 Hatching pools of 3.66m diameter iii. Overhead tank of 16,000 litre. capacity iv. Pumpset (5HP) v. Guard shed and office room vi. Brood stock pond, nursery pond, rearing pond vii. Brood stock-1.6 tonnes viii. Contingent expenses for nets, equipments, hapas etc.	15,00,000.00 (On the basis of estimate by DPP, AAU, Jorhat)

B. Recurring cost

For seed production (upto spawn stage)

i.	Feeding of brood stock (1600kg) @ 2% body weight for 90 days @Rs. 30 kg^{-1} of feed (32kg feed X 90 days X Rs. 30 kg^{-1} feed)	86,400.00
ii.	Synthetic Hormone required for 1600kg fish=400 ml @ Rs. 400 $10ml^{-1}$	16,000.00
iii.	POL @ Rs. 1000/operation for 40 operations (LS)	40,000.00
iv.	Worker, 320 mandays @ Rs. 200	64,000.00
v.	Miscellaneous including packing materials	25,000.00
vi.	Depreciation over the capital cost @ 5%	75,000.00

Total Cost	**3,06,400.00**

Production per operation = 20 lakh spawn
Production from 40 operation =800 lakh spawn
Revenue earn selling spawn @ Rs. 600 lakh^{-1} = Rs. 4,80,000.00
Total operational cost = Rs. 3,06,400.00
Profit: Rs. 4,80,000.00 – Rs. 3,06,400.00= Rs.1,73,600.00
% profit over operational cost = 56.66%

1.01.08 Chinese Circular Hatchery/ Eco-hatchery

A hatchery is the most vital component of modern fish farm. It may be defined as a facility for fish spawning, egg incubation and rearing of hatchlings up to larval stage. Eco hatcheries are Chinese origin and have become very popular in India. Due to its origin in China it is also referred as Chinese hatchery. For large scale fish seed production these hatcheries can be used. The main components of the hatchery are-

1. Overhead tank
2. Circular tank/pool
3. Hatching tank/pool
4. Spawnery

1.01.08.01 Overhead tank:

- The size of the overhead tank varies according to the scale of operation of breeding and hatching pool.
- A minimum of 30,000 litre tanks is needed for a medium sized hatchery.
- A tank should be installed at about 2.5-3.0 m height from the base level of breeding pool.

1.01.08.02 Circular spawning tank:

- The tank may be made of brick work or RCVC or FRP.
- The diameter varies from 5-8 m (for 5 million eggs /operation diameter should be 5 m).
- The floor of the tank slopes towards the centre where opening of the outlet is located.
- Outlet pipe leads to egg collection chamber or to the hatching pool.
- Inlet pipe of 2" or 3" diameter is arranged diagonally at 60^0 through the wall of the tank to create a circular water flow inside during operation.
- Two numbers of 6" diameter water showers are fixed at a height of 1 m over the tank.
- Stocking of brood fish in spawning pool is @3.5kg m^{-3}

- Speed of the water current in the pool should be between 3 to 5 m/second or 2 litre per second.

1.01.08.03 Hatching tank/pool:

- Circular in shape
- Two chambered-outer and inner
- Outer chamber 3-6 m diameter (diameter for incubating 5 million eggs should be 3.2 meters)
- Inner chamber 0.8-1.5 m diameter
- The quantity of eggs that can be incubated per cubic meter is 7 lakhs eggs.
- Water depth should be 1-1.5 m.
- The diameter of outer chamber may be 3 to 4 times the diameter of inner chamber
- The circular wall separating the outer and inner chambers is provided with fine meshed net having mesh size of 1/60" to 1/80".
- The net separating the chambers allows only water to flow from outer chamber to inner chamber but not the eggs or spawn.
- Outlet pipe is placed in the centre on the inner chamber.
- Outlet is provided with a vertically fitted pipe to maintain the water depth in the incubation chamber at the desired level.
- Inlet pipes are shaped as duck mouth inlets and fixed at the bottom of the outer chamber
- Duck mouth inlets are arranged in a row, 6-12 numbers equidistant from each other and from both outer and inner wall of the chamber.
- The eggs are collected from the egg collection chamber and released into the outer chamber of hatching pool.
- The speed of water current for first 12 hours should be 0.4-0.5 m second^{-1}
- The speed of water current for next 6 hour should be 0.1 - 0.2 m second^{-1} and then after the speed is increased to 0.3- 0.4 m second^{-1}.
- A spawn delivery pipe is also provided to collect the spawn after the hatching is over.

Fig. View of a Chinese Circular Hatchery

1.01.08.04 Production economics of Chinese Eco-hatchery (For production of carps spawn)

A. Capital Cost

Item	Cost(Rs.)
1. Construction of eco hatchery complex including- i. Circular breeding pool of 8 m diameter ii. 3 Hatching pools of 3m diameter iii. Overhead tank of 5000 gallons capacity iv. Shallow tube well 8"x 6"x200' v. Pumpset (5HP) vi. Guard shed and office room vii. Brood stock pond, Nursery pond, Rearing pond viii. Brood stock-5 tonnes ix. Contingent expenses for nets, equipments, hapas etc.	25,00,000.00 (As per NFDB guidelines 2016 Costing)

B. Recurring cost

For seed production (upto spawn stage)

i.	Feeding of brood stock (5000kg) @ 2% body weight for 90 days @Rs. 30 kg^{-1} of feed (100kg feed X 90 days X Rs. 30 kg^{-1} feed)	2,70,000.00
ii.	Synthetic Hormone required for 5000 kg fish=1250 ml @ Rs. 400 $10ml^{-1}$	50,000.00
iii.	POL @ Rs. 1500/operation for 50 operation	LS 75,000.00
iv.	Worker, 750 mandays @ Rs. 200	1,50,000.00
v.	Miscellaneous including packing materials	80,000.00
vi.	Depreciation over the capital cost @ 5%	1,25,000.00
	Total cost	**7,50,000.00**

Production per operation = 40 lakh spawn

Production from 50 operation = 2000 lakh spawn

Revenue earn selling spawn @ Rs. 600 $lakh^{-1}$ = Rs. 12,00,000.00

Total operational cost = Rs. 7,50,000.00

Profit: Rs.12,00,000.00 – Rs. 7, 50,000.00 = Rs.4,50,000.00

% profit over operational cost = 60%

1.02 INDUCED BREEDING, SEED PRODUCTION AND RAISING UPTO FINGERLING STAGES OF CARPS

The induced breeding technique includes stimulating mature brood fish to spawn under artificial environment through administration of hormone and manipulation of environmental conditions.

1.02.01 Hypophysation:

- ✓ The technique of inducing fish to spawn by administering pituitary gland extract is known as the hypophysation technique.
- ✓ The process of hypophysation involves different steps to complete and needs technical expertise for perfection of the breeding operation.

1.02.01.01 ***Different steps of hypophysation are as follows-***

1.02.01.01.01 Collection of pituitary gland

- Pituitary gland is the major endocrine gland situated below the hypothalamus of brain of fish. Pituitary glands are collected from freshly killed mature carp during breeding season or from mature fish properly preserved in ice by removing the upper part of the skull (scalp) by a sharp knife or a bone cutter.
- After removing the scalp, the brain is exposed which is then cut from the posterior end and lifted up anteriorly.
- As soon as the brain is lifted the pear shaped, creamy white coloured pituitary gland can be seen located in a depression covered by a thin membrane. It is carefully picked up with the help of tweezers and kept immersed in a cavity block or a petri dish in absolute alcohol under cover.
- For successful induced breeding, glands should be collected from fully mature, healthy donor fish, preferably from the same species or closely related one during or onset of the breeding season.
- Glands from both the sexes can be use.

1.02.01.01.02 Preservation and storage of pituitary glands

- While exposing and collecting the pituitary glands, great care is taken to avoid any contact with water. It is most important because the hormone of the pituitary gland is soluble in water.
- The collected glands may be used fresh (just after collection) or may be preserved in different medium for use later on. There are three methods for preservation of pituitary glands-
    a) Preservation in absolute alcohol
    b) Preservation in acetone
    c) Preservation by quick freezing

- When the glands are preserved in absolute alcohol in a sealed tube at room temperature the potency is retained for 2-5 years. When preserved in acetone, the gland retains its potency for about 6 months only.

1.02.01.01.03 Identification and selection of brooders for spawning

The success of induced breeding depends on the proper selection of brooders. The identification of the sex is made on the basis of the external characters.

- The mature males are distinguished from the females by the presence of denticulation on the dorsal surface of the pectoral fin which is hard and rough to touch.
- In males the abdomen is comparatively flat and the vent is not swollen but they ooze milt (whitish sexual product) at slight pressure on their abdomen (Fig. 1).
- The ripe females have soft and smooth pectoral fins and bulging abdomen with swollen pinkish genital opening (Fig. 2).

Fig 1: Male fish

Fig 2: Female fish

1.02.01.01.04 Method of examining maturity stage of egg

- Catheter of suitable diameter can also be used for examining the condition of the eggs. The catheter is introduced through the genital opening of the female fish to bring out egg samples.
- Fully mature eggs are of uniform shape and size, normally round, bright, separated or loosely attached to each other.
- For the production of quality seed, healthy fully mature brooders with appropriate body weight should be selected (Table 1).

Table 1: Recommended weight and age for selection of brood fish

Species	Minimum weight (kg)	Age (years)
Rohu	1.5	2
Catla	2.5	2
Mrigal	1.5	2
Kurhi/Mali	0.5	1
Silver carp	2.5	2
Grass carp	2.5	2

1.02.01.01.05 Raising brooders

- Brood fish means the male and female fish which are used for breeding and seed production. Complete sexual maturity of the brood fish as well as good health status are the most important factors for successful induced breeding operation. A good stock of brood fish raised through proper nutrition and care is the key for higher and better production of the stocking material of the cultivable carps.
- Use of own farm raised brooders for seed production is more convenient. However to avoid inbreeding depression intermittent replenishment with brooders from other sources or from nature is recommended for commercial seed production.
- Brooders should be stocked in specially earmarked and prepared ponds for the purpose.
- The brooder ponds are generally more than 0.15 ha area with a depth of 2.5-3.0m. The water depth should be maintained at 1.5-2.5m.
- The best time for collection and stocking of brooders is during the months from November to January.
- The optimal rate of stocking is 2,000-2,500 kg fish ha^{-1}.

1.02.01.01.06 Brood pond preparation & management

- Water replenishment or freshwater recirculation is advisable for maintaining the water quality particularly the dissolved oxygen content.
- Other management practices like maintaining water depth, deweeding, monthly liming and manuring as well as health monitoring are essential steps for proper management of the brood stock.
- The brooders ponds should be prepared before stocking with application of lime and manure to maintain the water quality as shown below, on the basis of soil and water quality status of the pond.

1.02.01.01.06.01 Liming schedule on the basis of water pH:

Refer Package 2.01.11.03.01.01

1.02.01.01.06.02 Fertilization schedule: Refer Package 2.01.11.04

1.02.01.01.06.03 Feeding for brood fish

- For brood fish other than grass carp, supplementary feed prepared by mixing deoiled rice polish and oil cake @ 1:1 ratio or balanced, ready to use formulated feed @ 3-5% of the body weight of fish stock is recommended.
- For proper nutrition management, the supplementary feed provided should have 28-30% protein content especially during the advanced stage of maturation.

Grass carp may be fed with submerged aquatic vegetation as well as terrestrial grass etc. at the rate of 1-2% of the body weight for acceleration of gonadal development. However, 3 months ahead of breeding programme foliage diet is completely withdrawn and fishes are fed with conventional diet @ 3-5% of the body weight of fish.

1.02.01.01.06.04 The sex-wise segregation

The mature male and female brooders are segregated and stocked sex-wise in separate ponds about 1-2 months prior to the breeding operation for optimizing spawning and their health and maturity status should be monitored periodically.

1.02.01.01.06.05 Collection, transportation and conditioning

- During breeding season, fully ripe male and gravid females are netted out carefully and after selection they are carried to the hatchery site for breeding.
- For long distance transport, polythene bag or PVC pillow or crates with provisions for oxygenation are recommended. However for short distance, canvas bag filled with water or big sized container with water may be used.
- At the hatchery site, the brood fishes are kept in breeding hapa fixed either in conditioning pool with inlet-outlet facility or in breeding pool of hatcheries filled with water for about 5-6 hours. This is done for conditioning of the brooders before the actual process of hormone administration.
- Fresh water should be sprinkled with the help of shower for oxygenation during the process of conditioning. After proper conditioning the individual brood fish is weighed using a spring balance. The brooders are then ready to receive injection. Hand nets or scoop nets are generally used during weighing and injecting process.

1.02.01.01.07 Determination of dosage for injection

- Dosages of pituitary gland extract are calculated on the basis of body weight of the recipient fish.
- Besides body weight, determination of proper dosages of pituitary gland depends largely on the stage of sexual maturity of the brooders and also to some extent on the environmental conditions.
- The female brood fish is administered with 2 doses of pituitary hormone at an interval of 6 hrs.
- The male fish is given only a single dose of hormone at the time of 2nd dose to the female. The dose of hormone to be used for both the male and female is given below-

Hormone	**Dose per kg of fish**	
	Male	**Female**
Pituitary	2-3 mg	1st : 2-3 mg 2nd: 4-6 mg
Ovaprim	0.3ml	0.5 ml
Wova-FH	0.3 ml	0.5 ml
Gonopro- FH	0.3 ml	0.5 ml
Ovatide	0.1-0.3 ml	0.2-0.5 ml

1.02.01.01.07.01 Steps for preparation of gland extract

- Once the quantity of glands required for injecting the brooders is calculated, the required quantity of glands is then taken out from tube or vials and placed in filter paper for absorption of the preservative.

- Then the glands are weighed and homogenized by using a tissue homogenizer with a little distilled water.
- The homogenized glands are then centrifuged and the supernatant liquid is decanted and diluted if necessary with the same solvent to a known volume. For injection of the brooder, the supernatant fluid is taken out with a syringe. Generally, pituitary gland extract is prepared in concentration of 40 mg gland in 1 ml of distilled water.

1.02.01.01.07.02 Process for administration of hormone

- The selected brood fishes are injected intra-muscularly at the caudal peduncle or the space between tail peduncle and dorsal fin above the lateral line. The intra peritoneal injection at the base of pectoral fin is also practised.
- A 2 ml capacity hypodermic syringe with 0.1ml graduation preferably with inter locking system is most convenient for injecting most of the fishes.
- The size of the needle depends upon the size of the brooder to be injected. Usually with increase in weight and length of fish, the specification number of the needle proportionately decreases.
- Generally B.D.H. No. 22 needle is used for fishes weighing between 1 to 3 kg and No. 19 for the larger ones.
- For smaller fishes with less than 1 kg weight, No. 24 needle is considered.
- Careful handling of brooder fish during the injection process is very important so that there is no physical strain to the brooder.
- Usually the recipient fish is taken out from the conditioning enclosure by hand net or scoop net and are carefully placed on a rubber cushion of suitable size. Before taking out the fish, the syringe is filled with required quantity of hormone.
- The piston of the syringe is hold firmly by placing the thumb finger on the head of the piston and the other fingers in suitable positions of the graduated cylinder of the syringe.
- Before inserting the syringe one person places his hand on the head of the fish and the person giving injection holds the caudal peduncle and inserts the needle at 45º angle and injects the fluid with thumb finger pressing the head of the piston (**Fig. 3**).

Fig 3: Administration of hormone

- Both the sexes are then put together in a definite ratio (preferably with ratio by number male: female 2:1 or 3:2 and by weight 1:1) in spawning pool of hatchery or in breeding hapa fixed in pond.
- The brooders are kept under shower before and after hormone injection. Water current is allowed in the pool before one hour of estimated spawning time, which triggers the spawning activity.

1.02.01.01.08 Playing and spawning

Under optimum conditions, the injected brooders take 6-8 hrs to spawn after the last injection. However, after a while of the last injection, the brood fish may start sexual play and courtship which is indicated by chasing and jumping excitedly.

1.02.01.01.08.01 Condition for successful spawning

- It has been observed that an ambient temperature ranging from 25-28ºC is most conducive for breeding. Although spawning could be induced at or below this temperature range, the percentage of fertilization and hatching under such conditions is not satisfactory.
- Circulation of fresh water containing 5-9 mg l^{-1} of oxygen promotes better success in spawning, higher fertilization of eggs and higher recovery of hatchlings from fertilized eggs.
- Induced breeding is observed to be more successful after a heavy shower of rain. Photoperiod is another important factor. A photoperiod ranging from 13-14 hours is optimum.

1.02.01.01.09 Breeding season:

In Assam, generally the time sequence of induced breeding is, silver carp and grass carp during April, followed by catla, rohu and mrigal, although there is no hard and fast rule.

1.02.01.01.10 Problems of hypophysation

1. The potency of available glands is uncertain and farmers cannot assess the potency.
2. Large scale collection and storage is often problematic.
3. Unavailability in proper quantity and quality and often available at higher cost.
4. The procedure is time consuming and requires several implements and drudgery.

1.02.01.01.11 Synthetic hormones

The technology of induced breeding has been further refined with the use of several ready to use synthetic inducing agents(Fig.4), which are available now a days in the market in a ready to use form.

The most commonly used synthetic compounds for induced breeding of fishes are as follows-

1. Ovaprim.
2. Ovatide
3. Ovapel
4. WOVA-FH
5. GONOPRO-FH

Fig-4: Various ready to use synthetic hormone

1.02.01.01.12 Embryonic development

For successful embryonic development optimum ecological conditions should be provided so that a higher hatching percentage and survival rate of the hatchlings can be obtained.

- The incubation period of IMC is about 14-18 hrs when water temperature ranges from 26-31ºC, for Chinese carps it is about 18- 20 hrs.
- Extreme fluctuation in temperature may have harmful affect on the embryonic development leading to even death or abnormalities of the embryo. During incubation the water should be cleaned with oxygen content not less than 5mg per litre of water.
- The phosphate content of water should be low-0.12 mg l^{-1}.
- Plankton free, especially the cyclope free water is suggested during embryonic development.
- The mild flow of water created in the hatchery or in the hatching hapa will not allow the fertilized eggs to drop down to the bottom, thus helping proper embryonic development.

1.02.02 SMALL SCALE SEED PRODUCTION

1.02.02.01 HAPA BREEDING OF CARPS

1.02.02.01.01 Hapa: Although there is considerable development of hatchery system, these primitive cloth hapa are still used by some small carp seed producers as these are less costly and easy to use. The hapa system consists of two components, i.e breeding hapa and hatching hapa.

1.02.02.01.01.01 Breeding Hapa

- A breeding hapa is a box shaped cloth container, made up of fine meshed nylon cloth, closed on all six sides except one opening on one side (on the wider side of the top cover) to facilitate introduction of fish.(Fig. 1)
- This opening is provided with cloth loops or fastening cords to enable proper closing so that the brooders do not come out of the enclosure during playing/jumping before and during spawning.
- The breeding hapa is fixed in pond with the help of bamboo poles.
- The mesh size of the cloth net should be such that the eggs do not pass out of the breeding hapa when released by the female fish and also facilitate mixing of the sex products during spawning for fertilization.
- The size of the breeding hapa varies with different size of fishes. As for example-
    a) 3.6 m x 1.8 m x 1.0 m (for brood fishes weighing over 3 kg)
    b) 2.4 m x 1.2 m x 1.0 m (for brood fishes weighing between 1.5 to 3 kg)
    c) 1.8 m x 1.0 m x 1.0 m (for brood fishes under 1.5 kg)
- Brooders are released in this hapa through the opening of the top cover, after hormone administration.
- Spawning takes place inside breeding hapa subsequently.
- After spawning the brood fishes are collected from the hapa and shifted to pond. Within 4-6 hours of spawning, water hardened eggs are collected carefully from the breeding hapa and transferred to the hatching hapa.

Fig-1: Breeding hapa fitted in pond with

1.02.02.01.01.02 Hatching Hapa

- A hatching hapa consists of two parts, one fitted inside the other. The outer hatching hapa is made up of thick meshed cloth like markin, nylon or any other good durable and cheap cloth, stitched into a rectangular trough without any lid or cover.

- Each of its eight corners is provided with a loop for fastening with bamboo poles (Fig. 2).
- In addition, four additional loops are provided to the four lower inner corners for fastening to the inner hatching hapa.
- The outer hatching hapa measures 1.8m x 0.9m x 0.9m. It is tied to four bamboo poles in the marginal waters of a pond at a water depth of about 1.0m. The hapa should normally project out 20-30cm above the water surface.
- The inner hatching hapa is made of mosquito net cloth of 1.75m x 0.75m x 0.45m size and stitched exactly in similar shape to outer hatching hapa, with eight outer loops in eight corners.
- The bottom corners of the inner hapa are tied to the inner loops of the outer hapa and top corners to the bamboo poles.
- Fertilized eggs are released evenly into the inner hatching hapas. Each hapa is provided with 0.075 to 0.1 million eggs, and in terms of volume of eggs, it may vary from 2000 to 3000 ml with an average of 2500 ml.
- The eggs hatch out in 14-29 hrs. at a temperature range of 24- 31ºC. After hatching, the hatchlings escape into the outer hapa through the meshes of the inner hapa. After completion of the hatching process, the inner hapa containing the eggshells, dead eggs and other debris is removed.
- The hatchlings remain in outer hapa till the 3rd day after hatching, which are then carefully collected and stocked in nurseries prepared in advance.

Fig-2: Hatching hapa with shower

1.02.02.02 PORTABLE PLASTIC CARP HATCHERY DEVELOPED BY CIFA SUITABLE FOR SMALL/MARGINAL FARMERS

This portable hatchery system completely made up of fibre glass reinforced plastic (FRP) has been developed at Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar and is suitable for small scale breeding with production capacity of 10-12 lakhs spawn per operation(Fig 3). The hatchery system possesses several advantages viz.

- Easy transportation to different locations
- Easy to install and operate.
- Requirement of less water for breeding and spawn production.
- Requirement of less space for installation and can even be placed on a pond dyke.
- Easy to repair and replace minor fitting.
- Low capital investment.

Fig-3: Portable Plastic Carp Hatchery developed by CIFA

1.02.02.02.01 Components of the Portable Carp Hatchery

The Portable carp hatchery system comprises of usual components such as breeding pool, incubation/hatching pool, egg/spawn collection unit and water storage tank (*Jena et al,* 2005) as that of Chinese eco-hatchery.

1.02.02.02.01.01 Breeding pool

- It is cylindrical in shape with 2.15 m diameter and 0.9 m height, with bottom sloping (1:22) uniformly towards outlets at the centre. The thickness of the FRP wall is 4.2-6.0 mm. Water circulation is created in the tank through a number of inlet pipes fitted at the bottom of the side wall of the tank.
- Showers are provided at the top to sprinkle water during spawning. The inlets and outlets of the system are properly fitted with water controlling valves. The water holding capacity of the breeding pool is 2,300 litres and is suitable to breed 10-12 kg of carps at a time.

1.02.02.02.01.02 Incubation/hatching pool

- The hatching pool is cylindrical in shape with 1.4 m diameter and 1.0 m height. It consists of egg incubation chamber, inner chamber, FRP socket, water supply and outlet systems.
- The diameter of the inner chamber is 0.4 m and height 0.9 m. It is covered with nylon bolting cloth to filter out the excess water from egg incubation chamber to the drain.
- Five RPVC (15 mm dia) duck-mouths are fitted at the bottom of the egg incubation chamber in between outer and inner walls at equal distances to get required water circulation.
- The unit has two drainage outlets, one at the centre and other at the outer chamber. The net egg incubation capacity of the tank is 1,200 litres.
- The fertilized eggs hatch out in 12-18 hrs. and remain in the incubation chamber for 72 hrs. An average water flow of 400 ml sec^{-1} is required in the incubation tank.
- It has the capacity to hold 10-12 lakh eggs per operation.
- The spawn is collected at the spawn collection chamber through a PVC hosepipe connected from the outlet of the outer chamber.

1.02.02.02.01.03 Egg/spawn collection tank

- The egg/spawn collecting tank is connected to breeding or hatching pool as per the need. It is a rectangular tank of 1.0 m x 0.5 m x 0.5 m with wall thickness of 3-4 mm and water holding capacity of 250 litres.
- The water level in the tank is maintained at a height of 0.4 m through an outlet fitted at the upper end of the tank.
- Cotton inner hapa of the same size is fixed inside the tank for collecting spawn/egg from incubation/breeding pool, respectively.

1.02.02.02.01.04 Overhead water storage tank

- FRP water storage tank of capacity 2,000 litres is required to operate the hatchery unit.
- As per the space availability, two tanks of 1,000 litre capacity each, can serve the purpose.
- The breeding pool and hatching pool are connected to the water storage tank separately or with a common water line.
- One 1 HP pump set is required to fill the water storage tank periodically to supply water to hatchery continuously.

1.02.02.02.02 Hatchery operation

- The operation procedure of the hatchery is same as that of eco hatchery.
- A temporary shed is required when the hatchery is placed outdoor to avoid direct impact of rain or sunlight.

1.02.02.03 PORTABLE FRP CARP HATCHERY (10-12 LAKHS/OPERATION)

Another model of portable hatchery is being manufactured by Plasticraft Corporation, Mumbai, which is completely detachable and collapsible and can be easily installed in limited space.

- The hatchery system consists of breeding pool, hatching pool and a spawn collecting tank. The size of the medium capacity breeding pool is 8 ft in diameter and 4 ft in height with an overflow outlet of 4 ft length, fitted in the centre of the pool.
- The hatching pool is of 4 ft x 3ft in size along with a 4 ft long overflow outlet. Both the pools are separately built and stand on aluminium frame. The body of both the pool is made up of aluminium sheet covered by PVC liner. The spawn collection tank is rectangular and made up of fiberglass reinforced plastic. The hatchery can produce 10-12 lakh eggs in one operation.

Fig: Portable FRP Carp Hatchery

1.02.03 CARP SEED RAISING

1.02.03.01 Raising spawn to fry stage

- The first step of the seed raising activity begins with the rearing of three to four day old spawn (5-6 mm in length) of cultivable carps in nursery pond. At this stage yolk absorption process of the hatchlings is completed and they start feeding independently from extraneous sources.
- The spawns are stocked in previously prepared nursery ponds.
- Nursery ponds are usually smaller in size, 100-500 m^2 (0.01-0.05 ha) in area with water depth 1-1.5 m.
- Seasonal earthen ponds which retain water during the monsoon season only may also be used for this purpose as this activity is confined to breeding season of fish (monsoon).

1.02.03.01.01 Nursery Pond Management:

The perennial nursery ponds should be subjected to specific management practices which encompasses the following steps-

1.02.03.01.01.01 Pre-stocking management

As pre-stocking management practice, the perennial ponds should be dewatered completely and the bottom should be sun dried so that the pond can be cleared off the undesirable weeds, predatory and weed fishes as well as insects and crustaceans. When complete draining is not possible, following steps need to be taken.

- Clearance of weeds (Refer Package 2.01.08.01)
- Eradication of predatory and weed fishes (Refer Package 2.01.08.03)

1.02.03.01.01.02 Liming of pond:

Application of lime depending upon the soil pH should be done. If analysis of pH is not possible, a general rate of quick lime @ 250-300 kg ha^{-1} after eradication of weed fishes should be applied as preparatory dose. In subsequent operations a monthly dose of 50kg ha^{-1} should be applied during the entire seed raising period to maintain the pH level. Liming in proper dose raises the soil and water pH to a desirable level to achieve the benefit of available nutrients for biological productivity.

1.02.03.01.01.03 Fertilization of pond:

- ✓ Cow dung should be applied @ 5000-6000 kg ha^{-1}, after 7-8 days of application of lime and 15 days prior to the anticipated date of stocking by mixing with water and broadcasting all over the pond which increases the plankton production in due course for the stocked spawn.
- ✓ In nursery ponds use of inorganic fertilizers is not recommended. In lieu of that, the following combination may be applied @ MOC 75% + cowdung 20% + SSP 5%.
- ✓ This mixture is applied @ 1000 kg ha^{-1}. 50% of this requirement is applied before 2-3 days of stocking of spawn and rest 50% is applied at 5-7 days interval during the rearing period depending on the level of plankton production.

1.02.03.01.01.04 Insect control in nursery pond:

- ✓ Soap oil emulsion is most commonly used for control of harmful insects like notonecta, ranatra, nepa etc. Soap-oil emulsion is a mixture of oil and soap (vegetable oil @ 56 kg ha^{-1} with soap @ 18 kg ha^{-1}) used to kill primarily the air breathing insects. The mixture is prepared by slight heating after mixing the ingredients and sprayed over the surface of the water to create an oil film covering the entire pond water surface.
- ✓ The mixture should be applied before 20-24 hours of stocking of spawn in the pond. For this a comparatively calm weather with no rain or wind is selected so that the oil film is retained for sufficient period of time to kill the air breathing insects through suffocation.
- ✓ After killing, the dead insects may be removed through netting.
- ✓ Liquid detergent may also be used in place of soap and in lieu of vegetable oil, diesel, kerosene oil or turpentine may be used. Emulsion of kerosene @ 100-200 litre ha^{-1} or diesel @ 75 litre ha^{-1} and liquid soap @ 560 ml ha^{-1} or detergent powder @ 2-3 kg ha^{-1} water area can be applied as an effective substitute.

1.02.03.01.01.05 Stocking of spawn:

- ✓ The 3-4 days old spawns are transferred from the hatchery to the nursery tanks preferably in cool morning hours.
- ✓ The stocking should be done at the rate of 30-50 lakh ha^{-1}. However, higher densities of 10-20 million ha^{-1} can be followed for nursery rearing in cement tanks with provision for water circulation as well as water quality maintenance.
- ✓ Though mono species rearing is basically recommended, in case of lack of sufficient number of ponds, multi-species rearing is also practised.
- ✓ For short distance transport, open container filled with sufficient water may be used, while for long distance transport polythene bags filled with water and oxygen is the most suitable option.
- ✓ At the time of stocking of seeds transported in open container, preliminary acclimatization is done by adding and mixing pond water with the water of the container for temperature adjustment.
- ✓ While in case of spawn transported in closed polythene bags, the bags before opening may be kept floated for some time on the pond water and then the spawn are released by opening the bag and allowing the seeds to swim out of the bag on their own.
- ✓ Touching or catching by hand during stocking should be avoided to minimize handling stress.

1.02.03.01.01.06 Post stocking management:

- ✓ Liming and manuring should be done during this period at scheduled rate. For supplementary feeding a mixture of finely powdered groundnut/mustard oil cake and rice polish, in equal proportion by weight is supplied to the spawn Table 1. In addition to this mixture micronutrients like cobalt, chloride may be added for better result.

- ✓ 'Sushama' the balanced fish feed produced by Fisheries Research Centre, Assam Agricultural University, Jorhat is one of the efficient feeds available for this purpose.
- ✓ Generally at this stage, finely grind feed is supplied through broadcasting over the pond surface commencing from the day of stocking during the morning hours and it should be stopped one day earlier to the harvesting programme.
- ✓ In adverse ecological conditions, feeding should be suspended temporarily. In grass carp spawn raising programme, chopped and minced vegetations like wolffia and hydrilla may be provided as feed after 10-12 days of stocking.

Table 1: Feeding schedule for raising spawn to fry stage

Period	Rate of feeding per day	Approximate quantity per lakh of spawn/day
1st to 5th day	4 times the initial total weight of spawn stocked	500-600g
6th to 13th day	8 times the initial weight of spawn stocked	1120-1200g
14th day	No feeding	-
15th day	Harvesting	-

1.02.03.01.01.07 Harvesting of fry:

- ✓ The fry in about 15 days of time generally grows up to 25-30 mm in size. They are harvested with fine meshed (1.5 mm) dragnet/nursery net in the cool morning hours avoiding heavy shower or too hot days.
- ✓ Under the agro-climatic condition of Assam, a low rate of growth is observed particularly during the month of April-May, when the ambient temperature is not within the optimum range. For this reason a longer duration of around 20-25 days is needed to attain the fry stage.
- ✓ The fry produced in nursery ponds are harvested after attaining the desired length and are transferred to rearing pond to raise them up to fingerling stage, which is considered as the suitable stage for stocking in culture or grow out ponds.
- ✓ In a seed raising farm, a nursery pond can be utilized for raising of 5-6 batches of spawn to fry stage considering average culture period of 20-25days per batch. The fry stage of cultivable carps can be identified by their specific distinguishing characteristics (**Table 2**).

Table 2 : Distinguishing characteristics of try of cultivable crops

Species	Characters
Catla catla	Large head, dorsal profile convex and the ventral profile concave, no distinct spot on the caudal fin or at the caudal peduncle, Lips thick, but not fringed.
Labeo rohita	Dark diffused transverse band present at the caudal peduncle. A pair of whitish or light greyish maxillary barbells present. Lips fringed.
Labeo calbasu	A semilunar yellow band appears on the nape and gradually the body gets the appearance of having alternative yellow and black bands, Two pairs of thick black barbells present, lips fringed, mouth narrow
Labeo gonius	Body is marked with number of very faint longitudinal white stripes. A pair of maxillary barbells present, lips fringed, mouth narrow.
Cirrhinus mrigala	Small head and slender body, lips are not fringed, the posterior edge of the caudal spot is slightly concave
Puntius sarana	Body is deep and moderately compressed. An oval dark spot present at the caudal peduncle, Lips are thin and not fringed. Maxillary barbells are present.

1.02.03.01.02 Economics (For 40 lakh spawn ha^{-1} area per operation)

A. Capital Cost

Item	Cost(Rs.)
1. Construction of nursery pond of 1 ha area.	7,00,000.00 (As per NFDB guidelines 2016)
2. Fishing gear (nylon net 2 nos.)	10,000.00
3. Water pump (5HP), 2 nos.	80,000.00
4. Store cum guard shed	2,00,000.00
5. Miscellaneous including farm implements	50,000.00
Total Cost	**10,40,000.00**

B. Recurring Cost

Sl. No	Item	Cost (Rs.)
i.	Spawn @ Rs. 600 lakh^{-1} for 40 lakh including packing and carrying charge	35,000.00
ii.	Lime- 350kg @ Rs.15 kg^{-1} (LS)	5,250.00
iii.	Manure & fertilizer (Cow dung, urea, SSP) (LS)	2,000.00
iv.	Supplementary feed- 1000 kg @ Rs. 30 kg^{-1}	30,000.00
v.	Workers- 150 mandays x Rs. 200/manday	30,000.00
vi.	Packing charge including oxygen cylinder (LS)	1,00,000.00
vii.	Miscellaneous including Soap-oil emulsion (LS)	10,000.00
viii.	Depreciation over capital cost @ 5%	52,000.00
	Total Cost	**2,64,250.00**

Production = 20 lakh fry assuming 50% survival rate.

Revenue earned by selling of fry @ Rs. 300/1000 = Rs. 6,00,000.00

Total operational cost = Rs. 2,64,250.00

Profit: Rs. 6,00,000.00 – Rs. 2,64,250.00 = Rs.3,35,750.00

% profit over operational cost = **127** % (approx)

1.02.03.02 RAISING FRY TO FINGERLING STAGE

Raising fish fry to fingerling stage to produce suitable stocking material should be considered as integral step by the fish seed growers for overall development of the culture sector. To avoid the problem of limited rearing space farmers can opt for cage or pen culture in large natural water bodies (e.g. *beels*) for raising fingerlings.

1.02.03.02.01 Rearing Pond Management

The fry are grown to fingerling stage in about 2-3months period. For pond preparation, steps followed for clearance of weed and unwanted fishes as well as liming are same as that of the nursery pond management.

Other steps specific to this process are as follows-

1.02.03.02.01.01 Manuring and fertilization:

Both inorganic fertilizer and organic manure are applied in rearing pond to increase the natural productivity of the pond which acts as the primary food material for the fry.

i. **Organic manure:** Cow dung @3000-4000 kg ha^{-1} is applied as basal dose during preparation after which application of fortnightly installments @500 kg ha^{-1} is done by mixing with water and spraying over the pond surface. First installment must be applied about 10 days before stocking of fry and after at least 7-8 days of liming. If mahua oil cake is used for removal of unwanted fish, then the basal dose is avoided.
ii. **Inorganic fertilizer:** Urea @10 kg ha^{-1} and single super phosphate @15 kg ha^{-1} may be applied as fortnightly doses after each installment of application of organic manure (cow dung).

1.02.03.02.01.02 Stocking of fry:

After 8-10 days of application of organic and inorganic fertilizer, the fry of about 25-30 mm in size are stocked in rearing ponds preferably in cool morning hours at the rate of 2-3 lakh ha^{-1} in various combinations (**Table 3**) :-

Table 3 : Different recommended combinations of crops for stoking in rearing ponds

Species	Ratio	Total
Catla + Rohu + Mrigal	20:40:40	100
Silver + Grass carp	50:50	100
Silver + Grass + Common carp	40:30:30	100
Catla + Rohu + Mrigal + Common carp	30:40:10:20	100
Catla + Rohu + Mrigal + Grass carp	30:30:30:10	100
Silver + Grass + Common carp + Rohu	40:20:20:20	100
Catla + Rohu + Mrigal + Silver + Common carp	20:30:30:10:10	100

1.02.03.02.01.03 Supplementary feeding:

- ✓ Rice polish and mustard oil cake are mixed at the ratio of 1:1 by weight for preparing supplementary feed for fry. 'Sushama' the AAU fish feed may also be supplied to the fry for better result. The amount of application of supplementary feed varies depending upon the bodyweight and their age.
- ✓ During first month of rearing, supplementary feed is provided at the rate of 8-10% of the total body weight of stocked biomass, while during second and third month, feed is supplied at the rate of 6-8% and 4-6% respectively of their body weight.
- ✓ Both bag or tray feeding and broadcasting method are found suitable for feeding the fry.
- ✓ For herbivorous fishes like grass carp, aquatic vegetations like *Wolfia, Lemna, Spirodela, Azolla, Hydrilla,Valisneria, Najas, Potamogeton* etc. and grasses like *para* as well as selected terrestrial and semi-aquatic vegetation should be provided after proper washing and mincing.

1.02.03.02.01.04 Harvesting of fingerling:

Harvesting of fingerlings should be done during morning hours by repeated netting with dragnet of suitable mesh size. Supplementary feeding should be stopped one day prior to the day of harvesting. The rearing ponds can be utilized to raise 2-3 batches of fingerlings in a season with average culture period of 2-3 months per batch.

1.02.03.02.02 Economics (For 3 lakh fry ha^{-1} area/ operation)

A. Capital Cost

Item	Cost(Rs.)
1. Construction of nursery pond of 1 ha area.	7,00,000.00 (As per NFDB guidelines 2016)
2. Fishing gear (nylon net 2 nos.)	10,000.00
3. Water pump (5HP), 2 nos.	80,000.00
4. Store cum guard shed	2,00,000.00
5. Miscellaneous including farm implements	50,000.00
Total Cost	**10,40,000.00**

B. Recurring cost

For seed production (fry-fingerling)

Sl. No	Item	Cost (Rs.)
i.	Fry @ Rs. 300/1000 for 3 lakh including packing and carrying charge	1,00,000.00
ii.	Lime- 350kg @ Rs.15 kg^{-1} (LS)	5,250.00
iii.	Manure & fertilizer (Cow dung, urea, SSP) (LS)	2,000.00
iv.	Supplementary feed- 2000 kg @ Rs. 30 kg^{-1}	60,000.00
v.	Workers- 250 mandays x Rs. 200/manday	50,000.00
vi.	Packing charge including oxygen cylinder (LS)	10,000.00
vii.	Miscellaneous (LS)	10,000.00
viii.	Depreciation over capital cost @ 5%	52,000.00
	Total Cost	**2,89,250.00**

Production = 1,95,000 fingerlings assuming survival rate 65%

Revenue earned by selling of fingerling @ Rs. 3.00/Piece = Rs. 5,85,000.00

Total operational cost = Rs. 2,89,250.00

Profit: Rs. 5,85,000.00– Rs. 2,89,250.00 = Rs. 2,95,750.00

% profit over operational cost **= 102.25** %

1.03 BREEDING OF CARPS IN MINI BUNDH

Advantages:

- Mini Bundh is considered to be most suitable for quality carp seed production.
- Many Departmental fish seed farms are using this structure successfully in Assam.
- Breeding process is close to natural.

1.03.01 Main Components of the Mini Bundh system:

1. Over head water storage tank.
2. Rectangular Mini Bundh.
3. Hatching Pool. Along with Mini Bundh, one or two hatching pool is also required for hatching of eggs.
4. Spawn collection Chamber.

1.03.01.01Over head water storage tank:

- Over head tank is used to supply water to mini bundh and hatching pool continuously.
- A pump is used to fill the over head tank with water from pond or deep tube-well.
- Capacity of the over head tank is 15,000 litres. Size may also vary according to the size of the bundh.

1.03.01.02 Mini Bundh:

- It is a rectangular concrete pond with an inner length and breadth of 17.8 m and 4.6 m respectively.
- It has two portions-one is shallower and another one is deeper.
- Area of shallower portion is 9.75 m x 3.8 m and that of deeper one is 4.6 m x 3.8 m.
- Depth of shallower part is 0.65 m which slopes down to the deeper part where maximum depth is 1.4 m.
- A coarse sand layer of 10 cm thickness (4 cubic meters) is provided on the bed of the shallower part.
- One outlet pipe (160 mm diameter) and one overflow pipe (160 mm diameter) are fixed at the bottom and top of the wall of deepest portion.
- A water supply line is laid along the top of the wall in order to provide showering facilities with nozzle mouth placed equally spaced and fixed at an angle of 45° towards the tank.
- Brood fish may be accommodated @ 3-5kg m^{-3}

1.03.01.03 Hatching pool:

- Hatching pool is circular in shape.
- Each hatching pool has 2 chambers of cement masonry work-outer and inner chamber.
- Outer chamber is 3.13 m and inner chamber is 1.0 m in diameter. The diameter may vary from 3-6 m in case of outer chamber and 0.8 -1.5 m in case of inner chamber.

- The circular wall of the inner chamber is fitted with a fixed nylon screen (1/60 to 1/80 inch) so that only water can flow through, not the eggs and spawn.
- Depth of tank is 1 m. Depth may increase up to1.5 m.
- To increase the force of water, the initial 50 mm diameter pipe line from the overhead tank is reduced to 25 mm diameter pipe line.
- 6-12 numbers equidistant duck mouth inlets are fixed with the circular inlet pipe at the bottom of the outer chamber.
- Required speed of water for first 12 hours is 0.4- 0.5 m $second^{-1}$ and it is reduced to 0.1- 0.2 m $second^{-1}$ during next 6 hours.
- One outlet pipe of 50 mm diameter is fitted vertically at the centre of inner chamber to maintain the water depth at desired level.
- Eggs are collected from the mini bundh and released into the outer chamber of hatching pool.
- About five million eggs can be hatched out in an outer chamber having 3.13 m diameter(@ 7-8 lakh m^3).
- One delivery pipe is provided to collect the spawn.

1.03.01.04 Spawn Collection Chamber:

- It is a rectangular cemented tank.
- Located at a lower elevation than the hatching pool to facilitate complete collection of spawn with the help of gravity with inside dimension is 2 m x 1.5 m x 1 m.
- Delivery pipe of hatching pool with regulator is directly connected to the spawn collection chamber.
- Some hooks are fixed on the side of the walls for fixing spawn collection hapa.
- Out let is provided to overflow the excess water.

1.03.02 Breeding Operation:

- Males are injected @ 3-6 mg kg^{-1} at the time of second injection to females.
- In case of hypothalamic hormone, single dose is injected to both male (0.2-0.3 ml kg^{-1}) and female (0.3-0.5 ml kg^{-1}) at the same time.
- Mini bundh is filled with water.
- Brooders are released to the mini bundh after injection.
- Outlet pipe is closed tightly.
- Both the inlet and overflow pipes are opened to create a mild flow.
- Breeding process completes within 4-6 hours of second injection.
- The eggs are collected from the mini bundh with the help of cotton/ nylon cloth.
- Remaining eggs are collected using cotton hapa at the outlet pipe.
- Valve for duck mouths is opened to run water.
- Showers are opened.
- Collected eggs are transferred to hatching pool.
- Hatching process completes within 20 hours.
- Hatchlings are kept in hatching pool for 3 days.
- Spawns are collected at the spawn collection chamber and are ready for release in to the nursery pond.
- A break of 3-4 days between two operations are required.
- Within a breeding season of three months 30 batches of spawn can be produced. With an average production of 5 million spawn in each batch, a total of 150 million spawn can be produced in a season.

1.03.03 Economics for 150 million carp seed production in Mini Bundh

Sl. no.	Name of the Item	Amount (Rs.)
Expenditure		
A.	**Capital Cost:**	
1	Rectangular mini bundh (17.8 m x 4.6 m size)	4,50,000.00
2	Overhead tank (5 m x 3 m x 1 m)	3,34,435.00
3	Hatching Pool 3.13 m diameter	72,615.00
4	Spawn collection tank (2 m x 1.5 m x 1 m,) 1 no	25,000.00
5	Water pumps and accessories (Electric/ diesel 5HP)	40,000.00
	Sub-total	**9,22,050.00**
B.	**Variable cost**	
1	Brood fish 3000 kg @Rs 250 kg^{-1}	7,50,000.00
2	Diesel ,electricity etc.	50,000.00
3	Inducing agent like Ovaprim, Ovatide, etc.(120 vial)	50,000.00
4	6 daily workers for 30 days @ Rs. 200 $man^{-1}day^{-1}$	36,000.00
5	1 full time worker for 3 months @ Rs. 6000 $month^{-1}$	18,000.00
6	Polythene bag,Oxygen etc	10,000.00
7	Miscellaneous expenditure	10,000.00
	Sub-total	**9,24,000.00**
C.	**Total Cost**	
1	Total variable cost	9,24,000.00
2	Depreciation cost on fixed capital @ 10% yearly	92,205.00
3	Interest on fixed capital @10% per annum	92,205.00
4	Interest on the variable cost @ 10% per annum for three months	92,400.00
	Grand Total	**12,00,810.00**
Gross Income		
1	Sale of spent brood 3000 kg @ Rs. 225 kg^{-1}	6,75,000.00
2	Sale of 1500 lakh spawn @ Rs 500 $lakh^{-1}$	7,50,000.00
	Grand Total	**14,25,000.00**
Net Income (Gross income - Total costs)		**2,24,190.00**

Percentage return on variable cost: 18.67 and BCR 1.19

1.04 BREEDING AND CULTURE OF *PUNTIUS SARANA*

Introduction:

- *Puntius sarana* is a medium sized carp species with moderate growth rate compared to the major carps.
- It is popularly known as *Cheniputhi* in Assam and English name is Olive Barb.
- A very popular fish of Assam and related with lots of old Assamese stories, songs and proverbs.
- It was once common in ponds, rivers, streams, reservoirs and lakes of India.
- The natural stocks of this species have dwindled to a great extent.
- It is a tasty, the most popular and favorite table fish among barbs.
- A suitable candidate for diversifying carp culture.
- In one year it can grow up to 400-500g.
- Critically endangered in Bangladesh and vulnerable in India.
- In Assam it is rarely found (critically endangered)
- Comprehensive approach is needed for brood stock development and standardization of breeding and seed raising technology.

Local Name:

- Cheni puthi , Muraputhi, Bhokaputhi (Assam)
- Sarana, Savalputi, Swarnaputi (West Bengal)

1.04.01 Identification of males and females :

- Abdomen is soft and bulging in females during monsoon season and eggs come out on slight pressure.
- In case of male, abdomen is not bulging and milt oozes out when pressed slightly.
- Pectoral fins of male fish are rough and sandy and very smooth to touch in case of female.
- The vent is pinkish and papillae rounded in female while vent is white and papillae pointed in case of male.

1.04.02 Brood Stock Management:

- *Puntius sarana* attains maturity within a year.
- Preferably 2-3 years old healthy males and females should be selected as brooders.
- Brooders should be stocked @ 1500 kg ha^{-1}
- Preferable size of brooders tank is 0.2 to 0.5 ha with average water depth 1.5 -2.0 m
- Feeding with rice polish and mustered oil cake at a ratio of 1:1 and @ 3% of body weight.
- Formulated diet @ 1-2% of body weight gives better result.
- About 150 kg brooders are required to produce 10 million spawn.
- Male and female ratio is maintained at 1:1 by weight and 2:1 by number.

1.04.03 Inducing Agent:

- Fish pituitary gland extract as well as other synthetic hormone can be used for breeding.
- Females are given two injections of Fish Pituitary Gland (PG)at an interval of 4-6 hours.
- First injection is given @ 3-4 mg kg^{-1} body weight of female.
- Second injection is given @ 5-7 mg kg^{-1} body weight of female.
- Males are given only one injection of PG @ 2-4 mg kg^{-1} body weight at the time of the second injection to female.
- Dose may be increased up to 8 mg kg^{-1} body weight of female in case of single dose.
- Apart from fish pituitary gland, synthetic hormone like Ovaprim, Ovatide, Gonopro-FH, Ova FH etc may also be used.
- In case of synthetic hormone a single dose of 1.25-1.5 ml kg^{-1} body weight of female and 0.75-1 ml kg^{-1} body weight of male is sufficient to breed *P. sarana*.

1.04.04 Formula for calculating amount of required Pituitary Gland:

Weight of PG (mg) = (Wt × Pt) / 1000 where, Wt represents total body weight (g) of all the fishes to be injected and Pt represent the rate of PG in mg to be injected/kg body weight. Thus weighed PG is then placed in a tissue homogenizer and crushed thoroughly. Required quantity of distilled water is added and centrifuged for precipitation of un-wanted materials. The supernatant solution thus obtained is the pituitary extract ready for injecting fish.

1.04.05 Methods of injection :

- Intramuscular as well as intraperitonial injections can be used.
- Intramuscular injection is administered in dorso-lateral muscle towards the caudal peduncle avoiding lateral line.
- Intraperitonial injection is administered in the soft region at the base of pectoral or pelvic fin.
- 2 ml hypodermic syringe with 0.1ml graduation is convenient for use.
- In case of split doses, pricks are made alternatively on right and left side of the fish.

1.04.06 Breeding Process:

- *P. sarana* can be bred in hapa as well as circular breeding pool.
- Hapa breeding is equally successful with circular hatchery.
- Brooders are kept in breeding *hapa or* circular FRP/ concrete tank after giving injection.
- A breeding hapa may be 3.5 m x 1.5 m x1.0 m and 2.5 m x 1.2 m x 1.0 m in size.
- All the sides of breeding hapa are stitched and closed keeping an opening at the top.
- Opening is securely closed after introducing brooders to prevent escape.
- Breeding hapa should be provided with sufficient quantity of water plant preferably water hyacinth.
- Eggs are released after 4-6 hours of injection.
- Eggs are attached to the roots or inner surface of these aquatic weeds.

- Hatchlings are kept in hapa till the yolk sac is absorbed and then transferred to nursery ponds.
- A 500 liters capacity circular FRP tank may also be used for breeding of *P. sarana.*
- The tank is filled with 450 liters of filtered fresh water and aeration is provided.
- 3-4 kg brooders can be accommodated per cubic meter.
- The tank is covered with a net on the top so that fish cannot jump out from the tank.
- Suitable substrates like bundle of jute ropes, polythene strips are provided to stick on eggs.
- Quantity of such substrate should not be less than 4-5 times the body weight of female.

1.04.07 Hatching of eggs:

- Substrates containing attached eggs are transferred either to hatching hapa or circular hatching pool.
- Hatching percentage is more in circular hatching pool than hatching hapa.
- Aeration is provided with the help of showers.
- A hatching hapa has two parts, the outer hapa and the inner hapa.
- The inner hapa is smaller in size and is fitted inside the outer hapa.
- The standard size of outer hapa is 2 m x 1 m x 1 m and that of inner hapa is 1.75 m x 0.75 m x 0.5 m.
- The inner hapa is made of round meshed mosquito net cloth and outer hapa is made up of a thin cotton cloth.
- Loops and ropes are provided with all the corners of inner and outer hapa to facilitate installation.
- The period of incubation largely depends on the temperature with a congenial range of 25-31°C and eggs normally hatches out within 20 hours.
- The new hatchlings come out from the inner hapa within a short time.
- The inner hapa containing egg shells and damaged eggs is removed immediately after hatching is complete.
- Once the yolk sac is absorbed they start feeding on other foods and are stocked in well prepared nursery tank.
- A circular concrete or FRP hatching pool can also be used for hatching of eggs.
- In a 1.4 m diameter and 1 m deep circular hatching pool about 1 million eggs can be hatched out. Hatching percentage is increased if aeration is used.
- It is also observed that hatchling of *P. sarana* starts feeding after two days of hatching although yolk sac remains up to 3 days of hatching.
- In that case they are fed with boiled egg.

1.04.08 Nursery pond management:

Refer Package 1.02.03.01.01

- The stocking density is maintained at 0.7 million spawn ha^{-1} water area.
- The spawn may also be raised along with other IMC spawn simultaneously in a single pond.

1.04.09 Rearing pond management: Refer Package 1.02.03.02.01

1.04.10 Grow out culture: Refer Package 2.01.11 to 2.01.13

- *P. sarana* can be introduced in to the carp polyculture system.
- Substratum may be provided for periphyton growth. It has positive effect on growth of *P. sarana.*
- A combination of catla, silver carp, rohu and olive barb at a ratio of 0.5:0.5:1:1 gives better result in carp polyculture system.
- Production of 4200 - 4819 kg ha^{-1} from polyculture with olive barb at 30- 35% of the stocking density of 9980 fingerlings ha^{-1} with major carps can be obtained.

1.04.11 Economics for production of 20 million spawn of *P. sarana* in hapa

Sl. No.	Name of the Item	Amount (Rs.)
	Expenditure:	
1	Maintenance of brood stock and brood stock pond (0.25 ha) for three months.	15,000.00
2	Prospective brood fish 250 kg @Rs 300 kg^{-1}	75,000.00
3	Breeding hapa (2.5 m x 1.2 m x 1.0 m in size) 12 nos	12,000.00
4	Hatching hapa including outer hapa (2 m x 1 m x 1 m) and inner hapa (1.75 m x 0.75 m x 0.5 m.) -20 set	24,000.00
5	Running cost including Inducing agent, oxygen etc	15,000.00
6	Full time labour for 6 months (1 no)	36,000.00
7	Daily labour for 40 man days @ Rs. 200 day^{-1}	8,000.00
8	Miscellaneous expenditure	5,000.00
9	Interest on total expenditure @10% per annum for three months	4750.00
	Total Expenditure	**1,94,750.00**
Gross Income		
1	Sale of spent brood 250 kg @ Rs. 300 kg^{-1}	75,000.00
2	Sale of 20 million spawn @ Rs 1000 $lakh^{-1}$	2,00,000.00
	Gross Income	**2,75,000.00**
Net Income (Gross income - Total expenditure)		**80,250.00**
Percentage return on variable cost		**41.21**
BCR		**1.41**

BREEDING OF MAGUR *(Clarias magur)*

1.05.01 Method : Male sacrifice method

1.05.02 Distribution: Fresh and brakish waters of India, Burma, Ceylon Pakistan, Bangladesh, Thailand, Philippines and South China.

1.05.03 Breeding period: Breeds during onset of monsoon. It starts from late May under hatchery condition. It breeds in shallow paddy field in the early part of monsoon.

1.05.04 Fecundity: 500-3000 eggs per female but while striping 500-600 intra ovarian oocytes/g of fully matured ovary is obtained.

1.05.05 Age at first maturity: At the end of first year.

1.05.06 Identification of male and female:

Genital papilla is long and pointed in the case of male whereas it is round/oval in the case of female(Fig 1). Abdomen bulges below pectoral spines in the case of female during breeding season.

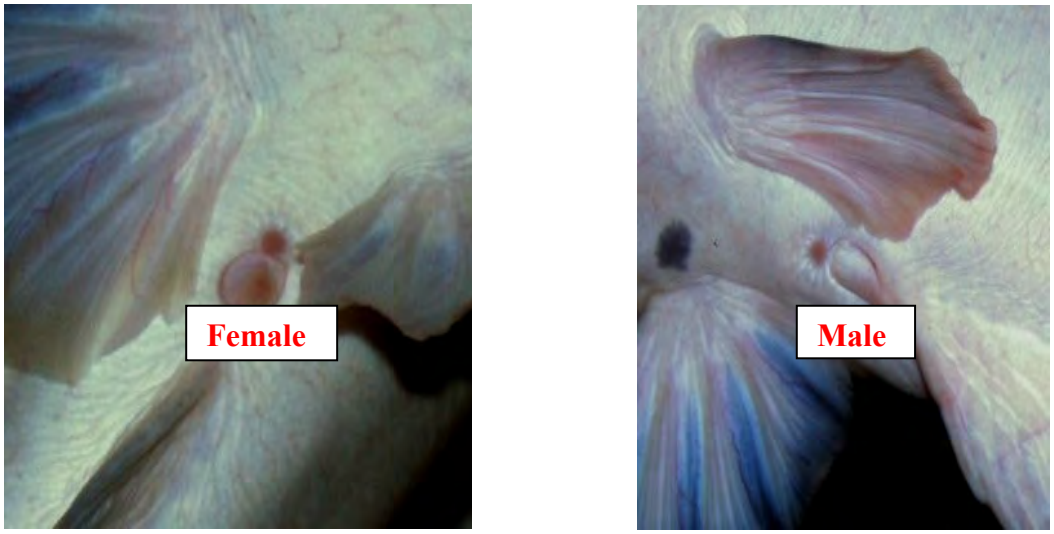


Fig -1 : GENITAL PAPILLA OF MALE & FEMALE MAGUR

1.05.07 Infrastructure requirement:

- **Shed:** A small shed of 20 m x 12 m with thatch roof and cement floor is required to make the operation indoor.
- **Brood stock ponds:** 3.0 m x 1.0 m x 1.0 m cement cistern with 10-15 cm thick soil bed. Outlet at 70 cm above bottom with water flow system. Four numbers of brood stock ponds are required to maintain 200 pairs of brood stock.
- **Plastic tub with flow through system:**

  Tub size: 12 cm dia. and 6 cm height.

  20 nos. of the aforesaid tubs can be kept in hatchery.

  Water is supplied through common pipe and out let is provided at 4cm from the bottom.

  Small circular fibre glass tank with water circulation system can replace the tub system.

- **Larval rearing tanks:**

  Size: 1.0 m x 0.5 m x 0.3 m

  Holding capacity: 1000-2000 spawn/ tank.

  Water flow and aeration must be provided.

  Fry rearing tanks: rearing period-10-12 days fry are reared to 25-30days.

- **Fibre glass /cement cistern size :** 4.0 m x 1.0 m x 0.5 m
- **Storage tank:** 10,000 L capacity.
- **Air compressor:** 1.0 hp compressor with accessories for air supply.
- **Working Table:** 3 m x1 m size.
- **Generator:** mini generator to meet up the emergency power cut.
- **Other small items:**

i. Pan balance	ii. Electric mixer	iii. Mortar & pestle
iv. Syringe	v. Scissors	vi. Forceps
vii. Enamel tray	viii. Glass beakers	ix. Measuring cylinder
x. Dropper	xi. Plastic mug	xii. Sponge cushion
xiii. Hand net	xiv. Towels	xv. Detergent soap etc.

- **Water requirement:** 5000 L day^{-1}.
- **Brood stock maintenance:** 200 pairs of brood of size above 80-150g should be stocked in cement cisterns.
- **Feed:** Minced trash fish and rice polish at the ratio of 9:1 and at the rate of 10% of the biomass.
- **Water exchange:** Twice /week.

1.05.08 Operational procedure

1.05.08.01 Day prior to stripping:

❖ Selection of brooder: 1 male against 3 females.

❖ Hormone administration: 0.1 ml/ male and 0.3-0.4 ml/female irrespective of weight. However these dosages may vary based on the maturity stage of the brood fish.

❖ Keep overnight (about 0.8 hrs) in collected rain water with cover to prevent jumping.

1.05.08.02 Flow diagram of operational procedure

Take out the male and dissect out the testes. Remove carefully without any blood on testes

↓

Cut into small pieces and macerate it with 0.9% saline solution

↓

Strip the female with gentle pressure on the abdomen over enamel trey

↓

Pour out the sperm suspension

↓

Mix thoroughly with a feather

↓

Allow to maintain for few seconds

↓

Add clean water

↓

Wait for seconds

↓

Transfer the eggs to plastic tubs or circular tanks before getting adhesive. Run water flow and aeration

↓

Drain out the unfertilized eggs. Keep for 18-24 hrs for hatching

↓

Keep them for three days with continuous water flow and aeration

↓

Transfer them to larval rearing tanks; feed them with minced meat, egg custard, artemia nauplii etc.

1.05.09 DEVELOPMENT AND HATCHING

- The young one hatch out in incubation troughs within 18-20 hrs at 27ºC-30ºC
- 4-cell stage within one hour.
- Morula stage- within 4 hrs.
- Head and tail ends become identifiable within 10-11 hrs.
- Twisting movement after 23 hrs of fertilization.
- Newly hatched larvae 4-5 mm in length.
- Weight- 2.8-3.2 mg.
- Yolk absorption- within 4 days (85-92 hrs).
- Feeding starts - once the yolk gets absorbed.

1.05.10 Larval Rearing is done in indoor rearing tank (1m x1 m x 0.3 m)

Stocking density = 2000-4000 m^{-2}
Rearing period = 10-12 days
Feeds = live plankton, artemia, boiled chicken eggs custard
Feeds sizes = 1st week- 20-30 µ. 2nd week – 50- 60 µ
Aeration = continuous
Water supply = 50% alternative days
Size at the end = 10-12 mm (30-40 mg)

1.05.11 Post larvae rearing

- Indoor or out door
- Soil bed - 6-8 cm thickness
- Water depth- 0.25-0.30 cm
- Provision of floating weeds
- Fertilization- similar to carps nursery (Refer Package 1.02.03.01.01.03)
- Water exchange- 50% on every 3rd day
- Feeds- feed pellet/mixture of trash fish and rice polish/white ants extract etc.
- Stocking density- 1000 nos/m²

1.05.12 Fry Rearing

- Nursery pond (50 m²) - Earthen/cement cisterns
- Water depth - 0.5-1 m
- Stocking density - 200 nos. m^{-2}
- Rearing period - 20 days
- Feeds - finely minced trash fish, rice polish/white ant/silkworm pupae powder etc.
- Feeding rate - 5-10 % of the biomass
- Size at end - 5.0 cm (about 2g)

ECONOMICS

Sl. No.	Items	Specification	No	Cost(Rs.)
A	**Capital Cost**			
i	Small shed	20 m x12 m	1	2,00,000.00
ii	Broodstock ponds (cement cistern)	3 m x 1 m x 1m	4	1,20,000.00
iii	Plastic tub with flow through system		1 unit	50,000.00
iv	Larval rearing tanks	1 m x 0.5 m x 0.3 m	6	60,000.00
v	Fry rearing cement cistern	4 m x 1 m x 0.5 m	5	1,75,000.00
vi	Storage tank	5000 L	1	1,50,000.00
vii	Air compressor		1	30,000.00
viii	Working table		1	10,000.00
ix	Generator		1	50,000.00
	SUB TOTAL (A)			**8,45,000.00**
B	**Recurring expenditure**			
i	Cost of brood stock			20,000.00
ii	Feed cost			10,000.00
iii	Miscellaneous cost including electricity			95,000.00
	SUB TOTAL (B)			**1,25,000.00**

C. Annual investment

a) Annual depreciation on fixed capital cost (10%) : Rs. 84500.00
b) Annual interest on fixed capital cost (10%) : Rs. 84500.00
c) Annual variable recurring cost : Rs. 1, 25,000.00
d) Annual interest on working capital@ 10% :Rs. 12,500.00
Total Annual investment : Rs. 3,06,500.00

D. Gross Income

i. Sale of 1, 50, 000 magur fry @ Rs 5.00 each = Rs. 7, 50,000.00

E. Net Income = Rs. 4,43,500.00

Return on annual investment = 144.7

BCR = 2.45

PACKAGE -2

CULTURE OF CARPS AND BARBS

2.01 COMPOSITE CULTURE OF CARPS AND BARBS

Culture of several compatible fish species of different feeding types and modes together in an aquatic system aiming at fuller utilisation of productivity at all ecological niches is called Polyculture. The manoeuvring of polyculture in the right combination in nutrient managed system is known as the the Composite Culture Technology.

Composite culture is operated in extensive, semi-intensive and intensive scales, of which the semi-intensive system where the water productivity is optimised through extraneous application of manures and fertilisers, and the nutritive demand of fish is partially met with supply of external feed is more popular than the other two. The semi-intensive composite culture technology of carps and barbs is described here.

2.01.01 MERITS

- Creates a controlled ecosystem where pond nutrients are efficiently utilized with minimum waste of bound carbon and nitrogen.
- Fuller utilization of space and food at all ecological niches yielding high production from unit area.

2.01.02 Site Selection: Refer Package 1.01.05

2.01.03 Feasibility of production: Refer Package 1.01.05.01

2.01.04 The economy factor: Refer Package1.01.05.02

2.01.05 Steps for site selection: Refer Package 1.01.05.03

2.01.05.01 A preliminary contour survey-

Topography, area available, accessibility

2.01.05.02 Site selection-Refer Package 1.01.05.03

2.01.05.02.01 Topography: Refer Package 1.01.05.03.02

A gently sloping site is preferable to facilitate drainage as well as water flow from one pond to the other. Plain type layout is also suitable.

2.01.05.02.02 Area available

- Availability of area is the most important and decisive factor for selection of a site for a self sufficient fish production farm. The minimum area required for a commercial fish production farm with 1 bigha grow-out pond and seed raising facility is 2055 m^2.

2.01.05.02.03 Soil characteristics for construction of ponds:

Refer Package 1.01.05.03.03

2.01.05.02.04 Source of water: Refer Package 1.01.05.03.04

2.01.05.02.05 Maximum flood level: Refer Package 1.01.05.03.06

2.01.05.02.06 Legal matters: Refer Package 1.01.05.03.05

2.01.05.02.07 Availability of inputs: Refer Package 1.01.05.03.07

2.01.05.02.08 Manpower: Refer Package 1.01.05.03.08

2.01.05.02.09 Road and transport: Refer Package 1.01.05.03.09

2.01.05.02.10 Market: Refer Package 1.01.05.03.10

2.01.05.02.11 Power supply: Refer Package 1.01.05.03.11

2.01.05.02.12 Storage facilities

Facilities for freezing, icing and storage etc. in the area are also additional advantage for site selection.

2.01.06 POND REQUIREMENTS:

2.01.06.01 Number

2.01.06.01.01 ***Grow-out pond:*** At least one. Number is increased depending upon the area and shape of the site.

2.01.06.01.02 ***Seed raising pond:*** For each unit of 0.28 ha area of grow-out pond, one seed raising pond is essential.

2.01.06.02 Size

2.01.06.02.01 ***Grow-out pond:*** 0.1 -1.0 ha water surface area. Satisfactory production is also obtained from ponds of 0.045 ha water area.

2.01.06.02.02 ***Seed raising pond:*** 0.01-0.045 ha water surface area for each 0.28 ha of grow-out pond.

2.01.06.03 Shape

Rectangular ponds are preferred over square, circular, oval and irregular shaped ponds.

2.01.06.04 Depth

2.01.06.04.01 ***Grow-out pond***: 2.5-3.0 m water level should be maintained in the grow-out pond. Water level should not recede more than 1 m per annum.

2.01.06.04.02 ***Seed raising pond*****:** 1.0-1.5 m water should be retained during rearing period.

2.01.06.05 Productive water conditions: Refer Package 1.01.05.03.13

2.01.07. FARM CONFIGURATION AND LEVEE DESIGN

With the site boundary considered and established, the next step is to survey the area to prepare the lay-out and design the farm.

2.01.07.01 Survey : A contour survey should be done following Grid method in case of small site (<1.0 ha) and Plan table and alided or Transit and studia method in case of large site (> 1.0 ha).

2.01.07.02 Lay out plan: A lay out of the farm indicating number of ponds, their length and breadth, levee, site for farm house, boundary wall, water supply, etc. should be drawn depending on the elevation, size and shape of the site.

2.01.07.02.01 Construction: An ideal pond for commercial culture- Minimum 1 bigha area (1400 m^2), with 2.5- 3.0 m depth with capacity of holding at least 1.5 m water depth throughout the year, with proper side slope and strong embankment. For smooth management a small carriedover seed raising pond (120 m^2) is required per bigha of grow out pond for provisioning fish seed at proper time of stocking.

- Minimum water area: 1 bigha (1400 m^2)
- Minimum land requirement: 2055 m^2
- Land distribution:
  - Grow out Pond 68%: 1400 m^2
  - Embankment etc. 26%: 535 m^2
  - Nursery for seed 6%: 120 m^2
  - The land distribution pattern may fluctuate according to the site, farmers' choice and other factors

2.01.07.02.02 Shape of the ponds- Refer Package 1.01.06.01
2.01.07.02.03 Season for pond construction- Refer Package 1.01.06.02

2.01.07.03 Method of construction of ponds- Refer Package 1.01.06
2.01.07.03.01 Side slope- Refer Package 1.01.06.04

2.01.07.04 Construction of a pond embankment- Refer Package 1.01.06.05

2.01.07.05 Construction of a model pond (Area 1 bigha)

- For construction of a pond of 1 bigha (1400 m^2), initially a rectangle of 40m x 35m should be demarcated with the help of 4 bamboo poles which are connected to each other with the help of rope or nylon thread to give the shape of rectangular area of the main pond.
- Now if the slope is to be maintained at 2:1 ratio and peak of the embankment is 1m wide, then width of the base would be 5m as mentioned earlier. As such, another two rectangles should be demarcated in a similar manner, one outside the main pond measuring 45m x 40m, and the other inside the main pond measuring 38 m x 33m.
- After demarcation of the three rectangles, the inner most rectangle (38m x 33m) should be dug out first and the excavated soils are deposited in the space between the outer two rectangles to construct the embankment.
- When digging of the 1st rectangle to the predefined level is completed, the second rectangle should be dug out in such a way, so that there is a slope from the boundary of this rectangle which finally touches the boundary of the innermost rectangle creating a slope of 2:1.

2.01.07.06 Levee protection measures

2.01.07.06.01 Turfing should be done to have a sod cover. Para grass (*Brachiaria* spp.) provides the best cover in Assam.

2.01.07.06.02 Burrowing aquatic animals should be controlled.

2.01.07.07 Seepage control

2.01.07.07.01 Compaction: Where soil particle size ranges from coarse sand to fine clay with minimum 10% clay, and depth is less than 3 m, compaction can alone prevent seepage, compacted depth should be minimum 20 cm. Sheepfoot roller can be used for compaction.

2.01.07.07.02 Clay blankets: For ponds of coarse grained soil with 3 m depth, clay blankets of 30 cm thickness can be used. For every 30 cm of depth increased over 3 m, thickness of blanket increased by 5 cm.

2.01.07.07.03 Bentonite: After proper analysis of soil properties bentonite (fine grained colloidal clay) can be applied at the rate of 5-15 kg ha^{-1}.

2.01.07.08 Other infrastructures

Land grading and levelling, construction of farm house, watchman shed, stores etc., and electrification, installation of farm equipments, boring of well and installation of pumps as per design should be executed in order.

2.01.08 RECLAMATION OF NON-DRAINABLE PONDS

Old fallow ponds are as such not suitable for semi-intensive composite culture of carps and barbs. Such ponds are often characterised by dense mass of aquatic vegetation and high organic load. These water bodies should be reclaimed in systematic succession, the order for which in planned as per convenience.

2.01.08.01 Eradication of aquatic weeds

A balanced biomass of submerged vegetation and algal growth is requisite for the ecosystem of a composite culture pond. Excessive infestation is harmful. Clearance of weeds is the primary consideration in case of reclamation of old ponds for fish culture.

Water hyacinth, Ipomoea, Sedges, Rushes, Lotus, Lilies, Otelia, Vallisneria, Pistia, Salvinia, other aquatic grass and planktonic and filamentous algae are the major menace to fish culture ponds. Ponds should be kept free of all these aquatic weeds.

2.01.08.02 Methods of weed eradication

2.01.08.02.01 ***Manual and mechanical method:*** When infestation is scanty and scattered or water body is small, weeds can be eradicated by hand picking, uprooting and/or by using scythes. Log weeder fitted with spikes and barbed wire can be dragged. Mechanical winches may also be used for cutting dense submerged weed.

2.01.08.02.02 ***Chemical method*****:** Large water bodies with heavy infestation can be cleared by applying chemical weedicides. Dead weeds generally settle down to the bottom and decompose. Common weedicides, the weeds on which they affect, their dose and method of application are given in Table-1. Chemical device and subsequent decomposition *in situ,* must not be adopted in high organic loaded water bodies.

Table-1: Common herbicides for chemical control of aquatic weeds

Weeds	Herbicides	Dose (g m^{-2})	Method of application
Water hyacinth	2,4-D	0.8-1.0	Foliar spraying
Ipomoea	2,4-D	0.2-0.4	Foliar spraying
Sedges and rushes	2,4-D	0.5-1.0	Foliar spraying or root zone treatment
Lotus and lilies	2,4-D	0.5-1.0	Root zone treatment
Otteleia & Vallisneria	2,4-D	1.0-2.0	Root zone treatment
Aquatic grasses In young stage In adult stage	Dalapon Parasuat Diuron	0.5-1.0 0.2 0.4	Foliar spraying Foliar spraying Root zone treatment
Planktonic & filamentous algae	Diuron	0.1-0.3 ppm	Root zone treatment or dispersal in water column
All submerged weeds	Ammonia		Root zone treatment or dispersal in water column
Pistia	Ammonia Paraquat	1% aqueous solution 0.2	Foliar spraying solution with 0.25% wetting agent Foliar spraying
Salvinia	Ammonia Paraquat	2% aqueous solution with 0.25% wetting agent 0.4	Foliar spraying Foliar spraying

Foliar spraying: *Herbicide is dissolved in sufficient volume of water and sprayed over the foliage uniformly by means of sprayer*

Root Zone treatment: *Brick pellet is soaked in herbicide solution and applied in the root zone of the weeds.*

2.01.08.03 Eradication of unwanted fishes

2.01.08.03.01 Application of bleaching powder: Bleaching powder (Calcium hypochlorite) can be applied at the rate of 25-30 ppm for this purpose. Required quantity is dissolved in water and sprayed over the water surface. After 3-4 hours of spraying, the killed and distresses fishes are removed by repeated netting. Bleaching powder is effective only when it is fresh and kept in air tight container. Toxicity lasts for 7-8 days. Fishes killed by this method are edible. Dose of bleaching powder can be reduced to half if it is applied 24 hrs. after application of urea @ 100 kg ha^{-1}.

2.01.08.03.02 Repeated netting: Drag netting in quick succession is an alternate choice. Complete eradication is not possible by this method.

2.01.08.03.03 Application of Mohua oil Cake: Oil cake of Mohua (*Madhuca latifolia*) can be applied as pesticide at the rate of 250 ppm. Toxicity lasts for 15-20 days. Fish killed by the application of mohua oil cake are edible. Mohua oil cake availability in Assam is limited.

2.01.08.04 Complete dewatering

Ponds are completely dewatered for proper reclamation and recovering. In such cases, piscicides need not be applied for eradication of unwanted fishes. Fishes are caught after dewatering.

2.01.08.05 Exposure of bottom to sun

After dewatering, pond bottom should be exposed to bright sun for about 15-20 days till it cracks. Evacuation of ditches of 'Fish-bone' design should be done for draining seepage water during the process. The water should be pumped out regularly.

2.01.08.06 Removal of muck

The pond bottom should be excavated to the optimum depth. Where optimum depth exists excess muck should be removed.

2.01.08.07 Repairing of side slopes

Embankments and sides should be repaired while removing the muck. Hard soil should be used for repairing the side slopes.

2.01.08.08 Soil correction

Bottom soil should be turned up for recovering the pond properly. Ploughing helps in releasing many obnoxious gases and in making the soil soft and bottom should be treated with lime as given in following sections.

2.01.09 WATER QUALITY MANAGEMENT IN FISHERIES

Parameters

Physical, Chemical and biological factors influence the quality parameters of fresh waters.

Important physical parameters are temperature, salinity and colour, which are dependent upon climatic and geophysical situations of a region. Preferred ranges are given below:

Chemical parameters are varied and for fresh water fisheries followings are important whose conducive ranges are given along with:

Factor	Range
Temperature (^oC)	26-32
Salinity (ppt.)	<0.5
Transparency (cm)	30-60 (Secchi Disc)
Mud turbidity (mg l^{-1})	<30
Dissolved oxygen (mg l^{-1})	5 – 10
Total Dissolve CO_2 (mg l^{-1})	<3
pH	6.7 – 9.2
Total Alkalinity (mg l^{-1})	25 -150
Total Hardness (mg l^{-1})	100-130
Total Solid Substance (mg l^{-1})	<500
Total dissolved substance (mg l^{-1})	30-200
Unionized NH_3 (mg l^{-1})	0-0.1
lonized NH_4 (mg l^{-1})	0-1.0
Chloride (mg l^{-1})	30 - 50

Nitrate (NO_3^{--}) (mg l^{-1})	0.1-3.0
Nitrate (NO_2^{--}) mg l^{-1}	0 - 0.5
Total Nitrogen (mg l^{-1})	0.5-4.5
Total phosphorus (mg l^{-1})	0.05 – 0.4
Potassium (mg l^{-1})	0.5 – 1.0
Calcium (mg l^{-1})	75 – 150
Sulfate (mg l^{-1})	20 – 200
Silica (mg l^{-1})	4-16
Iron (mg l^{-1})	0.01 – 0.3
Manganese (mg l^{-1})	0.001 – 0.002
Zinc (mg l^{-1})	0.002 -0.01
Copper (mg l^{-1})	0.003 – 0.005
Cobalt (mg l^{-1})	<0.003
Hydrogen Sulfide (mg l^{-1})	<0.002
Residual chlorine (mg l^{-1})	<0.003
BOD (mg l^{-1})	<10
COD (mg l^{-1})	<50
Redox potential (volt)	0.4 – 0.52

2.01.10 Techniques for Increasing Primary Productivity of fresh water.

Water qualities of ponds varies largely as these are dependent upon varied factors viz. location, size, source of water, bottom mud and its unsaturated condition, types of fish cultured and hydrology. Thus ponds in close- quarters also exhibit different qualities. Therefore, various treatments advocated (liming and fertilizations) for fish pond water quality managements and maintain the various ideal levels within the ranges indicated in the table above, in the geo-climatic locations of the Brahmaputra and the Barak valleys of Assam; the approximate quantities of inputs and their application procedures and monitoring for carp culture practices are described hereunder:

2.01.11 PREPARATION OF POND

To enhance the productivity at primary and secondary levels the pond is to be prepared properly and followings are the measures for it:-

2.01.11.01 Desilting: Other than the newly constructed ponds or reclaimed ones, the ponds are to be desilted at least once every two years. Ponds in integrated farming accumulates large amounts of organic matter and they be desilted every year.

2.01.11.02 Bottom raking: In case desilting become extremely difficult, as a temporary relief pond bottom must be raked manually or mechanically. A nylon rope or chain, tied with broken bricks at 0.5- 0.75 m interval can be dragged over the pond bottom several times for the purposes.

Only after desilting or bottom raking the initial dose of lime for pond preparation should be applied, to initiate fish culture.

2.01.11.03 Lime application:

Liming is done based on the bottom mud unsaturation condition (determined by cation exchange capacity test) or soil pH status of the pond. Although former test is more precise, farmers' accessibility to it cannot be ascertained and thus dosages of lime are recommended on the basis of soil pH.

2.01.11.03.01 Liming materials:

1) Agricultural lime or calcium carbonate ($CaCO_3$)= neutralizing value (nv)= 100%

2) Dolomite ($CaMgCO_3$)= nv = 109%

3) Slaked lime, hydrated lime, builders' lime ($Ca(OH)_2$= nv= 136%

4. Quick lime, burnt lime, calcium oxide (CaO)= nv= 179%

Dosages of lime are calculated based on the neutralizing value of liming material. Agricultural lime or dolomite is more preferred material as these release bicarbonate ions slowly and for longer period of time to maintain alkalinity at desired levels. Normally slaked lime and Quicklime should be applied in dry powdered form uniformly to the pond bottom after desilting or in reclaimed pond bottom prior filling with water.

2.01.11.03.01.01 Dosage of liming material on soil pH status

Soil pH range	Required amounts in kg yr^{-1} $bigha^{-1}$ (ha^{-1}) water area			
	Agricultural lime	dolomite	Slaked lime	Quick lime
7.5 – 6.5	96.00 (720.00)	81.00 (606.00)	68.00 (509.00)	53.00 (400.00)
6.5 – 6.0	240.00 (1800.00)	214.00 (1605.00)	174.00 (1303.00)	133.00 (1000.00)
6.0 – 5.0	287.00 (2150.00)	254.00 (1907.00)	201.00 (1508.00)	160.00 (1200.00)
5.0 – 4.0	477.00 (3580.00)	428.00 (3208.00)	347.00 (2603.00)	267.00 (2000.00)

2.01.11.03.01.02 Methods of application

Followings are some of the most effective methods:

(1) Lime should be applied in split-up dose and it is dangerous for fish if the amount for the year is applied as a single dose. Normally 25-30% of the total requirement is applied during pond preparation to dry bottom raked wet bottom soil. Remaining quantities of lime is applied in equal monthly instalments and 7 days prior to application of manures, specially phosphate fertilizers.

(2) Dry bottom of ponds is treated with powdered slaked or quick lime to disinfect and reduce acidity of the soil. In case of water filled ponds if these two liming materials are used they be pre-dissolved to liquid state in a container and after the exothermic reactions, dispersed over the water surface.

(3) Required quantities of Agricultural lime or dolomite are normally applied on plateforms raised 15-30 cms underneath surface water as a pile/heap in the wind-ward direction to facilitate slow melting of lime over a period of time and gradual mixing with water.

2.01.11.04 Fertilization

Pond fertilization for herbivorous fish culture is a must to increase productivity at various levels. Organic and inorganic fertilizers are used world over and a combination of both has been found more suitable and economic for carp fish culture.

2.01.11.04.01 Organic fertilizers (Manure):

A wide variety of organic materials can be used to fertilize pond waters. They are Classified as follow:-

- Manure containing little or no carbohydrate
- Animal excreta
- Manures containing some amount of carbohydrate
- Farm yard manures (cow/pig dung), brewery refuse, sewage, sludge etc.
- Manures containing chiefly carbohydrate
- Plant material, cellulose waste, molasses, cotton seed meal, tea seed cake, oil seed cakes etc.
- For carp culture normally manures containing some amount of carbohydrate are preferred.

2.01.11.04.02 Inorganic fertilizers:

Inorganic fertilizers containing, primary nutrient viz. nitrogen (N), phosphorus (P) in branded compounds are usually used. Potash (K) is also a primary nutrient which play important role in seed/ fruit bearing is normally not used in fisheries.

- Important nitrogen containing inorganic fertilizers are urea (45-46% N), Sodium nitrate (16% N), Ammonium sulfate (20-21% N), Calcium nitrate (15.5% N), Ammonium liquor (20% N)
- Important phosphate fertilizers are single super phosphate (SSP: 16% P_2O_5), Triple super phosphate (TSP : 32-54% P_2O_5).
- Mixed fertilizer are Monoammonium Phosphate (MAP: 11% N and 48% P_2O_5), Diammonium Phosphate (DAP: 18% N and 48% P_2O_5).

2.01.11.04.03 Application:

A combination of organic manure and inorganic fertilizers has been considered as most effective way to increase primary productivity of carp culture ponds.

The farm yard manures preferably should be semi dried prior applying to the pond; although as slurry the required quantities can be directly injected to the water.

Inorganic fertilizers should be applied on platforms, as described in case of lime application.

Nitrogen and phosphate may be applied together.

2.01.11.04.04 Dosages of fertilizer:

It is essential to know the inherent fertility of soil, to determine the required dosages of organic and inorganic fertilizers. Table below shows the required amounts, based on fertility status of soil.

Table: Fertilizer dosages based on status of soil fertility.

Fertility Status	Organic matter (%)	Avl. N ($mg100g^{-1}$)	Avl. P_2O_5 ($mg100g^{-1}$)	Total Fertilizer requirement kg $bigha^{-1}$ ($kg\ ha^{-1}yr^{-1}$)		
				Manure	N	P
Low	<0.5	<25	<3	1470 (11,000)	14.67 (110)	13.33 (100)
Medium	0.5-1.5	25-50	3-6	1200 (9,000)	13.33 (100)	10.0 (75)
High	1.5-2.0	>50	>6	1000 (7,500)	12.00 (90)	6.70 (50)

N.B. Depending upon the type of commercial brands of inorganic fertilizers the actual dosages of fertilizers shall be of following order. From the list below select any one of the nitrogen and the phosphate fertilizer to apply. If DAP/MOP is used it should be accompanied by urea as indicated along with.

Type of fertilizer	Requirement for soil status kg $bigha^{-1}yr^{-1}$		
	Low	Medium	High
A. Nitrogen fertilizer			
1) Urea (45% N)	32.60	29.60	26.67
2) Ammonium Sulphate (20.5% N)	71.60	65.00	58.50
3) Calcium nitrate (15% N)	97.80	88.87	80.00
4) Sodium nitrate (16% N)	91.69	83.30	75.00
B. Phosphate fertilizer			
1) Single super phosphate (19% P_2O_5) (SSP)	70.00	52.00	35.26
2) Triple super phosphate (43% P_2O_5) (TSP)	31.00	23.26	15.58
C. Mixed fertilizer			
MAP (11% N & 48%P_2O_5) + urea (45% N)	27.77 MAP +24.15 Urea	20.83 +23.00	13.96 +21.81
DAP (18%N & 54%P_2O_5) +Urea (45%N)	24.69 DAP +45.00 Urea	18.52 +33.75	12.40 +22.60

N.B. At the time of procurement, it is necessary to check the percentages of N and P_2O_5 in the branded fertilizers; accordingly the calculations should be made.

2.01.11.04.05 Mode of application

- Initial dose of organic manure should be 20% of total required amount. It should be applied after a week of application of initial dose of lime indicated earlier. Rest 80% be applied as split up equal dose at monthly intervals.
- Nitrogen and phosphate fertilizers are split-up into 11 equal installments to apply at monthly intervals. Initially nitrogen fertilizer should be applied after one week of manuring; while ensure pre liming to add phosphate fertilizer.
- All the organic fertilizers should be placed in heaps under shallow water for slow mixing in water by wind action and proper utilization by phytoplankton.

2.01.11.04.06 Suspension

- Manuring and inorganic fertilizations are to be suspended if algal bloom occur, till such time when such bloom disappear.
- Application of higher dose of nitrogen fertilizer in water enhance the rate of denitrification and escape of N_2 to atmosphere. It also facilitate growth of unwanted blue-green algae which causes odd flavour in cultured fish. Shelf life of harvested fishes also get reduced.

2.01.11.04.07 Table-1: Generalised fertilization schedule for composite fish culture

Manure/ Fertilizer	**Qty (kg 0.045ha^{-1} Month^{-1})**	**Qty (kg 0.28 ha^{-1} Month^{-1})**	**Qty (kg ha^{-1} Month^{-1})**	**Remarks**
Cowdung	90	560	2000	Initially
Cowdung	45	280	1000	Monthly
Urea	1.125	7	25	Monthly
SSP	0.900	5.6	20	Monthly

Suspension: Manuring and fertilization is immediately suspended on occurrence of algal bloom till it disappears.

2.01.12 STOCKING

2.01.12.01. Selection criteria

The basic consideration for selection of fish species are:

- Rapid growth potential
- Ability to use the natural food efficiently and accept artificial feed with low conversion ratio.
- Should have small head, high body and thick back.
- Should be hardy and disease resistant
- Should be easy to breed.
- Should have prolonged breeding season or multiple spawning frequency.
- Should be non-predacious and filter feeder, grazer, or forage on benthic materials or extract organic material from muck.
- Should be compatible with others which are cultured together.
- Should have low bone to flesh ratio.
- Should have high nutritive value and palatability.

2.01.12.02 Species

Indigenous species:

Sl. No.	Species	Scientific name
1.	Catla	*Catla catla*
2.	Rohu	*Labeo rohita*
3.	Mrigal	*Cirrhinus mrigala*

Exotic species:

Sl.No.	Species	Scientific name	Origin
1.	Silver carp	*Hypophthalmichthys molitrix*	China
2.	Grass carp	Ctenopharyngodon idella	China
3.	Javaputhi	*Puntius javanicus*	Indonesia
4.	Common carp	*Cyprinus carpio* Var. *Communis*	Bangkok & Germany

2.01.12.03 Stocking: Ponds are generally stocked with fingerlings @ 8000 to 10000 ha^{-1}.

2.01.12.04 Species combination:

i. Six species composite culture

Sl. No.	Species	Percent composition	Nos. ha^{-1}
1.	Silver carp	15	1200
2.	Catla	25	2000
3.	Rohu	25	2000
4.	Grass carp	10	800
5.	Mrigal	15	1200
6.	Common carp	10	800

ii. Three Species composition:

Sl. No.	Species	Percent composition	Nos. ha^{-1}
1.	Catla	40	3200
2.	Rohu	40	3200
3.	Mrigal	20	1600

iii. Combination with Minor carps & barbs:

Sl. No.	Species	Percent composition	Nos. ha^{-1}
1.	Silver carp	10	800
2.	Catla	25	2000
3.	Rohu	25	2000
4.	Java puthi	10	800
5.	Mrigal	10	800
6.	*Labeo calbasu*	10	800
7.	*L.gonius*	10	800

iv. Combination with Minor carps

Sl. No.	Species	Percent composition	Nos. ha^{-1}
1.	Silver carp	10	800
2.	Catla	25	2000
3.	Rohu	25	2000
4.	Mrigal	10	800
5.	*L.bata*	10	800
6.	*Labeo calbasu*	10	800
7.	*L.gonius*	10	800

v. Combination with Minor carps and Magur

Sl. No.	Species	Percent composition	Nos. ha^{-1}
1.	Silver carp	10	800
2.	Catla	25	2000
3.	Rohu	25	2000
4.	Mrigal	10	800
5.	*L.bata*	10	800
6.	*L. calbasu*	10	800
7.	*L.gonius*	5	400
8.	Magur	5	400

2.01.12.05 Stocking size

Pond should be stocked with fingerlings of 10- 15 cm size. In case such fingerlings are not available, advance fry may be used.

2.01.12.06 Stocking time

Stocking should be done at the onset of high temperature regime in March so that optimum temperature can be obtained for a maximum period i.e. 7-8 months. However, breeding season in Assam does not tally with the optimum stocking time. Fish fingerlings become available from June onwards. Therefore to redress the problem carried over seeds should be used.

2.01.12.07 Carried over seed:

The method of carried over seed from first year to second year is detailed below:

2.01.12.07.01 ***Seed raising pond:*** As mentioned in 2.01.06.01.02

2.01.12.07.02 ***Pond preparation:*** As described in 2.01.11

2.01.12.7.03 ***Stocking*****:** Early fry catla (25%), mrigal (33%), rohu (25%) and grass carp (17%) are stocked at the rate of 1,00,000 ha^{-1} in August-September. Since common carp and silver carp fingerlings are available by the end of March, these two species need not be carried over.

2.01.12.07.04 ***Feeding:*** Supplementary feeding is done with rice bran at the rate of 0.5% body weight once in two days

2.01.12.07.05 ***Water management:*** Liming should be done regularly. Water depth should be maintained at 1.0 m. Algal bloom should be controlled.

2.01.12.08

Table-1: Cost of carried over seeds from first year to second year for stocking in a 0.28 ha pond

VARIABLE COST			
Head of expenditure	**No./Qty**	**Rate (Rs.)**	**Cost (Rs.)**
Early fry (including transportation)	1200 nos.	30 hundred^{-1}	360.00
Lime	17.0 kg	15 kg^{-1}	255.00
Cowdung	84.0 kg	0.6 kg^{-1}	50.00
Urea	1.8 kg	10 kg^{-1}	18.00
SSP	1.5 kg	10 kg^{-1}	15.00
Rice polish	21.0 kg	20 kg^{-1}	420.00
Total Expenditure			**Rs.1118.00**
PRODUCTION			
Product			**Nos.**
Carried over seeds			800 nos.
Cost of production per seed			**Rs.1.40**

Transportation of seeds is best done in early morning hours. Water for transportation should be collected from ponds in which they are reared. Fingerlings are transported in oxygenated polythene bags for distant places. Fingerlings to a nearby pond can be shifted by buckets with wet cloth flap.

2.01.12.09 Releasing seeds in grow out pond

The transporting container is dipped in pond water and given sufficient time for thermal acclimatization. The container is untied and tilted slowly.

2.01.12.10 Toxicity test

Before releasing fingerlings in the ponds (specially in newly reclaimed ponds and where weedicides, insecticides or piscicides are applied) toxicity should be tested. A few fingerlings are released in a hapa and observed carefully for 24 hours. The comfortable behaviour indicates detoxification of the pond.

Table-1: Food and feeding habits of Indian Major Carps and Common carp

Species (Common name)	Stage	Food	Feeding habits
Catla catla (Bhakua/Bahu)	Fingerlings	Water fleas, Planktonic algae and Vegetable debris	Surface feeder
	Adult	Crustaceans, Plants, Rotifers, Insects, Vegetable debris (Zooplankton form the main food)	
Labeo rohita (Row)	Fingerlings	Vegetable debris, microscopic plant	Predominantly column feeder
	Adult	Vegetable debris, microscopic plant, decayed higher plants, detritus and periphyton	
Cirrhinus mrigala (Mirika)	Fingerlings	Decayed plant and animal matter, algae, detritus, mud etc.	Bottom feeder
	Adult	Decayed plant and animal matter, algae, detritus, mud etc.	
Hypophthalmichthys molitrix (Silver carp)	Fry (10-20 mm)	Zooplankton such as rotifer, nauplii of copepods, water flea etc.	Surface feeder
	Fry (30 mm)	Mainly Phytoplankton and secondarily zooplankton	
	Adult	Predominantly Phytoplankton	
Cyprinus carpio (Common carp)		Omnivorous, feeds voraciously	Bottom feeder
Ctenopharyngodon idella (Grass carp)	Fry (<30mm)	Zooplankton such as rotifer, nauplii of copepods, water flea etc.	Surface feeder
	Fry (30–100 mm)	Tender aquatic plant	
	Fingerling (>100-150 mm)	Many kinds of aquatic vegetations	
	Adult	Aquatic and land plants	

2.01.13 Nutritional Requirements of carps:

- Dietary crude protein requirement varies between 25-45%.
- Young fish (<1g) require 40-45% Crude protein.
- Fish weighing more than 5g appear to need 25-35% crude protein.
- Level of Lipids require is 10-20%.
- Carbohydrate level requirement is up to 30%.
- Vitamins and minerals requirement is at 2% level.
- Required energy level is between 3.5-4.0 Kilo calorie g^{-1} of diet.

2.01.13.01 Importance of Feed:

- In extensive & semi-intensive systems, the exogenous food supply needs to provide only nutrients which may be deficient in the natural food.

2.01.13.02 Supplementary Feeding:

❖ **Ingredients:**

- Ingredients are available from plant & animal origin.
- Plant origin- Rice polish, Wheat flour, Wheat bran, Oil cakes (Mustard, Ground nut, Soybean, Sunflower) Dried leaf powder etc.
- Animal origin – Fish meal, Slaughter house waste, Blood meal, Silkworm pupae, meal etc.

2.01.13.03 Balance of Nutrients:

- An ideal feed should have adequate levels of bio-available energy, a blend of proteins & fatty acids and adequate levels of Vitamins & Minerals.
- All the nutrients must be in balanced proportions in the diets offered to cultured fish.

2.01.13.04 Traditional Fish feed / Conventional feed:

- Rice polish and Mustard or Ground nut oil cake (MOC or GOC) are the traditional /Conventional fish feed ingredients.

2.01.13.04.01 Preparation:

- Rice polish and oil cakes are mixed at the ratio of 1:1 by weight.
- Oil cake is soaked for few hours and mixed with dry rice polish.

2.01.13.04.02 Pelleted Fish Feeds:

- Floating pellets
- Sinking pellets

2.01.13.04.03 Feeding Methods:

- Powdered dry fish feed mixture need to be broadcasted for young fishes
- For adult fishes feed mixture is divided into several parts and supplied on feeding trays (Bamboo trays, plastic trays etc.) placed in the peripheral areas of the pond.
- Feed mixture may also be kept in perforated synthetic bags tied to bamboo poles. About 20-30 bags are kept per hectare.
- Floating pellet is broadcasted over the pond
- Small boat need to be used for broadcasting feeds in fish ponds over 0.5 ha

2.01.13.04.04 Feeding Rate:

- Feeding rate varies between 1-5% of the fish biomass.
- The amount of feed to be given daily can be calculated as follows:

Feed to be given = No. of fish x Average weight x Feeding rate (% biomass /100)

2.01.13.04.05 Feeding Frequencies:

- Continuous feed supply for young fishes
- For adult fishes daily ration of feed is offered in several meals often 4-6 times a day (6 am to 6 pm).

2.01.13.04.06 Feed for grass carp:

- Grass carp generally feeds on aquatic vegetation specially submerged and marginal plants. In absence of aquatic vegetation, green fodder such as Para, hybrid Napier, barseem, green vegetable wastes, banana leaves may be supplied. Sufficient feed should be supplied for grass carp. Aquatic plants such as *Hydrilla*, *Najas*, *Vellisnaria* etc. are preferred.

2.01.14 WATER MANAGEMENT: Refer Package 2.01.09

2.01.14.01 Depth

Depth should be maintained at 1.5 m and maximum should not exceed 3.0 m. Excess water should be drained out and when recedes, water should be let in.

2.01.14.02 Liming: Ref Package 2.01.11.03

2.01.14.03 Fertilization: Ref Package 2.01.11.04 to 2.01.11.04.07

2.01.15 Control of algal bloom

- Suspension of fertilization.
- Suspension of supplementary feeding.
- Chemical methods
- Prevention of light penetration: Light penetration into the pond is prevented in order to stop photosynthesis of phytoplankton by a temporary vegetative cover on the pond surface. Floating aquatic weeds such as water hyacinth, *Pistia* etc. are used for this purpose.
- Reducing nutrients in pond water: Introduction of aquatic macrophytes such as water hyacinth, *Pistia* etc. can reduce the nutrient level in pond water thus discouraging multiplication of phytoplankton.

2.01.16 HEALTH CARE

- Proper hygienic conditions should be maintained in the farm.
- Test netting should be done at monthly interval for monitoring disease and growth.
- Behaviour of fish should be observed every morning.
- Prophylactic and curative measures should be taken as described in package-7

2.01.17 HARVEST

Above 0.750 kg fishes are considered to be marketable. Depending on productivity and management practices, some fishes attain 0.750 kg weight within of period of 6-7 months rearing. Such fishes should be harvested to facilitate smaller fishes to grow. Partial harvesting is done in the month of September, when stocking is done in March. The stock is replenished with same number of fingerlings of harvested fish. Final harvesting is done in January, i.e. at the end of eleventh month of rearing.

Final harvesting is done by complete dewatering of pond.

2.01.18 ANNUAL WORK CALENDER

An annual work calendar is outlined below 8 for proper management of semi-intensive culture of carps and barbs. Adoption of the calendar can assure a production of 4000 kg fish per ha per yr.

Table : Operational calendar for composite culture of carps & barbs		
Month	**Activities**	**Remarks**
February	Weed clearance & removal of unwanted fishes. Pond liming & pond fertilization	$1/3^{rd}$ of total quantity of lime on pond bottom or in water
March	Stocking-bottom feeder followed by column feeder & surface feeder. Feeding, Liming & fertilization. Keep embankment clean.	Feed rice polish & oil cake @ (1:1) 4 kg $ha^{-1}day^{-1}$. Grass is chopped well.
April	Feeding, liming & fertilization. Keep embankment clean	Feed @ 5kg $ha^{-1}day^{-1}$
May	Feeding, liming & fertilization. Keep embankment clean	Feed @ 6 kg $ha^{-1}day^{-1}$
June	Feeding, liming & fertilization. Prevent over flow	Feed @ 8 kg $ha^{-1}day^{-1}$
July	Feeding, liming & fertilization. Control algal bloom, prevent over flow	Feed @ 10 kg $ha^{-1}day^{-1}$ fertilization may be suspended to prevent algal bloom
August	Feeding, liming & fertilization. Control algal bloom	Feed @ 12 kg $ha^{-1}day^{-1}$
September	Feeding, liming & fertilization. Control algal bloom. Partial harvesting & replenishment of stock. Health check up. Dip treatment in $KMnO_4$	Fishes above 0.750 kg size should be harvested. Feed @ 14 kg $ha^{-1}day^{-1}$. Dip in 1 ppm solution after every netting.
October	Feeding, liming & fertilization. Control algal bloom. Health check up & $KMnO_4$ bath dip treatment.	Feed @ 16 kg $ha^{-1}day^{-1}$ Bath or dip in 1 ppm solution.
November	Feeding, liming & fertilization. Control algal bloom. Health check up & treatment	Feed @ 16 kg $ha^{-1}day^{-1}$. Bath or dip in 1 ppm solution as previous month
December	Feeding, liming & fertilization. Control algal bloom. Health check up & treatment	Feed @ 16 kg $ha^{-1}day^{-1}$. Bath or dip in 1 ppm solution as previous month
January	Feeding, liming & fertilization. Control algal bloom. Health check up & treatment. Final harvest	Feed @ 16 kg $ha^{-1}day^{-1}$. Pond should be dewatered in possible cases for harvesting

2.01.19 PRODUCTION

A production of 4000-4500 kg fish per year can be achieved from 1 ha water surface area.

2.01.20 ECONOMICS

The variable cost and return functions of semi-intensive culture of carps & barbs, operated by adopting the above annual work calendar are calculated for 0.28 ha pond are given below which shows that an investment of Rs.1,32,000.00 assures a return of Rs.1,80,000.00. The net return on variable cost worked out is 36.36% and cost of production per kg fish worked out is Rs.110.00

ECONOMICS OF COMPOSITE CULTURE OF CARPS AND BARBS (0.28 ha)

VARIABLE COST			
Head of expenditure	**Qty/No**	**Rate (Rs.)**	**Cost (Rs.)**
Dewatering & desilting			5000.00
Agricultural lime	602 kg.	7 kg^{-1}	4214.00
Cow dung	3360 kg.	0.6 kg^{-1}	2016.00
Urea	70kg	10 kg^{-1}	700.00
Single Super phosphate	98 kg	10 kg^{-1}	980.00
Carried over seeds	2400	5/seed	12000.00
Feed: Rice polish Mustard oil cake	 570 kg. 570 kg.	 10 kg^{-1} 20 kg^{-1}	 5700.00 11400.00
Labour wage	80 man days	200/day	73000.00
Misc. Expenditure			1000.00
Total			1,20,000.00
Interest		10%	12,000.00
Total variable cost			1,32,000.00
RETURN			
Product	**Qty (kg)**	**Rate (Rs.)**	**Sale proceed (Rs.)**
Fish	1200	150 kg^{-1}	1,80,000.00
Total return			**1,80,000.00**
Cost of production per kg fish			**110.00**
Profit			**48000.00**
Per cent Return to variable cost			**36.36%**
Per cent profit to turn over			**26.67%**
BCR			**1.36**

N.B.: Cost of fodder is not included

2.02 MULTIPLE STOCKING AND MULTIPLE HARVESTING OF CARPS

There are some basic agro-climatic problems in Assam and the neighboring states in achieving better production of carps through yearly harvesting system. Some of the identified problems are like:

i. Soil and water of this region is normally acidic and unless soil and, thereby, water is made sufficiently alkaline, fish do not grow well and incidence and intensity of disease increase.

ii. From mid November, water temperature starts declining, reaches down to 10-15^{0}C during December-January and ambient temperature prevails only from the fag end of the month of February. Except common carp, feeding rate of all carps go down during this period. Below 20^{0}C, the fishes stop feeding. Therefore, during this period fish growth is virtually stands still.

iii. To get optimum temperature range for maximum time period, stocking should be done in March-April. However, due to insufficient water depth in most of the ponds, it is not done. Fishes are normally stocked in the month of June. Because of this, culture period is reduced to 7-8 months only (high temperature regime)

iv. Most of the districts of Assam are flood – prone which makes fish cultivation of one yearly harvest cycle an uncertain production system.

2.02.01 The Technology

In this system, a rearing pond is required preferably adjacent to the stocking pond.

2.02.01.01 Size of Pond:

Stocking pond: 0.3-0.4 ha

Rearing pond: 0.07-0.08 ha

2.02.01.02 Pre-stocking management

2.02.01.02.01Stocking pond:

Construction of new ponds: Refer package 1.01.06

Renovation of old pond: Refer Package 2.01.08

2.02.01.02.02 Liming: Refer package 2.01.11.03

2.02.01.02.03 Manuring:

- Manuring is done after 7 days of liming. The first installment is applied @ 3000kg raw cow dung / 1300kg poultry droppings / 1500 kg pig dung per ha.
- Mix the required quantity with pond water evenly, spray over the entire water surface of the pond. Stocking is done after 10-12 days.
- After this, manure is applied in heaps in the four corners of the pond every month @1000 kg cow dung/ 250 kg poultry droppings/ 350 kg pig dung per ha.
- The monthly installment may be divided and applied on weekly basis.

2.02.01.02.04 Fertilization:

- Inorganic fertilizers are applied @ 18 kg urea and 27 kg single super phosphate per ha per month after 7 days of application of organic manure.

- Urea is dissolved in water and sprayed over the water surface. Phosphate fertilizer is divided in 3-4 equal parts, placed in porous gunny bags, tied to strong bamboo pools/sticks and kept immersed at 6 inch down the water surface at equal distance.

2.02.01.03 Stocking:

- Stocking is done after 10-12 days of spraying of liquid manure when water colour becomes slight greenish.
- **Species:** Catla, Rohu, Mrigal, Silver Carp, Grass Carp and Common Carp.
- **Size:** Unequal size, from 8-15 cm.
- **Rate of stocking:** 20,000 – 25,000 ha^{-1}. Experienced farmer may go up to 30,000 ha^{-1}.

Ratio:

Catla	: 15
Rohu	: 30
Mrigal	: 25
Silver carp	: 15
Grass carp	: 10
Labeo bata /Common carp	: 5
Total	**: 100**

2.02.01.04 Supplementary feeding: Nutritional supplementation should be done for quick growth of fish. Rice polish, mustard oil cake and fish meal are the major ingredients fortified with vitamin and mineral mix.

Feed ingredients	Composition (%)
Rice polish	40
Mustard oil cake	40
Fish meal	20
Total	100

Vitamin and mineral mix: 1 kg 100 kg^{-1} feed

Preparation:

Mustard oil cake is soaked in water overnight. Before feeding, required quantity of rice polish, fish meal and vitamin & mineral are mixed properly to make dough and fed to fishes. For better digestibility of feed and, thereby, for better enhancement of growth, the feed mix is cooked, cooled, fortified with vitamin and minerals.

Feeding Method:

Bag or tray feeding method is adopted. The daily ration is divided into two meals and served morning and afternoon at a fixed time.

Feeding Rate: 4-5% of body weight.

Feeding for grass carp:

Grass carp should be fed *ad-libitum* with submerged aquatic weeds such as *Hydrilla, Najas,Vellisneria* etc. In absence of these, they may be fed with nutritious terrestrial grasses, such as paragrass, hybrid napier grass, etc. These grasses can be grown on pond dykes and dyke slopes using pond silt as the fertilizer.

2.02.01.05 Rearing pond:

2.02.01.05.01 Construction of new pond: Refer package 1.01.06

2.02.01.05.02 Renovation of old pond: Refer package 2.01.08

2.02.01.05.03 Liming: Refer Package 2.01.11.03

2.02.01.05.04 Manuring: Refer Package 2.02.01.02.03

2.02.01.05.05 Fertilization: Refer package 2.02.01.02.04

2.02.01.05.06: Stocking

Stocking is done after 10- 12 days of application of liquid manure.

Species: Same as that of stocking pond. Refer package 2.02.01.03

Size: 2.0cm to 2.5cm

Rate of stocking: 2,00,000 ha^{-1}.

The pond is stocked two times in the entire cultivation period of three years.

2.02.01.05.07 Supplemental feeding: Feeding in rearing pond is done at controlled rate, not more than 1% of the total fish biomass weight. Feeding is done with rice polish and mustard oil at 1:0.5 ratio. After three months, when the fry reach fingerling stage of 8.0-10.0cm, manuring is continued, but feeding is controlled, usually feeding on alternate day. After 6-7 months, supplemental feeding is stopped. These stunted seeds when released into stocking pond having enough of food and space, grow in a faster rate than of the normal fish seeds.

2.02.01.06 HARVESTING:

As because unequal sized fingerlings are stocked, all fishes do not grow at equal rate. In addition, 'shoot carp's will grow in the fastest rate.

In this system, the following weight- ranges are considered harvestable size:

Species		weight range (g)
Catla	:	400-500
Rohu	:	250-300
Mrigal	:	250-300
Silver carp	:	800-900
Grass carp	:	900-1000
Common carp	:	400-500

Partial harvesting should be started after 4 months of stocking. The stock is immediately replenished species- wise from the rearing pond.

To minimize spoilage time and to fetch better price, the harvested fishes are kept overnight in a big happa before disposal. In absence of such facility, supplemental feeding is stopped one day ahead of harvesting.

After this, harvesting is done every month followed by replenishment till 30^{th} month of first stocking. After that harvesting is stopped. At this stage, stocking density should not be more than 8,000 nos. ha^{-1}.

After 36^{th} month, stocking pond is completely dewatered, fishes are disposed, bottom is exposed to the sun at least for 10 days and desilting is done by digging the pond up to 15-30 cm depth. Bottom is ploughed and made ready for stocking.

At this time, the rearing pond is also dewatered, desilted and made ready for next crop of seed raising.

2.02.01.07 Important instructions:

i. Mesh size of the drag net should be such that fishes less than 250g can easily escape the net.

While harvesting, the fishes should not be gathered in one corner of the net. Picking of the harvested size should not take much time. Allow the rest of the fishes to go out of the net by themselves first silver carp, then catla - grass carp – rohu - mrigal and common carp in that order.

ii. The fishes to be released back to the pond should not be touched with naked hand as far as possible.

iii. Harvesting should be done in the morning hours.

iv. Netting should be suspended when water temperature goes below 20°C. During this period, pH of water should be maintained at 8.0-8.5.

v. In this system maintenance of balance between total fish biomass and carrying capacity of the pond is most important.

Advantages:

i. Capital investment is less. As harvesting starts from the 4th month, a part of the earnings can be reinvested in the cultivation.

ii. When the bigger fishes are harvested out, smaller ones grow at a faster rate

iii. The stunted seeds maintained in the rearing pond when released to the stocking pond where enough food and space are available, they grow very fast. Digestion and assimilation capability of these fishes are much higher than the normal seeds.

iv. Occurrence of diseases can be detected at early stage.

v. Efficient use of supplemental feed.

vi. Net profit is many folds more than composite fish culture of one harvest cycle.

vii. Even if flood water submerges the pond, loss is partial.

Production: 6,000-6,500 kg ha^{-1}yr^{-1} (average of three years)

2.21.06 Economics of Multiple Stocking and Multiple Harvesting System of Composite Fish Culture in a 0.4 ha stocking pond with a 0.08 ha rearing pond

Sl. No.	Head of Expenditure	Quantity/No.	Rate (Rs.)	Expenditure (Rs.)
1.	Renovation of the two ponds: dewatering, desilting and repairing of the dykes (annual average expenditure: average of 3 years) Rs. 20,000 ÷3			6,667.00
2.	Cost of purchasing of two drag nets (i) For the stocking pond 50m × 5m # 0.04m (annual average of 5 years) 6000 ÷ 5 (ii) For the rearing pond 20m × 4m # 0.01m Life span: 5 years 3000÷5			1,200.00 600.00
3.	Fish seeds (i) Fingerlings (8-15cm) (ii) Fry	 10,000 20,000	 5.00 per piece 300.00/1000	 50,000.00 6,000.00
4.	Quick lime	240 kg	15.00 kg^{-1}	3,600.00
5.	Cost of purchasing of supplemental feed ingredients: <u>Rice polish</u> 942 kg (stocking pond) + 140 kg (rearing pond) <u>Mustard oil cake</u> 942 kg (stocking pond) + 35 kg (rearing pond) <u>Fish meal</u> Vitamins and minerals mix	 1082 kg 977 kg 471 kg 24 kg	 10.00 kg^{-1} 20.00 kg^{-1} 30.00 kg^{-1} 140.00 kg^{-1}	 10,820.00 19,540.00 14,130.00 3,360.00
6.	Labour charges (for one year)	1Person / day	200.00 day^{-1}	73,000.00
7.	Cost of manures and fertilizers: Cow dung Urea Triple super phosphate	 6240 kg 132 kg 58 kg	 0.6 kg^{-1} 10.00 kg^{-1} 10.00 kg^{-1}	 3,744.00 1,320.00 580.00

8.	Medicines	L.S	-	1,000.00
9.	Miscellaneous expenditure	-	-	1,500.00
	Total			**1,97,061.00**
10.	Interest (10%)	-	-	19,706.00
	Total expenditure			**2,16,767.00**

B. Gross Income:

@ 6400 kg $ha^{-1}yr^{-1}$ = 2,560 kg × Rs. 120.00

= Rs. 3,07,200.00

C. Net income:

@ Rs. 3,07,200.00 - 2,16,767 = Rs. 90,433.00

Cost of production per kg of fish = Rs.84.68
Percent return on variable cost = 41.72
Percent profit to turn over = 29.44
BCR = 1.42

2.03 SHORT DURATION/ HOTEL SIZE CARP CULTURE

- Short duration fish culture is the system of raising IMC to a suitable table size fish in 80-90 days.
- To produce 80-350g fish commonly referred as "HOTEL FISH".
- To utilize fish culture pond before monsoon period.
- To supply fish to the consumer during lean and non-fishing period.
- To do fish culture in the pre-flood period.

2.03.01 Methods

- Culture period : Feb to May
- Pond preparation : By Feb (Refer Package 2.01.07; 2.01.08;2.01.09; 2.01.10 & 2.01.11)
- Water level : Minimum 1.5m
- Stocking : Yearlings
- Fish species : Catla, Rohu, Mrigal
- Species ratio : Catla – 40%
  Rohu - 50%
  Mrigal – 10%
- Stocking density : 4-5 fish/m^3
- Stocking size : Catla – 50-60g
  Rohu - 30-40g
  Mrigal – 20-30g
- Feeds : MOC (Mustard oil cake) : RP (Rice polish) = 60:40
- Feeding methods : Tray and bag feeding
- Feeding rate : 5-1% daily

2.03.02 Management

- Liming : At 10 days intervals
- Fertilization: RCD (Raw cow dung) (0.01 kg m^{-3}) + MOC (0.035 kg m^{-3}) + SSP (Single super phosphate) (0.025 kg m^{-3})
  Production: 6000 – 6400 kg ha^{-1}

2.03.03 Economics (Pond area 0.28 ha)

A.	**Variable Cost**	
1.	Cost of pond preparation	Rs. 6,000.00
2.	Cost of lime, fertilizers, etc.	Rs. 10,000.00
3.	Cost of fish seeds @ Rs. 5 /seed (10000 nos.)	Rs. 50,000.00
4.	Cost of feeds i) MOC (1000 kg @ Rs. 20.00 kg^{-1}) ii) RP -700 kg (350 kg @ Rs. 10.00 kg^{-1})	 Rs. 20,000.00 Rs. 7,000.00
5.	Labour 90 days @ Rs.200/manday	Rs. 18,000.00
6	Misccellneous	Rs. 4000.00
7	**Total**	**Rs.1,15,00.00**
8	Interest (10%)	Rs. 11,500.00
	Total expenditure	**Rs. 1,26, 500.00**

B. Gross return

Sale of 1700 kg fish @ Rs.120.00 per kg = Rs. 2, 04,000.00

C. Net return (B-A) = Rs.77,500.00

Cost of per kg fish production : Rs. 74.41
Net profit per kg fish : Rs. 45.60
% Return on investment : Rs. 61.26
BCR : 1.62

2.03. 04 Activities schedule

Activities	**Feb**	**March**	**April**	**May**
Pond prep.	by 15th	-	-	-
Stocking		1	-	-
Feeding	Daily	Daily	Daily	Daily
Liming	18	1,11,21	1,11,21	1,11,21
Fertilization	24	10,30	19	11
Harvesting				25-31

PACKAGE -3

DIVERSIFIED AQUACULTURE

3.01 Polyculture of Giant Freshwater Prawn with Carps:

Freshwater prawn is a delicacy for the food lovers. A few well known species of freshwater prawn are Giant freshwater prawn (*Macrobrachium rosenbergii*), Indian river prawn (*M. malcolmsonii)*, Ganga river prawn (*M. birmanicum choprai*), and *M. assamensis*. We can culture some of these species in captive condition through monoculture and polyculture with carps using semi intensive technology. However, polyculture of prawns along with carps is only possible with giant freshwater prawn. This technology can be a good option for availing the sea food in land locked state like Assam.

3.01.01 Merits

- Creates a controlled ecosystem where pond nutrients are efficiently utilized with minimum waste of bound carbon and nitrogen.
- Fuller utilization of seasonal ponds (rain fed) for production of high valued prawn along with carps.

3.01.02 Site selection

Where land and water is not at premium, inexpensive, semi-intensive polyculture of prawn is possible. The site is selected on the basis of complementation of species and location. The following criteria are considered in selecting the site.

3.01.02.01 Area

Minimum : 0.14 ha.
Maximum : No upper limit.

3.01.02.02 Topography

Ravines with 1-5% slope, marshy and swampy areas are suitable.
Plain type layout is suitable.

3.01.03 Soil characteristics

3.01.03.01 Types: Alluvial, both new and old.

3.01.03.02 Texture: Impervious soil such as heavy clay, silty clay and clay loam. Percolative soils with high water table are also suitable. Soil fraction of about 90% of whole soil, stone and gravel not exceeding 10%.

3.01.03.03 Soil fertility: The productive soil status includes mainly 30-50 mg available nitrogen (N) $100g^{-1}$, 6-16mg available phosphorous (P_2O_5) $100g^{-1}$, 1-2% organic carbon and 5% free calcium carbonate ($CaCO_3$). The site should be free from excessive decomposed organic matter.

3.01.03.04 Soil pH: The optimum range is 7-8.5. In case of acidic soil, the pond should be treated with lime as corrective measure. Details discussed in 2.01.11.03.

3.01.04 Water table: Refer Package. 1.01.05.03.03.05

3.01.05 Source of water: Refer Package 1.01.05.03.04

3.01.06 Maximum flood level: Refer Package 1.01.05.03.06

3.01.07 Legal matter: Refer Package 1.01.05.03.05

3.01.08 Availability of inputs: Refer Package 1.01.05.03.07

3.01.09 Manpower: Refer Package 1.01.05.03.08
3.01.10 Road and transport: Refer Package 1.01.05.03.09
3.01.11 Market: Refer Package 1.01.05.03.10
3.01.12 Power supply: Refer Package 1.01.05.03.11
3.01.13 Storage facilities: Refer Package 2.01.05.02.12

3.01.14 Pond requirements: Refer Package 2.01.06
3.01.14. 01 Number: Refer Package 2.01.06.01
3.01.14.02 Size of the pond: Refer Package 2.01.06.02
3.01.14.03 Shape: Refer Package 2.01.06.03
3.01.14.04 Depth of ponds: Refer Package 2.01.06.04
3.01.15 Productive water condition: Refer Package 1.01.05.03.13
3.01.16 Reclamation of ponds: Refer Package 2.01.08
3.01.16.01 Eradication of aquatic weeds: Refer Package 2.01.08.01
3.01.16.02 Methods of weed eradication: Refer package 2.01.08.02
3.01.16.02.01 Manual and mechanical method: Refer package 2.01.08.02.01
3.01.16.02.02 Chemical method: Refer package 2.01.08.02.02
3.01.16.03 Eradication of unwanted fishes: Refer Package 2.01.08.03
3.01.16.04 Complete dewatering: Refer Package 2.01.08.04
3.01.16.05 Exposure of bottom to sun: Refer Package 2.01.08.05
3.01.16.06 Removal of muck: Refer Package 2.01.08.06
3.01.16.07 Repairing of side slope: Refer Package 2.01.08.07
3.01.16.08 Soil correction: Refer Package 2.01.08.08
3.01.17 Pond preparation: Refer Package 2.01.11
3.01.17.01 Desilting: Refer Package 2.01.11.01

Ponds, other than those which are newly constructed or reclaimed, should be desilted every year.

3.01.17.02 Bottom racking: Refer Package 2.01.11.02
3.01.17.03 Liming: Refer Package 2.01.11.03
3.01.17.03.01 Liming materials: Refer Package 2.01.11.03.01
3.01.17.03.02 Dose based on the soil pH status: Refer Package 2.01.11.03.01.01
3.01.17.03.03 Methods of application: Refer Package 2.11.03.01.02
3.01.17.03.04 Fertilization: Refer Package 2.01.11.04
3.01.17.04.01 Application: Refer Package 2.01.11.04.03
3.01.17.04.02 Dose: Refer Package 2.01.11.04.04
3.01.17.04.03 Mode of application: Refer Package 2.01.11.04.05
3.01.17.04.04 Generalised fertilizer schedule: Refer Package 2.01.11.04.07
3.01.17.04.05 Suspension: Refer package 2.01.11.04.06
3.01.18 Stocking: Refer package 2.01.12
3.01.18.01 Species density and size:

Ponds are generally stocked with juvenile prawn (4-6 cm) of Giant freshwater prawn (*M. rosenbergii*) @ 15,000-25,000 ha^{-1} along with fingerlings or carried over seeds of selected carps of 15 cm size @ 2500-3500 ha^{-1} of water surface area. 10% mortality allowance should be added for each species.

3.01.18.02 Species composition of carps

Table: Percentage composition and stocking density of carps for polyculture of prawn along with carps

Sl. No.	Species	Percentage composition	Nos./Hectare
1	Silver carp	15	450
2	Catla	35	1050
3	Rohu	35	1050
4	Grass carp	15	450
	Total	**100**	**3000**

3.01.18.03 Stocking time:

Since prawn juvenile is only available after May (in Assam) so farmers need to wait till May for stocking of prawn. Culture periods of 6-8 months considered as best for prawn.

However, farmers can stock the carp species in the month of March for obtaining more growth due to onset of high temperature regime in March so that optimum temperature can be obtained for a maximum period i.e. 7-8 months.

3.01.18.04 Supplementary feeding:

Feed should be accepted by both prawns as well as fish species cultured in the pond. Feed having protein content of 30-40% is suitable for this purpose.

- Mixture of locally available ingredients; rice bran/polish and mustard oil cake at the ratio 1:1 along with 1% of mineral mixture can be used as supplementary feed.
- It can be fed @2-3% of body weight of biomass.
- The feed mixture is supplied on feeding tray or in bags at different depth of water.
- Ready to use supplementary feed like SUSHAMA (developed in AAU) as well as other brand of commercial fish and prawn feed also can be used for this purpose.
- For grass carp aquatic vegetation need to be supplied.
- It is estimated that about 5000kg of supplementary feed is required for one cycle of culture in one hectare area.

3.01.18.05 Pond environment management:

Since prawns are cannibalistic in nature and also having territorial behaviour so they necessitate special hiding arrangement during moulting phase. It is to be noted that moulting is the only process of growth of shellfish. During moulting phase prawns are weak and are exposed with soft muscle. Thus to prevent the cannibalistic nature during moulting plastic pipe, hollow bamboo, beetalnut leaves, coconut leaves, tyres, tree branches, etc need be provided as hiding arrangement.

3.01.19 Health care

- Proper hygienic conditions should be maintained in the farm.
- Test netting should be done at monthly intervals for monitoring disease and growth.
- Behaviour of fish should be observed every morning.

3.01.20 Production

Above 0.750 kg fishes and 30-45g prawns are considered to be marketable. Such fishes and prawns should be harvested to facilitate the growth of smaller fish and prawns. Final harvesting is done by complete dewatering of pond.

Prawn: 700-900 kg $ha^{-1}yr^{-1}$

Fish : 2000 kg $ha^{-1}yr^{-1}$

Percentage profit to turn over: > 50%.

3.02 Seed rearing of Magur in Cage

Presently, induced breeding of Magur (*Clarius magur*) is a handy process for the progressive fish farmers of the state of Assam. However, nursery management of magur fish is still a headache for the breeders as most of the magur breeders said that recovery rate of magur fingerlings from both concrete tank and earthen tank is very less. On the other hand whenever the farmers use plastic and concrete tanks for nursery purpose the growth and survival rate is poor compared to earthen tanks. To overcome these problems, a cage is designed using the locally available materials to rear the magur early fry in earthen ponds.

3.02.01 Cage designing and construction:

Cage made up of locally available bamboo is economical. After fabrication of fine mesh bamboo wall of the cage, nylon net inside the cage is lined to protect the escaping of magur fry. Cage doesn't require top cover. This cage can be used for 2-3 years.

3.02.02 Size of the cage: It depends on the available water spread area.

Generally cage size of (3.0×2.0×1.5) m^3 or (5.0×3.0×1.5) m^3 is suitable for operation.

3.02.03 Stocking density of magur fry:

@ 200-300 nos. m^{-3}

3.02.04 Feeding practice:

Ponds where cage is installed need to be prepared according to standard package of carp culture. Availability of ample zooplankton in water is desired.

Apart from this a regular dose of supplementary feed need to be given for this purpose. In the early days, feeding with tubifex worms gives better survivality of the seeds. For this purpose a few culture tank of tubifex is required.

Tubifex worm is given 5-6 times daily as feed.

After 20-25 days of culture formulated feed made up of mixture of mustard oil cake (40%), rice polish (35%), fish meal/soybean meal (24%) and mineral mixture (1%) or commercial feed having 35% protein can be given as feed.

Feeding in evening hours is always advisable.

3.02.05 Management:

Apart from regular feeding water quality of the cage is need to be monitored. One or two branches of marginal weeds like *Ipomea, Ludwigia* etc. may be planted in the cage to have some natural shade in the cage.

3.02.06 Production:

After culture of six weeks fingerling recovered from this system is around 45-65% of total fry stocked, out of which 30% is comparatively bigger in size (6-9 cm) and others around 4-5cm.

Hence from a cage where 1800 fry are stocked we can have about 900 fingerlings after a cycle of culture. Price of one fingerling is around Rs 6 to 8/- in the market. In a year two cycles of seed rearing is possible.

3.03 Koi (*Anabas testudineous*) farming

Climbing perch *Anabas testudineus* (Order: Perciformes, Family: Anabantidae) is one of the popular aquaculture candidate species among small indigenous fishes.

3.03.01 Culture importance:

- *Anabas testudineus* fetches higher market price
- Highly preferred fish in domestic and international market due to its high nutrition, good taste and flavour
- Good growth and its ability to withstand unfavourable environmental conditions in its habitat; both natural water and culture ponds.
- Prolonged longevity and freshness out of water,
- Contain easily digestible protein, fat of very low melting point and many essential amino acid

3.03.02 Sexual maturity:

- Male and female *A. testudineus* attain their first sexual maturity when they grow to 11.3 gm and 12.2 g in weight and 8.0 cm and 8.2 cm in body length respectively.
- Fecundity has been estimated to be 9,500-10,002 for a 9.5 cm sized female. Fertilized eggs are 0.55- 0.88 mm in diameter.
- Maturity occurs at the age of one year when the fishes reaches a size of 10-12 cm in total length.
- Females have light brown colour on body and pelvic fins, which turns deep brown during breeding season.
- Mature male acquires a reddish shape/tinge on the body, particularly on the pectoral and ventral fins. A distinct diamond shaped black spot appears in the caudal peduncle of male and they acquire glazy black colour during breeding season (during pre to post monsoon months).
- The fish has a tendency to walk away from pond during rainy days. It migrates from one pond to another pond with the help of their sharp gill plate during rainy season for spawning and return to the permanent water bodies on the onset of dry season.
- The indigenous variety attains a maximum of 9 inches in length and can gain up to 52 g body weight in one year.

3.03.03 Breeding and larval rearing:

Climbing perch has been successfully induced bred by hormonal treatment with Wova – FH at a dose of 0.3 ml kg^{-1} of fish to both the sexes is effective which might be considered for raising captive population of *A. testudineus.*

Ovaprim @ 1.5 ml kg^{-1} body wt. to both male and female is also found to be effective.

3.03.04 Farming of *A. testudineus*

The name of *A. testudineus* is widely used for both the native and Thai strains of climbing perch. Thai strains of *Anabas* have already entered the market of Assam. Morphologically spots on the body surface are present in the Thai variety of *A. testudineus* but those are 100% absent in native *A. testudineus.* In the native species colour at the pelvic fin region is yellowish or whitish to yellow, but in the Thai variety it is only whitish or whitish to yellow. Thai variety do not show yellowish colour at the pelvic region even in the mature stages. The rapid increase in aquaculture output envisaged upon the species diversification through culture of both native and Thai variety of *A. testudineus.* The Thai strain of climbing

perch has high market price and can be cultured with other cat fishes like *C. magur*, *Heteropneustes fossilis* and *Mystus cavasius,* etc. The Thai strain has much higher growth rate which attain 80-100 g size within 3-4 months. Culture of Thai variety has started to meet the demand in Tripura and West Bengal in India and with full intensive culture operation is practiced in Bangladesh. In West Bengal, some private fisheries entrepreneur has started rearing seed of Thai variety of *A. testudineus.*

3.03.05 Farming method

- Generally a two pond culture system is recommended.
- Initially 2.0-2.5 cm size fry are stocked in a small pond of 0.24-0.32 ha.
- @ 500000 fry ha^{-1} and reared for 20 days.
- Water depth is maintained at about of 1.2-1.5 m.
- Subsequently the fry are transferred to the second pond and stocked @ 1,25,000-2,50,000 nos ha^{-1}.
- Before stocking, 25 kg ha^{-1} area is added to the pond water to facilitate growth of zooplanktons.
- Commercially available grower feed (floating type) with 30% protein is effective for culture of Thai variety, which is applied thrice a day.

PACKAGE -4

INTEGRATED AQUACULTURE-AGRICULTURE

4.01 PADDY CUM FISH CULTURE

Integrated Aquaculture-Agriculture though literary means combined farming of fish with agriculture, but in broader perspective it encompasses a fully integrated management of all natural resources available to farm households, in context of which many prefer to use the term Integrated Resource management (IRM) to Integrated Farming System (IFS). Aquaculture, even if in small scale in terms of aquatic produce has the pivotal role in economically and ecologically viable IRM. This view goes beyond aquaculture as an enterprise to aquaculture and water management as an engine for the entire agro ecosystem.

4.01.01 MERITS IN GENERAL

- Reduces risk factors because of the system efficiencies derived from synergisms among enterprises, their diversity of produce and their environmental soundness.
- Aquaculture serves as means to a variety of ends for agriculture such as providing irrigation source.
- Aquaculture serves as an excellent agent for Integrated Pest Management (IPM) and Aquatic Lives Management (ALM).
- Aquaculture increases soil productivity and boosts the production from agriculture, such as rice yield in Rice- Fish Farming.
- Agriculture serves as means to a variety of ends for aquaculture such as feed for fish.
- Agriculture helps in soil conservation: an adverse effect frequently encountered in stand-alone aquaculture.
- Boosts productivity and income from unit area, thus serving much to reduce poverty and malnutrition.

4.01.02 TECHNOLOGIES

Two sets of Aquaculture-Agriculture technologies are standardized for Assam.

4.01.02.01 Rice-Fish Farming

4.01.02.01.01 Perennial System of Rice-Fish Farming.
4.01.02.01.02 Synchronous Refuge Pond System of Rice-Fish Farming.
4.01.02.01.03 Enclosure System of Rice-Fish Farming.

4.01.02.01.01 PERENNIAL SYSTEM OF RICE-FISH FARMING

In perennial rice fish farming system, a single crop of fish is raised along with two crops of paddy viz. *Ahu* & *Sali* covering nearly both the seasons. The system is particularly suitable for very low lying areas. Excavation of a big pond or a trench and construction of a perimeter dyke both covering around $1/3^{rd}$ of the total plot area are distinctive features for plot renovation under this system.

4.01.02.01.01.01 MERITS

- ❖ Conversion of very low lying unproductive land into productive units through proper land shaping and introduction of a fish crop.
- ❖ Raising of fish crop up to table size.
- ❖ All the species of carp used in composite carp culture, excluding grass carp can be reared in this system.
- ❖ Water of the trench/pond can be used as a source of irrigation during dry months.

4.01.02.01.01.02 SITE SELECTION

Low lying fields with high rainfall and poor drainage can be brought under this system.

Other conditions for site selection are:

4.01.02.01.01.02.01 Area

4.02.01.02.01.01 Minimum : 0.27 ha

4.02.01.02.01.02 Maximum : 1.0 ha

4.01.02.01.01.02.02 Topography

Fields having almost uniform contour is preferred.

4.01.02.01.01.02.03 Soil characteristics

Soil having high water retention capacity is suitable (Refer Package 1.01.05.03.03).

4.01.02.01.01.02.04 Source of water

Precipitation, direct run-off and ground water inflow are the major sources. Fields adjacent to irrigation canals facilitate extension of fish crop duration.

4.01.02.01.01.02.05 Maximum flood level

Preferably flood free.

4.01.02.01.01.02.06 Legal matters

Refer Package 1.01.05.03.05

4.01.02.01.01.02.07 Availability of inputs

For fish crop detailed description is given in package-1. For paddy crop, availability of seeds of the suitable varieties (both *Ahu* & *Sali*), field implements for land preparation, deweeding, harvesting, fertilizers, pesticides, etc. are basic prerequisites.

4.01.02.01.01.02.08 Manpower

Skilled labourers are required for both paddy and fish cultivation.

4.01.02.01.01.02.09 Road and transport

Refer Package 1.01.05.03.09

4.01.02.01.01.02.10 Market

Refer Package 1.01.05.03.10

4.01.02.01.01.02.11 Power supply

Refer Package 1.01.05.03.11

4.01.02.01.01.02.12. Storage

Facilities for storage and preservation of both rice and fish.

4.01.02.01.01.03 CONFIGUATION AND LEVEE DESIGN

4.01.02.01.01.03.01 General specifications

Fish farming in integration with rice cultivation is crucially dependent on availability of sufficient water for survival and growth of fish without any detrimental effect on the rice crop. It is therefore imperative that the plot is renovated for holding sufficient water in the area. The design for renovation is made depending on the specific land contour.

In perennial rice-fish farming system the water area created is comparatively larger than that of the other systems. The general specifications for renovation under this system are given below.

Paddy plot: The low lying area is so renovated that at least 61 to 67% of land is made available for paddy cultivation. Rest area is utilized for digging trench/pond and construction of a dyke.

Trench /pond: A trench or a pond covering 21- 33% of the plot is excavated which serves as the shelter for fish even in dry periods.

Dyke: A strong and stable dyke is constructed around the plot creating a confinement for the fish and preventing entry of water from outside. Construction of the trench or the pond and allocation of area for paddy cultivation, trench/pond and dyke is primarily dependent on the topography of the area.

4.01.02.01.01.03.02 Design

Three topographical situations in low lying areas have been identified and for each different models are adopted.

4.01.02.01.01.03.02.01 Perimeter trench model: Suitable for plots with moderate elevation towards the middle and sloping on all sides. In such situations, a perimeter trench is dug and the earth excavated is used to further elevate the middle plot and for construction of a dyke at the outer periphery of the trench. The size of the trench should be one-fifth of the plot area. The depth of the trench should be kept at 1.2m, but may be increased depending on land situation.

The area for the perimeter dyke base is to be kept within the range from $1/8^{th}$ to $1/9^{th}$ of the plot area. The height of the dyke should be minimum 1m, but may be increased depending on the inundation level of the plot. Land allocation and design of a typical area is given below.

❖ Total area of the plot (100 m ×100 m) : 1 ha

❖ Trench:

Total length of the perimeter trench	: 352 m
Top width	: 6 m
Bottom width	: 3.6 m
Depth of the trench	: 1.2 m
Total trench area (6 m × 352 m)	: 0.21 ha

❖ Dyke:

Total length of the dyke	: 388 m
Base width	: 3 m
Crest width	: 1 m
Average height	: 1 m
Total dyke area (388 m × 3m)	: 0.12 m

❖ Paddy plot:

Breadth of the paddy plot	: 82 m
Total paddy area (82 m × 82 m)	: 0.67 ha

4.01.02.01.01.03.02.02 Lateral trench model: Suitable for plots having gradient towards lateral sides. In such situation two trenches are dug on the sloping lateral sides. If the site is sloping towards one side or corner, coinciding trenches are dug in lower sides, while in case of slope on both lateral sides, parallel trenches are dug on each lateral side. The area for the perimeter dyke is kept at $1/8^{th}$ to$1/9^{th}$ of the plot area. The height of the dyke should be at least 1m, but may be increased according to the inundation level of the plot. Land allocation pattern and the design of a typical area suitable for this system are given below:

❖ Total area of the plot (125m × 80m) : 1ha

❖ Trench

Total length of the lateral trench	: 74 m
Top width	: 18 m
Bottom width	: 15 m
Depth	: 1.5 m
Total trench area (2 m×18 m×74 m)	: 0.27 ha

❖ Dyke:

Total length of the dyke	: 398 m
Base width	: 3 m
Crest width	: 1m
Total dyke area (398 m × 3 m)	: 0.12 m

❖ Paddy plot:

Length of the paddy plot	: 83 m
Breadth of the paddy plot	: 74 m
Total paddy area (83 m × 74 m)	: 0.61 m

4.01.02.01.01.03.02.03 Central pond model: Suitable for plot exhibiting depression towards the middle part. In this type, a pond is excavated in the middle of the plot. The area of the plot should be about 1/3rd of the plot area and the depth should be 1.0 m. Pond embankment should not be constructed. The area of the perimeter dyke base is kept at one-fifteenth of the total plot area but may be increased depending on the flood situation of the area. The height of the dyke may be kept at 30 cm which again may be increased depending on the inundation level of the plot. Land allocation pattern and design for renovation for typical plot suitable for this type is as follows:

- Total area of the plot (100 m ×100 m) : 1 ha
- Pond:

  Length of the pond : 58 m
  Breadth of the pond : 58 m
  Depth : 1 m
  Total pond area (58 m ×58 m) : 0.33 ha

- Dyke:

  Total length of the dyke : 398 m
  Breadth of the dyke : 0.5 m
  Total dyke area (0.5m × 398m) : 0.12 m

- Paddy plot:

  Length of the paddy plot : 234 m
  Average breadth of the paddy plot : 41.5 m
  Total paddy area (41.5 m × 234 m) : 0.65 ha

4.01.02.01.01.04 CONSTRUCTION

4.01.02.01.01.04.01 Trench/pond

While constructing the trench/pond in all the three designs of renovation; the top soil is deposited in the portion demarcated for paddy cultivation. This is done to elevate the bed of the paddy plot. The rest excavated soil is utilized for constructing the perimeter dyke. During construction of the perimeter and lateral trenches, a side slope of 1:1 (horizontal: vertical) ratio is to be maintained; whereas for construction of central pond, 1.5:1 (horizontal: vertical) ratio in the slide slope is to be kept. Inner embankment for trench/pond is not to be constructed so as to facilitate easy access of fish from the trench/pond to the paddy field.

4.01.02.01.01.04.02 Dyke

The perimeter dyke is to be constructed in such a way so that it can withstand weather conditions and current of water and can give full protection to the fish crop. Provision for guarded outlet through the dyke at different levels is to be kept for maintaining the desired water level in the paddy plot.

4.01.02.01.01.05 PADDY CULTIVATION

Paddy is grown in about 2/3rd area of the plot. The normal crop sequence of Assam i.e. *Ahu* followed by *Sali* can be practiced. The package of practices for both the crops as recommended by the Assam Agricultural University maybe adopted.

4.01.02.01.01.05.01 *Ahu* crop

4.01.02.01.01.05.01.01 Varieties: Recommended varieties of *Ahu* are- Culture -1, Rangadoria, Fapori, Govind, Lachit and CH -63.

4.01.02.01.01.05.01.02 Plot preparation: To be done during February-March, Ploughing 3-4 times, Manuring as per table -1.

4.01.02.01.01.05.01.03 Sowing/transplantation: For direct seeded varieties seeds to be sown in lines at 20 cm inter lines distance during March-April. Rate of sowing is 75 kg ha^{-1} (10 kg $bigha^{-1}$). For transplanted varieties, well germinated seeds to be sown during March to April at the bed of 10 m length and 1.25 m in breadth. For 1 ha plot amount of seed required is 40-45 kg. Transplanting is done during April-May in lines with 2-3 seedlings per hill. Spacings should be 20 cm × 20 cm for tall varieties.

Table -1: Manuring schedule of *Ahu* crop

Instalment	Compost or FYM($kgha^{-1}$)	SSP ($kgha^{-1}$)	Urea ($kgha^{-1}$)	MOP ($kgha^{-1}$)	Time of application
First	10,000	62	14.6	16	During land preparation
Second	--	--	14.6	--	Top dressing during active tillering stage
Third	--	--	14.6	--	Top dressing during panicle initiation stage

4.01.02.01.01.05.01.04 Weeding: To be done periodically during the entire cultivation period as and when necessary, preferably two deweeding at 20 to 40 days after transplanting/sowing.

4.01.02.01.01.05.01.05 Periodical manuring: Manuring should be done regularly as given in table -1.

4.01.02.01.01.05.01.06 Water management: In the paddy plot, water level should be maintained at optimum desired range recommended for the particular paddy variety grown, at least upto 20-25 days after sowing of seeds for direct seeded variety or upto 15-20 days after transplanting for transplanted variety. After this control period, water level can be raised slowly. However, level of water should not be above half the height of the paddy plant at any time during the entire cultivation period.

4.01.02.01.01.05.01.07 Plant protection measures: For control of pests like hispa, Nuvacron, an organophosphate pesticide can be applied at the rate of 1.25 litre (diluted with 400 litres of water) ha^{-1}.

4.01.02.01.01.05.01.08 Harvesting: During June-July. If necessary, water level in the paddy plot may be reduced by opening the outlet, for harvesting.

4.01.02.01.01.05.01.09 Plant protection measures at seed bed: Application of carbofuran (Furadon) granules at the rate of 3 g m^{-2}, 5-7 days after sowing in the seed bed and 5-7 days before uprooting for transplantation.

4.01.02.01.01.05.02 Sali crop

4.01.02.01.01.05.02.01 Variety: Recommended varieties for Sali paddy are: *Pankaj*, *Manohar sali*, *Sial sali*, *Ranga sali*, *Gudumoni*, *Badshah bhog, Gejep Sali, Ranjit, Jalashree, Jalakunwari* etc.

4.01.02.01.01.05.02.02 Plot preparation: To be started just after harvesting of *Ahu* crop. If necessary, water level in the paddy field should be reduced, so that fishes can take shelter in the trench/pond. Ploughing is done 3-4 times. Manuring is done as per table – 2.

Table -2. Manuring schedule in *Sali crop*

Sl. No.	Manure/Fertilizer	Rate of application (kg ha^{-1})		Remarks
		Plot preparation	Top dressing*	
1.	Compost FYM	10,000	-	*Once during tillering stage, another during panicle initiation stage
2.	Urea	22	11+11	
3.	SSP	62	-	
4.	MOP	16	-	

4.01.02.01.01.05.02.03 Seed sowing: During July-August, 650-1000g seed per bed of 10 m length and 1.25 m breadth. Requirement of seed for the area is 40-45 kg.

4.01.02.01.01.05.02.04 Transplanting: During August-September, 30-35 days old seedlings to be transplanted in lines. The difference between lines should be 15-20 cm for medium duration varieties (120 – 130 days like *pankaj*) and 20 -15 cm for long duration varieties (more than 130 days) like *Manohar Sali*. Number of seedlings per hill is 2-3 nos.

4.01.02.01.01.05.02.05 Periodical manuring: To be done as per table -2

4.01.02.01.01.05.02.06 Water management: As in *Ahu* paddy (Refer package 4.01.02.01.01.05.01.06)

4.01.02.01.01.05.02.07 Plant protection measures: As in *Ahu* paddy (Refer package 4.01.02.01.01.05.01.07)

4.01.02.01.01.05.02.08 Weeding: Fishes often control the weeds of rice field completely. Therefore, weeding may not be an essential step in *sali* crop under this system.

4.01.02.01.01.05.02.09 Harvesting: By November – December.

4.01.02.01.01.06 FISH CULTURE

Three species of IMC (Rohu, Catla and Mrigal) two species of exotic carps (Silver carp and Common carp) are reared in this system. Minor carps like bata (*L. bata*) and other fishes like Silver barb, Java barb (*P. javanicus*) may also be stocked along with it.

4.01.02.01.01.06.01 Preparation of pond/trench

Preparatory works for fish culture should be started during February-March, synchronously with preparation of plot for *Ahu* cultivation. This trench/pond should be cleared of aquatic weeds, predatory fishes and excess organic deposit by manual or mechanical methods.

4.01.02.01.01.06.02 Liming

Liming and application of additional dose of manure are done depending upon the trench/pond area and water level. Liming and manuring schedule is given in table- 3.

Table-3: Liming and fertilization schedule for fish crop in perennial system of rice-fish farming.

Sl. No.	Item	Rate	Time of application
1.	Lime	10 ppm initially and 5 ppm monthly	When water level raises
2.	Cow dung	1000 kg ha^{-1} monthly	7 days after liming
3.	Urea	12.5 kg ha^{-1} monthly	7 days after manuring (application of cow dung)
4.	SSP	10 kg ha^{-1} monthly	7 days after manuring (application of cow dung)

Manuring/fertilization is suspended till one month after transplanting of *Sali* paddy. Monthly doses of manure and fertilizers should be as scheduled in table -3.

4.01.02.01.01.06.03 Stocking

There should be about 1m water depth in the trench/pond for releasing the fish seed. At least 15 days interval should be maintained between application of the 1st instalment of inorganic manure and stocking of fish. Stocking density and species ratio recommended for this system are given in table – 4. Stocking of Common carp should be done after 15-20 days of paddy transplantation. Size of seeds 8-15 cm.

4.01.02.01.01.06.04 Supplementary feeding

Supplementary feeding, comprising of mustard oil cake and rice polish at 1:1 ratio given daily at the rate of 3% of body weight of the stocked fishes.

4.01.02.01.01.06.05 Health care

If there is any outbreak of fish disease, package -12 should be adapted as curative measures.

Table-4: Species composition and ratio for stocking in perennial system of rice-fish farming.

Sl. No.	Species	Percentage	No. ha^{-1}	No./2 Bighas
1.	Silver carp	20	1,600	432
2.	Catla	10	800	216
3.	Rohu	25	2,000	540
4.	Mrigal	20	1,600	432
5.	Common carp	25	2,000	540
	Total	**100**	**8,000**	**2,160**

4.01.02.01.01.06.06 Harvest

After harvesting the *sali* crop during November –December, the paddy plot gradually dries up. The fishes take shelter in trench or pond. In plots with internal water only provisions, partial harvesting of fishes weighing above 500g should be done at that time. Smaller fishes may be raised for another two months (till starting land preparation for *Ahu* crop) by providing desired level of water in the plot.

If there is no provision for supplying water, complete harvesting to be done when the water in the trench/pond lowers than 80 cm.

4.01.02.01.01.06.07 Annual work calendar

An annual work calendar for perennial system of rice farming is outlined in table-5. Adoption of this work calendar can assure a production of 1000 - 1100 kg paddy, 1200-1300 kg straw and 400-450 kg fish per 0.28 ha per annum.

Table-5: Annual work calendar for perennial system of rice-fish farming

Sl. No.	Months	Works for paddy cultivation	Works for fish cultivation
1.	January-February	• Plot renovation	• Excavation of trench/pond • Dyke construction • Repairing work (as necessary)
2.	February – March	• Plot preparation for *Ahu* • Ploughing and manuring • Preparation of seed bed (for transplanted variety)	• Cleaning of trench/pond, muck removal • Eradication of weed and unwanted fishes (wherever necessary)
3.	March-April	• Sowing of seeds: on seed beds for transplanted variety and on main field for direct seeded variety • Initial plant protection measures	• Liming • Manuring 7 days after liming
4.	April-May	• Transplantation • Water management • Weeding	• Fertilization 7 days after manuring
5.	May-June	• Weeding • Top dressing • Plant protection measures • Water management	• Stocking of fish seed 15 days after transplantation/ fertilization • Supplementary feeding
6.	June-July	• Harvesting of *Ahu* crop • Seed bed preparation for *Sali* crop • Plot preparation for *Sali* crop	• Manuring and fertilization • Liming • Supplementary feeding • Health monitoring
7.	July-August	• Sowing of seed bed • Plot preparation for *Sali* crops • Manuring/fertilization • Initial plant protection measures	• Liming • Supplementary feeding • Manuring and fertilization • Health monitoring
8.	August-September	• Transplantation of *Sali* • Plant protection measures • Water management	• Raising of water level 15 days after transplantation • Liming • Supplementary feeding • Manuring and fertilization • Health monitoring
9.	September – October	• Plant protection measures • Water management • Top dressing	• Manuring and fertilization • Supplementary feeding • Liming • Health monitoring
10.	October-November	• Plant protection measures • Water management • Top dressing	• Manuring and fertilization • Supplementary feeding • Liming • Health monitoring
11.	November – December	• Harvesting	• Health monitoring • Supplementary feeding • Partial harvest followed by final harvest.

4.01.02.01.01.06.08 Production

Production achieved by adopting this technology in an area of 0.28 ha in one year is as follows:

Paddy: 1000 – 1100 kg
Hay: 1200 – 1300 kg
Fish: 400 – 450 kg

4.01.02.01.01.06.09 Economics

The variable cost and return function of perennial rice-fish farming calculated for 0.28 ha are given in table-6. The table showed that an investment of Rs. 43,472.00 assures net income of Rs. 19,404.00 the percentage return on one variable cost worked out is 44.64.

Table-6. Economics of Perennial system of Rice-Fish farming (0.28 ha.)

VARIABLE COST				
Sl. No.	**Head of expenditure**	**Qty./No.**	**Rate (Rs.)**	**Cost (Rs.)**
1.	Earthwork	-	-	8000.00
2.	Bamboo Bridge	-	-	1000.00
3.	Ahu crop	-	-	2000.00
4.	Sali crop	-	-	2000.00
5.	Agril.lime	95 kg	7 kg^{-1}	665.00
6.	Fish seed	2160 Nos.	5 each	10,800.00
7.	Cowdung	259 kg	0.6 kg^{-1}	156.00
8.	Urea	5.30 kg	10 kg^{-1}	53.00
9.	SSP	4.35 kg	10 kg^{-1}	43.00
10.	Mustard oil cake	482 kg	20 kg^{-1}	9640.00
11.	Rice Polish	482 kg	10 kg^{-1}	4820.00
12.	Harvesting cost	-	-	1500.00
13.	Misc. expenditure	-	-	1000.00
	Total			**Rs. 39,520.00**
	Interest		**10.0%**	**Rs. 3952.00**
	Total variable cost			**Rs. 43,472.00**
		RETURN		
Sl. No.	**Product**	**Qty (kg)**	**Rate (Rs. Kg^{-1})**	**Sale proceeds**
1.	Paddy	1053	11.25 kg^{-1}	Rs. 11,846.00

2.	Hay	1215	2.00 kg^{-1}	Rs. 2430.00
3.	Fish	405	120 kg^{-1}	Rs. 48,600.00
	Total return			**Rs. 62,876.00**
	Paddy cultivated area			**0.182 ha.**
	Trench and dyke area			**0.094 ha.**
	Income from paddy			**Rs. 14,276.00**
	Income from fish			**Rs. 48,600.00**
	Gross Income			**Rs. 62,876.00**
	Net income (Profit)			**Rs. 19,404.00**
	Percent profit to turn over			**30.86**
	Percent return on variable cost			**44.64**
	BCR			**1.45**

4.01.02.01.02 SYNCHRONOUS REFUGE POND SYSTEM OF RICE FISH FARMING

In Synchronous Refuge Pond system of Rice-Fish farming, the fish crop is raised synchronously with sali paddy during the monsoon period. The plots are so renovated that fish can take shelter in the pond within the plot.

4.01.02.01.02.01 MERITS

- Conversion of monocrop paddy growing areas to multicropping system through introduction of a fish crop along with paddy.
- Lesser involvement of permanent conversion of land, in comparison to perennial rice fish farming system.
- Other merits are mentioned in the merits of Aquaculture-Agriculture in general

4.01.02.01.02.02 SITE SELECTION

Medium low lying area suitable for *Sali* paddy and with poor drainage is selected for this system. Plots having naturally existing small ponds can be efficiently brought under this system. Other conditions such as topography, soil characteristics, source of water, maximum flood level, legal matters, and availability of inputs, manpower, road and transport, market, storage facilities are as described as in Package 1.05.03. Area should be a minimum of 0.05 ha and maximum should not exceed 0.1 ha.

4.01.02.01.02.03 DESIGN AND CONSTRUCTION

4.01.02.01.02.03.01 Specification

4.01.02.01.02.03.01.01 Paddy plot: 78.88% of the plot area is utilized for paddy crop

4.01.02.01.02.03.01.02 Pond: 10-20% of total plot area is utilized for pond construction

4.01.02.01.02.03.01.03 Dyke: A perimeter dyke is designed depending on the topography of the plot to prevent overflow of water

4.01.02.01.02.03.01.04 Model

Total area of the plot : 0.1 ha.

Refuge pond:

- Length of the pond : 5 m
- Breadth of the pond : 4 m
- Area of the pond : 20 m^2
- Area of the paddy plot : 0.078 ha.
- Area used for dyke : 0.02 ha.

4.01.02.01.02.04 CONSTRUCTION

4.01.02.01.02.04.01 Pond

While constructing the pond, a side slope of 1:1 (horizontal to vertical) ratio is maintained. Inner embankment of pond is deferred so as to facilitate free access of the fish from the pond to the paddy field.

4.01.02.01.02.04.02 Perimeter of the dyke

The perimeter dyke should be adequately compacted so that it offers full protection to the fish crop and create confinement of the water spread. Provision for guarded outlet and inlet through the dyke at different level in the paddy plot.

4.01.02.01.02.05 FARMING TECHNOLOGY

4.01.02.01.02.05.01 Paddy:

Refer package 4.01.02.01.01.05.01.01 and 4.01.02.01.01.05.01.02

4.01.02.01.02.05.02 Fish

All the five fish species of major carps can be reared as described in package-4.01.02.01.01.06

4.01.02.01.02.05.02.01 Preparation of pond

Pond preparation should be started in April – May.

The pond should be cleared of aquatic weeds, predatory fishes and excess organic deposit.

4.01.02.01.02.05.02.02 Liming

As described in package-4.01.02.01.01.06.02

4.01.02.01.02.05.02.03 Manuring

Additional manuring is not required for fish culture

4.01.02.01.02.05.02.04 Stocking

There should be a depth of minimum 80 cm in the pond and 15 cm in the paddy plot at the time of introduction of fish seed. Stocking is done at the rate of 10,000 per hactre. The species combination practiced for Perennial rice-fish farming is as described in package-4 (Table -4) is recommended for plots having pond area more than $1/7^{th}$ of the plot area.

4.01.02.01.02.05.02.05 Supplementary feeding:

Refer package 4.01.02.01.01.06.04

4.01.02.01.02.05.02.06 Health care:

Refer package 4.01.02.01.01.06.05

4.01.02.01.02.05.02.07 Harvesting:

Harvesting is done before or after harvesting of sali paddy depending on the water level in the plot. If the pond retains sufficient water level, partial harvesting may be done and smaller fishes may be reared further. The small size fishes may also be used for rearing in perennial ponds.

4.01.02.01.02.06 Production:

Paddy	: 2900 - 3000 kg ha^{-1}.
Hay	: 4250 - 5000 kg ha^{-1}.
Fish	: 900 - 1000 kg ha^{-1}.

4.01.02.01.02.07 ECONOMICS:

The variable cost and return function of synchronous refuge pond system calculated for 0.1 ha area is given in table - 1. The calculation shows that an investment of Rs. 12,213.00 assures a return of Rs. 16,600.00. The percent return to variable cost is 35.92.

Table 1: Economics of synchronous refuge pond system of rice-fish farming (0.1ha)

VARIABLE COST				
Sl. No.	**Head of expenditure**	**Qty./No.**	**Rate (Rs.)**	**Cost (Rs.)**
1.	Earthwork (av. Annual expenditure/3yrs life span)	-	-	1500.00
2.	Sali crop	-	-	1000.00
3.	Agril.lime	7.5 kg	7 kg^{-1}	53.00
4.	Fish seed	1030 Nos.	5 each	5150.00
5.	Mustard oil cake	70 kg	20 kg^{-1}	1400.00
6.	Rice Polish	70 kg	10 kg^{-1}	700.00
7.	Harvesting cost	-	-	800.00
8.	Misc. expenditure	-	-	500.00
	Total			**Rs. 11,103.00**
	Interest		**10.0%**	**Rs. 1110.00**
	Total variable cost			**Rs. 12,213.00**
		RETURN		
Sl. No.	**Product**	**Qty (kg)**	**Rate (Rs. kg^{-1})**	**Sale proceeds**
1.	Paddy	320	11.25 kg^{-1}	Rs. 3600.00
2.	Hay	500	2.00 kg^{-1}	Rs. 1000.00
3.	Fish	100	120 kg^{-1}	Rs. 12000.00
	Total return			**Rs. 16,600.00**
	Paddy cultivated area			**0.078 ha.**
	Trench and dyke area			**0.02 ha.**
	Pond area			**0.002 ha.**
	Income from paddy			**Rs. 4600.00**
	Income from fish			**Rs. 12000.00**
	Gross Income			**Rs. 16600.00**
	Net income			**Rs. 4387.00**
	Percent profit to turn over			**26.43%**
	Percent return on Variable cost			**35.92%**
	BCR			**1.34**

4.01.02.01.03 ENCLOSURE SYSTEM OF RICE FISH FARMING

In enclosure system of Rice-Fish farming, the fish crop is raised with *bau* paddy in deep water areas by enclosing the plot with pegged screens.

4.01.02.01.03.01 MERITS

- Conversion of monocrop *bao* paddy areas to multiple crop unit.
- Permanent loss of land due to pond/trench construction is avoided.
- Other merits are mentioned in package-4 (Ref. Package 4.01.01).

4.01.02.01.03.02 SITE SELECTION

Typical deep water rice growing areas where water level remains 1.5 m during the paddy cultivation period are selected. Other conditions for site selection are –

4.01.02.01.03.02.01Area
4.01.02.01.03.02.01.01 Minimum: 0.05 ha.
4.01.02.01.03.02.01.02 Maximum: No upper limit.
4.01.02.01.03.02.02 Topography
Preferably having uniform contour.
4.01.02.01.03.02.03 Soil characteristics
As described in package – 1(1.01.05.03.03).
4.01.02.01.03.02.04 Maximum flood level
Highest flood level must not exceed 3.0 m
4.01.02.01.03.02.05 Legal matters
As described in package – 1(1.01.05.03.05).
4.01.02.01.03.02.06 Input availability
As described in package – 1(1.01.05.03.07).
4.01.02.01.03.02.07 Manpower
As described in package – 1(1.01.05.03.08).

4.01.02.01.03.03 DESIGN AND CONSTRUCTION

4.01.02.01.03.03.01 Specifications

The length, breadth and the diameter of the area is accurately measured and provision for enclosing the area with a screen is made. The height of the screen is kept at least 1m above the highest flood level.

4.01.02.01.03.03.02 CONSTRUCTION

Bamboo is the suitable material for preparation of enclosing screen. The screen must be strong enough to withstand water current and weather action. The screen is erected while the plot is semi-dry. Supporting bamboo poles at 2 m distance are provided. The screen should be well pegged.

4.01.02.01.03.04 FARMING TECHNOLOGY
4.01.02.01.03.04.01 Paddy
Deep water paddy (*Bao*) is cultivated in the enclosed paddy plot.
4.01.02.01.03.04.01.01 Variety: Recommended varieties are *PJNB – 95-2*, *PJNB-96-10, Negheri bao, Padmapani, Kekowa, Panikekowa, Rupohi, Maguri, Tara bao.*

4.01.02.01.03.04.01.02 Land preparation: Stubbles of the previous crops should be burnt thoroughly to minimize nematode and other pest infection in February-March. The plot is ploughed and cross ploughed 3-4 times.
4.01.02.01.03.04.01.03 Sowing: Sowing is done in March-April at the rate of 75 kg ha^{-1} in lines with 20-25 spacing between lines.
4.01.02.01.03.04.01.04 Weeding: As and when necessary.
4.01.02.01.03.04.01.05 Fertilization: Top dressing with 4% urea at the tillering stage.
4.01.02.01.03.04.01.06 Plant protection: Carbofuran at the rate of 30 kg ha^{-1}, 3-5 days after sowing.
4.01.02.01.03.04.01.07 Harvesting: Before harvesting fish.

4.01.02.01.03.04.02 Fish
4.01.02.01.03.04.02.01 Species: As described in package- 2.01.12.04. All 5 species can be cultivated except grass carp.
4.01.02.01.03.04.02.02 Stocking: Best stocking time is April – May. The plot must have at least 50 cm water level at the stocking time. Stocking must not be done within 7-10 days of application of carbofuran in paddy. Stocking is done at the rate 8,000 in combination as shown in package- 4 (Table-4).
4.01.02.01.03.04.02.03 Supplementary feeding: Rice polish and oil cake mixed at 1:1 ratio at 3% body weight of fish.
4.01.02.01.03.04.02.04 Harvesting: Harvesting is done after harvesting of paddy when the water level lowers down to 70-80cm.

4.01.02.01.03.05 PRODCUTION

Paddy : 3500 - 3600 kg ha^{-1}
Hay : 2300 - 3500 kg ha^{-1}
Fish : 700 - 800 kg ha^{-1}

4.01.02.01.03.06 ECONOMICS

The variable cost and return function of the system calculated for 0.1 ha area is shown in table-1. The table shows that an investment of Rs. 13,970.00 assures a return of Rs. 16,437.00. The percent return on variable cost is 17.66.

Table-1: Economics of Enclosure System of Rice-Fish Farming (0.1 ha)

VARIABLE COST				
Sl. No.	**Head of expenditure**	**Qty./No.**	**Rate (Rs.)**	**Cost (Rs.)**
1.	Bamboo screen	-	-	1400.00
2.	Paddy crop	-	-	1000.00
3.	Fish seed	1000 Nos.	5.0 each	5000.00
4.	Mustard oil cake	70 kg	20 kg^{-1}	1840.00
6.	Rice Polish	70 kg	10 kg^{-1}	700.00
7.	Harvesting cost	-	-	600.00
8.	Misc. expenditure	-	-	500.00
	Total			**Rs. 12700.00**
	Interest		**10.0%**	**Rs. 1270.00**
	Total variable cost			**Rs. 13,970.00**
		RETURN		
Sl. No.	**Product**	**Qty (kg)**	**Rate (Rs. kg^{-1})**	**Sale proceeds**
1.	Paddy	350	11.25 kg^{-1}	Rs. 3937.00
2.	Hay	250	2.00 kg^{-1}	Rs. 500.00
3.	Fish	100	120.00 kg^{-1}	Rs. 12,000.00
	Total return			**Rs. 16,437.00**
	Paddy cultivated area			**0.078 ha.**
	Gross Income			**Rs. 16,437.00**
	Income from paddy			**Rs. 4187.00**
	Income from fish			**Rs. 12,000.00**
	Net income			**Rs. 2467.00**
	Percent profit to turn over			**15**
	Percent return on variable cost			**17.66**
	BCR			**1.18**

4.02 INTEGRATED HORTI-FISH FARMING

In integrated horticulture with fish farming, the dry area in the fish farms are used for raising fruit crops and vegetables in such a way that maximum economic and conservation benefits are obtained from the fish farm.

4.02.01 MERITS

- Efficient utilization of available high land resources in the fish farm.
- Conservation of soil, nutrients and energy.
- Recycling of green wastes.
- Efficient utilization of manure rich water.
- Water quality control.
- Multi commodity food production, increase of farm income.
- Improvement of aesthetic value of the farm.

4.02.02 PRINCIPLES

Considering that horticulture is the secondary crop in this integrated system, utmost care is taken to make sure that the horticulture activity does not hamper the fish production programme in any way but offers maximum economic and conservation benefits to harness this, the following principle are strictly adhered.

4.02.02.01 Optimum solar energy

The horticulture crops must not cover the sunlight into the pond, so that the primary productivity sustains at optimum level. For this, tall trees are allowed only on the northern side.

4.02.02.02 Preservation of the embankments

The horticulture crops must not crack or erode the embankments. For this deep rooted tall plants are deferred. Trees must be at safe distance from the margins of the ponds. Crops that need fine land preparations should be avoided.

4.02.02.03 Prevention of toxicity

The horticultural crops must not cause any toxic effects to the water. For this, crops needing extensive chemical plant protection measures are avoided. Defoliating trees are deferred.

4.02.02.04 Green for fish

The horticultural crops should be preferably useful to fish culture. For this, crop leaves or any part of which serves as food to macrophytophagous fish are preferred.

4.02.02.05 Tune to environment

The horticultural crops raised must be suitable for the locational environment and soil.

4.02.03 LAYOUT AND DESIGN

4.02.03.01 Technical feasibility

Layout for the horticulture is made depending on the contour, physiography and size of the farm, market demand for the product, own preference and depending on the distinct advantage sought for the horticultural activities.

4.02.03.02 Selection of crops

Crops are selected as per their distinct advantages. Example: Assam lemon for fencing, Para for soil conservation, Banana as feed for fish, etc.

Pineapple and banana cultivation over the pond embankment

Tapioca grown over the pond embankment

Arahar cultivation over the pond embankment

Nappier grass cultivation over the pond embankment

4.02.03.03 Segmentation for crops

In order to reap maximum benefits it is necessary that the entire dry area in the farm is put into use for horticulture by judicious segmentation.

The dry segments of the fish farm can be classified as under.

4.02.03.03.01 Farm boundary

4.02.03.03.02 Pond embankment

4.02.03.03.03 Interpond embankments

4.02.03.03.04 Freeboards for ponds

4.02.03.03.05 Surplus dry area

4.02.03.03.06 Area over the water body: On the northern embankment not exceeding one fifth of the total area of the pond.

4.02.03.04 Model design

Depending on the principle and considering the points under 4.02.03.02 and 4.02.03.03 above, specific designs are made. A few model designs are given below.

4.02.03.04.01 For small ponds (single)

Land segmentation –

Total farm area	:	0.05 ha
No. of ponds	:	1
Total water area	:	0.02 ha
Total dry area	:	0.02 ha

Pond embankments	:	Present
Surplus dry area	:	Nil
Area over the water body	:	1/5th of the total area of pond in northern side

Cropping pattern

Farm boundary	:	Plantation optional. Arecanut on all sides except north. Tall banana on the north.
Pond embankments -		
Margins	:	Hybrid Napier
Middle	:	Dwarf cavendish or papaya except the north
Freeboard	:	Para grass
Area over water body	:	Bottle gourd, Ridge gourd, etc.

4.02.03.04.02 For small farm

Total farm area	:	0.15 ha
No. of ponds	:	More than one
Total water area	:	0.11 ha
Total dry area	:	0.04 ha
Farm boundary	:	200 m (approx)
Pond embankments	:	Present
Inter pond embankments	:	Present (one or more)
Freeboard area of ponds	:	Present
Surplus dry area	:	Nil
Area over water body	:	1/5th of the total area of the pond in northern side

Cropping pattern

Farm boundary	:	Arecanut and Assam lemon on all sides. Tall Banana or amliso on the north
Pond embankments -	:	As for small ponds (4.02.03.04.01)
Inter pond embankments	:	Hybrid Napier or dwarf banana or barseem or papaya or pumpkin
Freeboard of ponds	:	Para grass

4.02.03.04.03 For medium farm

As for small farm (4.02.03.04.02)

If surplus land area is present, cash crops may be grown. Northern boundary may be used for raising coconuts.

4.02.03.04.04 For big farm

As for medium farm. (4.02.03.04.03)

Depending on the size of the embankments, fodder may be grown on the interpond embankments. Coconut may be grown all along the northern boundary. Litchi, Guava, Tapioca, Maize etc. may also be introduced.

4.02.04 FARMING PRACTICE

4.02.04.01 Fish stocking

As described in package -2.01.12

If sufficient fodder is grown, the number of grass carp may be increased upto 50% of the total stocking density.

4.02.04.02 Horticulture

Expert aid for raising horticulture may be obtained from horticulturist.

For ready reference, the package of practice for a few selected horticultural /fodder crops are given below.

4.02.04.02.01 *Banana (Musa* spp.*)*

Soil	:	Must not be water logged
Propagation	:	By suckers
Planting	:	In pits
Pit size	:	45 cm × 45 cm ×45 cm
Spacing -	:	200m (approx)
Dwarf	:	1.4 m ×1.4 m
Medium	:	2.1 m ×2.1 m
Tall	:	2.4 m ×2.4 m
Time of plantation	:	March to April
Manure and fertilizer -		
FYM or pond silt	:	12 kg/plant
N	:	110 g/plant
P	:	33 g/plant
K	:	330 g/plant
(Increase K_2O to 550 g in Dwarf Cavendish)		

Manuring and fertilization:

FYM	: At plantation
N	: Half in 3rd month and half in 5th month
P	: Whole quantity in 3rd month
K	: As per nitrogen
Weeding	: Periodical
Harvesting	: Fruits –
	Dwarf: 12-14 months
	Tall: 14-18 months

		Leaves: All leaves at harvesting in case of mother plant an at desuckering in case of sapling
Crop cycle		: 1 main crop followed by 2 ratoons

4.02.04.02.02 Papaya (*Carica* spp.)

Soil	:	Well drained
Propagation	:	By seeds
Variety	:	Dioceous: - Co-1, Washington, Ranchi Harmaphrodite – Coorg, Honey dew
Planting	:	In pits
Pit size	:	45 cm × 45 cm × 45 cm
Spacing		1.8 m ×1.8 m
Method of planting		Dioceous: 4 saplings/pit Harmaphrodite: 1 sapling/pit
Weeding		Periodical
Harvesting		First harvest at 9 months after planting. New plantation after 1-3 years
Yield		40 kg $plant^{-1}yr^{-1}$

4.02.04.02.03 Pumpkin (*Cucurbit* spp.):

Soil	:	Well drained and rich in organic matter
Propagation	:	By seeds
Cultivar	:	Arka Chandan, Arka Suryamukhi and selected local cultivars.
Spacing	:	1-1.5 m plant to plant
Manure and fertilizers -		
FYM	:	2.5 kg m^{-2}
N	:	7.5 g m^{-2}
P	:	8.0 g m^{-2}
K	:	8.0 g m^{-2}
CaO	:	3.0 g m^{-2}
Manuring and fertilization	:	Basal application
Harvest	:	At ripening of fruits
Yield	:	30-50 kg/plant

4.02.04.02.04 *Hybrid Napier*:

Soil	:	Well drained and fertile
Propagation	:	By seeds and rooted nodes
Variety	:	NB -21, IGFR-1, IGFR-3, HGA/BN-7
Spacing	:	0.3 m ×0.3 m
Planting	:	General practice is harrowing and planking. In the integrated farming, pits measuring

		0.2 m × 0.2 m are prepared where planting is done in rows
Time of planting	:	April-June
Manure and fertilizers -		
FYM	:	8-10 t ha^{-1}
N	:	120 kg ha^{-1}
P	:	50 kg ha^{-1}
K	:	48 kg ha^{-1}
Manuring and fertilization	:	Basal application
FYM	:	At plantation
N	:	4 split up doses
P	:	Single basal dose with first instalment of N
Weeding	:	Periodical
Irrigation	:	First watering at planting and subsequent watering as and when required
Harvesting	:	First cutting after 9-10 weeks of planting. Subsequent at 4-6 weeks interval
Yield	:	30-60 kg/plant/year

4.02.04.02.05 *Para* (*Brachiaria* spp):

Soil	:	Slope of pond derelict and swamp
Propagation	:	By seeds, nodes and cuttings
Spacing	:	50 cm × 50 cm when planted /3kg seeds/ha when sowed
Manure and fertilizers -		
FYM	:	25-30 t ha^{-1}
N	:	40 kg ha^{-1}
P	:	30kg ha^{-1}
K	:	30 kg ha^{-1}
Weeding	:	Periodical
Harvesting	:	First cutting after 80-85 days after planting. Subsequent at 20-30 days interval
Yield	:	25-30 t ha^{-1}

4.02.05 ECONOMICS

Depending on the type of horticultural crops selected, the production economics may vary. Economics of some crops cultivated on the embankments of a 0.05 ha pond are given in table -1.

Table-1 Economics of Integrated Horti-Fish Farming

1. Economics of Fish Culture: Area 0.05 ha

VARIABLE COST			
Particulars	**Qty/No.**	**Rate (Rs.)**	**Cost (Rs.)**
Dewatering & desilting	-	-	1000.00
Agricultural lime	120kg	7.00 kg^{-1}	840.00
Cowdung	672kg	0.6 kg^{-1}	403.00
Urea	14kg	10.00 kg^{-1}	140.00
SSP	20kg	10.00 kg^{-1}	200.00
Carried over seed	350nos.	5.00 kg^{-1}	1750.00
Feed			
Rice polish	115 kg	10.00 kg^{-1}	1150.00
MOC	115kg	20.00 kg^{-1}	2300.00
Labour wage	70 mandays	200.00 day^{-1}	14,000.00
Miscellaneous cost	-	-	1000.00
Total			**22,783.00**
Interest		@10%	2278.00
Total variable cost	**-**	**-**	**25,061.00** **Say Rs. 25,000.00**

RETURN

Product	**Quantity (Kg)**	**Rate (Rs.)**	**Sale proceed (Rs.)**
Fish	240	150.00 kg^{-1}	36,000.00
Net profit	-	-	11,000.00

2.Economics of Banana cultivation:

VARIABLE COST			
Particulars	**Qty/No.**	**Rate (Rs.)**	**Cost (Rs.)**
Seedling	50	10.00 per seedling	500.00
Manure	2 *Thelas*	200.00 /Thela	400.00
Labour	26 nos.	200.00 /labour	5200.00
Total variable cost	**-**	**-**	**6100.00**

RETURN

Product	**Quantity (kg)**	**Rate (Rs.)**	**Sale proceed (Rs.)**
Fruits	600	30.00 kg^{-1}	18,000.00
Grass	30	1.00 kg^{-1}	30.00
Gross return			18030.00
Net profit from banana plantation	-	-	11,930.00

3.Economics of Papaya cultivation:

VARIABLE COST			
Particulars	**Qty/No.**	**Rate (Rs.)**	**Cost (Rs.)**
Seedling	30	2 per seedling	60.00
Manure	1 *Thela*	200.00 /*Thela*	200.00
Labour	1 no.	200.00 /labour	200.00
Total variable cost	**-**	**-**	**460.00**

RETURN

Product	**Quantity (kg)**	**Rate (Rs.)**	**Sale proceed (Rs.)**
Fruits	600	10.00 kg^{-1}	6000.00
Gross return			6000.00
Net profit	-	-	5540.00

4.Economics of Pumpkin cultivation:

VARIABLE COST			
Particulars	**Qty/No.**	**Rate (Rs.)**	**Cost (Rs.)**
Seeds	1/2kg	200.00 kg^{-1}	100.00
Manure	2 *Thelas*	200.00/*Thela*	400.00
Labour	1/2 nos.	200.00 /labour	100.00
Total variable cost	**-**	**-**	**600.00**

RETURN

Product	**Quantity (Kg)**	**Rate (Rs.)**	**Sale proceed (Rs.)**
Fruits	600	10.00 kg^{-1}	9000.00
Gross return	-	-	9000.00
Net profit from pumpkin	-	-	8400.00

Total net profit from Horti-fish farming

= Rs. (11000.00+11930.00+5540.00+8400.00)

= Rs. 36,870.00

Percent return on investment = 114.65

BCR = 2.14

PACKAGE -5

INTEGRATED ANIMAL-FISH FARMING SYSTEM

5.01 INTEGRATED PIG-FISH-HORTICULTURAL CROP PRODUCTION

In this system, fish farming is done using pig dung and spilled feed; silt of the pond bottom deposited due to continuous addition of pig manure is used as the manure for growing seasonal vegetables, banana, tapioca, arhar, lemon, dhaincha and fodder crops etc. on pond embankments, slopes and the open spaces of the farm. Bio-wastes of these crops are used in pig and fish farming directly as well as indirectly.

5.01.01 Benefits:

- Abatement of air pollution caused in pig farming as fish pond acts as sanitary disposal site of pig wastes.
- Drastic reduction in cost of production of fish and horticultural crops.
- Efficient recycling of farm wastes.
- The system spread the risks associated with fish farming because of the increased diversity of produce.
- Better management and fuller utilization of manpower.
- Better profit from the entire system.

5.01.02 Site selection:
5.01.02.01 Area: Minimum: 0.4 ha
Maximum: No upper limit
5.01.02.02 Topography: Refer Package 1.01.05.03.02
5.01.02.03 Soil characteristic: Refer Package 1.01.05.03.03
5.01.02.04 Size: Refer Package 2.01.06.02.01

5.01.03 Models of Integration
5.01.03.01 Direct integration
5.01.03.01.01 Pig fattening:

A predetermined number of pigs are reared for six months in the pigsty constructed on the widest embankment of the pond. The wastes are collected, mixed with water and spread over the water surface of the pond before stocking. After stocking, the collected wastes is dumped in 4-6 pre-fixed shallow sites of the pond. Urine part and the rest are drained to the pond directly through the delivery pipe.

Pig sty over the pond embankment

Pig waste and spilled feed directly falling into the pond water

Stored pig dung released into the fish pond

Upgraded Hamshire piglets in the pig sty kept for fattening

5.01.03.01.02 Pig breeding:

Pens are constructed on the opposite longer embankments of the pond, as shown in Fig-1. Methods of use of pig dung, spilled feed and urine are same as that of 5.01.03.01.01.

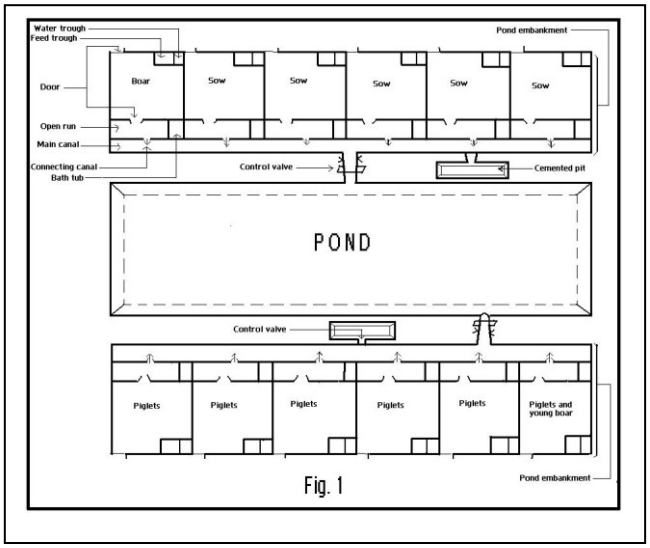


Fig. 1

Piglet Production

5.01.03.01.03 Farm lay out, design and construction:

5.01.03.01.03.01 Layout: Refer package 2.01.07.02

5.01.03.01.03.02 Design and construction: Refer package 2.01.07.02.01

5.01.03.01.03.03 Pond construction:

At least one embankment should be made sufficiently broad for construction of the pigsty in the case of rearing of fattening pigs. In the case of pig breeding unit, two opposite longer embankments should be made sufficiently broad to construct two rows of pens facing each other as shown in Fig.-1.

5.01.03.01.03.04 Construction of pigsty for fattening pigs:

Floor space 1.25-1.5 m^2 per pig, 25% of total floor space required for open run. Height of pigsty 1.5-1.7 m. Floor must be strong, made of two layers, the lower layer of 12.0 cm thickness filled with sand and gravel. The upper layer of 10.5 cm thickness made of bricks soling rough cement mortar pasted. The floor is slightly slanted towards which a drainage canal is constructed. The canal is connected to the pond through a hard plastic delivery pipe. The drainage canal is preferably be provided with a diversion canal leading to a cemented pit, where the wastes are stored in the days when the entire water surface of the pond is covered by algal bloom, or when frequent surfacing of fish occurs particularly at dawn. Feeding and drinking troughs are to be constructed alternatively attached to the side walls length wise.

Bricks of 75.0 mm thickness are used to construct the sidewalls to a height of 0.90-1.0 m. The open run is separated by brick wall from both sides with a wooden door in the middle.

Bath tubs are constructed laterally along the side walls of the open run. The open run is constructed for use of pigs as dunging space and for taking direct sunlight and bath. The design of the pigsty should be such that direct sunlight falls on the open run till late mid day. 20 mm x 50 mm meshed expanded metal net of 18 gauge (1.22 mm) thickness may be fitted above the walls in wooden frame up to a height of 60 cm. The frame of the roof is to made of wooden battens and/or bamboo, providing thatch roofing with sun grass (*Imperata cylindrica*) in layers of 75.0 mm thickness with 1/4 split bamboo fillet, tying with galvanized wire. Asbestos may also be used as roofing material.

The pigsty is also provided with an outdoor fitted to the concrete half-walls.

Depending on the number of pigs in the pigsty, one or two quarantine rooms are to be constructed separately to accommodate at least 5% of the total pig population with floor space of 1.5 m^2 per pig. The rooms are to be well ventilated and sunlight should fall directly on them. Washings of these rooms are never allowed to enter the ponds, channeled to a top covered 3 m deep earthen pit.

5.01.03.01.03.05 Construction of pig breeding pens:

The method of construction is same as that of pigsty. The drainage is such that all wastes are channelized to a common drainage canal which is connected to a hard plastic pipe leading to the pond. The cemented pit is constructed separately as shown in Fig.-1.

5.01.03.01.03.06 Space requirements:

Boar : 6.0 m^2/ boar
Breeding sows : 6.0 m^2/sows
Weaned piglets (to be disposed) : 0.5 m^2/ piglet
Weaned piglets kept for breeding purpose : 1.0 m^2 / piglet
Young boar : 1.0 m^2/boar

5.01.04 Construction of pond: Refer Package 1.01.06
5.01.04.01 Reclamation of old pond: Refer Package 2.01.08
5.01.04.02 Preparation of pond: Refer Package 2.01.11
5.01.05 Fish Husbandry
5.01.05.01 Fish seeds
5.01.05.01.01 Species:

Catla, rohu, mrigal, silver carp, grass carp, common carp, magur and feather-backs (to be used as biological agent to control weed fishes).

5.01.05.01.02 Size:

Not less than 12.0 cm. Magur not less than 5.0 cm. Major carps stunted seeds of previous year are preferred.

5.01.05.01.03 Number:

Stocking rate 9000-10000 nos. ha^{-1} for yearly harvesting system. Magur up to 5% of the total density.

5.01.05.01.04 Species composition:

Species	Percentage
Catla	20
Rohu	25
Mrigal	20
Grass carp	10
Silver carp	20
Common carp	5

Number of feather-backs depends on the intensity of weed fish infestation in the pond. Normally 100 feather-backs per ha is sufficient. If seeds are not available, juveniles can be introduced. Since fish culture is continuously done for three years, the fish will establish in the pond if hard substrates like dry apex part of bamboo are provided during May-July months in one side of the pond. The adults can be harvested from the next year.

In the case of multiple stocking and multiple harvesting, stocking density of 20,000-25,000 of unequal size seeds (8-15 cm) can be maintained.

5.01.06 Pig Husbandry

5.01.06.01 Breed:

Pure breed is not easily available. Hampshire, Large black, Landrace, Large white Yorkshire are suitable. Crossed varieties are better for fattening. For breeding, the boar should preferably be of pure breed.

5.01.06.02 Age:

2-3 months old weaned piglets, average weight not less than 12.0 kg for fattening. For breeding, 5-6 months old female juveniles, 7-8 months old boar. The boar should not be procured from the same farm.

5.01.06.03 Number:

(i) 40-45 piglets ha^{-1} water area for six months fattening.

(ii) 30 (Female) + 6 (male) = 36 pigs ha^{-1} initially for breeding farm.

5.01.07 Farming Technology:

5.01.07.01 Fish farming:

5.01.07.01.01Stocking:

Stocking after 10-12 days of application of liquid pig dung, when water takes slight greenish colour. Silver carp should stocked after one month of stocking of other carps, particularly catla. Stocking should preferably be done in March-April, however with a minimum water depth of 1.5 m.

5.01.07.01.02 Water Management:

5.01.07.01.03 Liming: Regular liming at monthly interval.

5.01.07.01.04 Feeding: No supplemental feeding other than supply of grass to Grass carp.

5.01.07.01.05 Control of algal bloom:

Partial covering of water surface is not a problem. In case the entire water surface is covered with algal bloom, suspend application of pig dung and stop feeding grass carp. The bloom can be manually removed using dry banana leaves tied one after another. Two persons can push the bloom to one corner of the pond and one or two persons can remove the thick bloom layer using steel or plastic plates. Repeat the process after two days.

5.01.07.01.06 Pond bottom raking:

Must be done once in a week in order to remove the toxic gases from the pond bottom and to boost primary productivity of pond water. Bottom raking is done with a rope fixed with several sinks(Fig. 2). When it is pulled, the sinks hits surface of pond bottom and help to emit toxic gases and release of nutrients to the photic zone of pond water. When pearl size attached eggs of feather-back on the apex part of bamboo during June- July are seen, raking be done carefully to avoid the site.

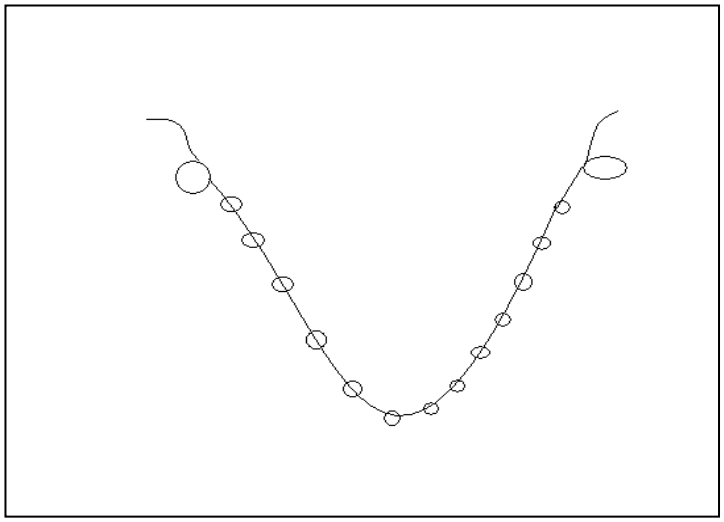


Fig: 2.Rope tied with sinks for raking pond bottom

5.01.07.01.07 Health care of fish: Refer Package 7.

5.01.07.01.08 Monitoring of DO level:

Problems may occur during the summer months, particularly when water depth is below 1.5m and water temperature is above 29º C. if the fishes start surfacing at dawn or at any time on cloudy day frequently, application of pig dung and feeding of grass carp should be stopped till the problem is over. For remedial measures refer package 7.03.04.06

5.01.07.01.09 Harvesting:

Partial harvesting of silver carp and grass carp can be done after 6-7 months.

Others with 600-750 g weight can also be harvested. This stock should be replenished. Final harvesting is done on the 12th month, *i.e*. on the month of March, if stocking is to be done in the month of April. Before final harvesting, partial dewatering is done to expose the pigdung dumping sites. Deposited silt is to be removed manually upto a water depth of 60 cm using bamboo basket. Partial dewatering also facilitate efficient netting. All fishes more than 400 g are harvested. The rest are released back. The pond is to be refilled with fresh water to at least 1.5 m depth, limed and stocked to maintain the density at 9,000-10,000 ha^{-1}. The same is done in the second year. In the third year, the pond is completely dewatered and bottom is exposed to the sun for a minimum of 10 days. The upper layer of soft bottom soil (20- 30 cm) is removed, bottom is ploughed, leveled, limed, filled if facility available or wait for accumulation of rain water to a minimum depth of 1.5 m, apply liquid pig manure and stock after 10 -12 days.

5.01.08 Pig Husbandry:

5.01.08.01 Rearing of pigs for fattening:

The first batch is introduced at least 15 days ahead of stocking of the pond. After 6 months when they attain slaughter maturity of 60- 70 kg are disposed. Necessary repairing of the pigsty is done and the second batch is brought in. Accordingly pig farming is done continuously for 3 years. After 3 years, pigsty is properly disinfected and kept vacant for 15-20 days. Piglets are introduced 15 days before stocking the pond.

5.01.08.02: Rearing of pigs for breeding:

Production of good quality piglets is one of the most profitable ventures. Sows of 5-6 months and boar of 7-8 months old are brought to the pens. One boar is required for five sows. Sow matures at the age of 7-8 months, gestation period is 114-120 days, give litters two times in a year. Boar becomes serviceable at the age of 10 months. Production of piglets starts after 6 months of introduction of the breeders into the pens. The boar is sold out after sows become pregnant for the 4th time and a new boar is brought in. The sows are also sold out after the 4th batches of piglets are weaned. Weaning is done after 1½ - 2 months of birth when the piglets' starts taking feed.

Female for breeding are to be selected from the third litter, preferably from the batch having less litters (5-6). These piglets will be ready for breeding at the age of 7-8 months. In this way piglets are produce continuously.

The extra dung voided by the piglets for short time will not create problem to the fish farming, since manurial value of these is less than that of the adults.

5.01.08.03 Pig feed:

Pigs can be fed with balanced pig mash concentrate (PMC). The composition of the PMC:

Ingredient	Amount (kg)
Rice bran	30
Rice polish	15
Wheat bran	27
Maize broken	10
Ground nut oil cake	10
Fish meal	4
Mineral mixture	3
Common salt	1
Total	**100**

However, raising pigs with PMC has not been found profitable. Pigs can be raised by feeding locally available feed ingredients. The following composition developed through trial and error, is being used in the College of Fisheries, AAU, Raha, with great success:

Ingredient	Percentage
Wild *Colocasia* stems, leaves and rhizomes, and/or Azolla	15
Kitchen wastes of hostels etc	30
Rice bran	20
Rice polish	10
Broken maize/ mustard oil cake	5
Fish meal	4
Tea waste, half rotten potato (washed), banana spadix, unripe banana, tapioca (debarked), papaya, vegetable wastes etc.	4
**Jubili*	10
Salt	1
Vitamin and mineral mixture	1
Total	**100**

**Jubili is a byproduct of a special type of beverage prepared and consumed by the tribal people of Assam. Half cooked rice and molasses are the major raw materials used to prepare the beverage.*

Pigs reared for breeding are not given mustard oil cake. Piglets brought/ kept for fattening are fed with the feed containing broken maize for 1½ months after weaning. After that broken maize is omitted and percentage of rice bran increased to 25%. When the percentage of animal origin wastes are more in the kitchen wastes, the percentage of fish meal is reduced; otherwise fish meal is one of the most important ingredient for all types of pigs.

5.01.08.04 Method of preparation:

The *Colocacia* leaves, stems and rhizomes are cut into small pieces, mixed with the ingredients other than rice bran, *jubili* and vitamin and mineral mixture, boiled properly. Rice bran and *jubili* are mixed and allow to cool. Prior to serving, vitamin and mineral mixture is mixed thoroughly and fed to the pigs at the following rates:

Table: Rate of Feeding

Age (month)	Quantity feed per pig/day (kg)
2-4	1.5-2.0
4-6	2.0-3.0
6-8	3.0-4.0
Above 8	5.0

The daily ration is divided into two meals and served two times, morning and afternoon. Sows on mounting (which is to be done for a minimum of 3 times at second 'heat' occurs after 21 days of first 'heat') should be given feed 1/10th of the daily ration on the first day of mounting and increased at that rate to provide full ration on the 10th day onwards.

In addition, pigs are to be fed with wilted water hyacinth (*Eichhornia crassipes*) collected from unpolluted water body regularly at mid day *ad libitum.* Hybrid napier, paragrass and cut pieces of tender banana saplings should also be supplied. Bed of grass with intact interlocked soil (SOD) is to be provided to the weaned piglets once in a week up to the age of four months.

5.01.08.05 Health Care:

- Keep pigsty dry and clean.
- Wash the pigsties thoroughly with enough water sweeping by bamboo made brush every morning and afternoon.
- Give bath to the pigs at the time of washing the pigsty. However, in December-January, pigs may be given bath once a day at noon.
- Disinfect the pigsty every week with $KMnO_4$ (4 ppm) and CaO (3 ppm) alternatively. When CaO is used, pigs to be kept confined at the open run.
- Supply drinking from the well. Pond water treated with pig dung should never be supplied. Filled the bathtubs with the well water.
- During the winter months pig pens having piglets should be wrapped with plastic sheets over wire mesh netting.
- Vaccination and medications:
  Swine fever vaccine (Lapinished Living): 5 doses per ampule. Mix with 5 ml cold distilled water and inject 1 ml at the base of the ear. Immunity lasts for 1 year.
  Anthrax Spore Vaccine (Living): 1 ml subcutiously at the base of the ear. 1 year immunity.
  Deworming: At the time of introducing in pen and one month after.
  Analogon (Albendazole): 0.5 – 1.0 ml per 5 kg body weight in empty stomach.
  Alnoma (Albendazone): As in above.
  Valbaren (Albendazone): As in above.
  Veterinary experts should be consulted for treatment of any disease and vaccination.

5.01.08.06 Harvesting:

5.01.08.06.01 Fattening pigs: Every six months when average weight reaches 60-70 kg.

5.01.08.06.02 Piglets: Weaned at the age of 1½ - 2 months, vaccinated specially against swine fever and sold out after 10-15 days of weaning.

5.01.09 Horticultural crop farming:

Most preferred horticultural crops are banana, lemon, tapioca, papaya, arhar, dhaincha and fodders like hybrid napier and paragrass in addition to the seasonal cash crops. Tall banana can be grown on the northern side, the dwarf varieties on the inter mbankments. Lemon can be cultivated on the boundary area around the perimeter of the farm. Arhar and dhaincha are to be raised on the other unused portions of the farm. Tapioca is cultivated on the soft soil. Hybrid napier is also grown on the pond embankments while paragrass is planted on the slopes of the embankments. Expert aid for raising these crops may be obtained from horticulturists. Pond silt will be available only when old ponds are renovated, otherwise cultivation is to be started with extraneous supply of organic manure and inorganic fertilizers. Once pond silt becomes available, cultivation can be done using only pond silt.

5.01.10 Production:

5.01.10.01 Fish: Normally more production is achieved from the second year onwards in the case of newly dug out ponds.

Average production: **3,500-4,000 $kgha^{-1}yr^{-1}$**

5.01.10.02 Pigs:

i. Pig fattening: @ 45 pigs $ha^{-1}yr^{-1}$, with a maximum of 5% mortality and average finished weight of 65.0 kg = **5557.0 $kgha^{-1}yr^{-1}$**
ii. Piglet production: With an average production of 7 piglets / sow/ litter = **420 piglets $ha^{-1}yr^{-1}$**

5.01.10.03 Horticultural crop production:

Indirect contribution to total production:

i) Dhaincha, arhar plants (after harvest) and dry banana leaves meet partial requirement of firewood for cooking pig feed

ii) Dry banana leaves ash and cut pieces of banana plant used in pond water reduces the requirement of lime. Such practice drastically reduces the chances of occurrence of EUS of fish during the winter months**.**

iii) Cut pieces of tender banana plantlets (saplings) are fed to the pigs.

iv) Hybrid napier and paragrass are used as feed of grass carp and pigs. Paragrass grown on the slopes on the dykes prevent soil erosion of pond dykes and, thereby, enhances the longivity of the pond. Pond water does not become turbid during the rainy months which facilitates better photosynthetic activity of the primary producers.

v) Tapioca, banana spadix and papaya used as pig feed.

vi) Lemon grown on the boundary margins of the pond/farm acts as good bio-fence.

vii) In addition, cash crop of **3,000 kg banana $ha^{-1}yr^{-1}$, 100kg arhar $ha^{-1}yr^{-1}$**and **3,000 nos. lemon $ha^{-1}yr^{-1}$**can be produced.

However, horticultural crop production facilities are reduced when integrated pig breeding-fish farming is adopted.

5.01.11 Cost-benefit Structures:

The economics of integrated pig (fattening)- fish- horticultural crop production in Pond water area of 0.5 ha is given below

A. Cost Function: Non recurring expenditure

Sl. No.	Item	Total Expenditure (Rs)	Average Yearly Expenditure (Rs)
i	Renovation of the pond, repairing of the embankments, widening of the pigsty construction site. Life expectancy: 15 years	65,000.00	4,333.00
ii	Construction of the pigsty for 23 pigs. Life expectancy: 20 years	1,10,000.00	5,500.00
iii	Purchasing of a readymade drag net.65 m x 5 m #3cm. Life expectancy: 4 years	10,000.00	2,500.00
iv	Purchasing of a water pump. 5 HP. Life expectancy: 16 years	20,000.00	1,250.00
v	Setting of a deep tube well. Life expectancy: 20 years	18,000.00	900.00
vi	Purchasing of a cooking vessel, made of cast iron. Life expectancy: 12 years	1,200.00	100.00
vii	Construction of a concrete feed mixing tub. 1.5 m x 1.0 m x 0.45 m. Life expectancy : 12 years	5,600.00	466.00
viii	Construction of a quarantine room. 3.0 m x 2.25 m. Life expectancy: 20 years	8,000.00	400.00
ix	Purchasing of a wooden *thela* Life expectancy: 5 years	3,800.00	760.00
	Total	**2,41,600.00**	**16,209.00 Say Rs16,200.00**

B. Cost Function : Recurring Expenditure

(a) Cost of fish and horticultural crop farming

Sl. No.	Item	Unit	Requirement per ha	Actual requirement	Rate (Rs)	Expenditure (Rs)
i	Carp fingerlings	No.	9,000	4,500	5.00/ seed	22,500.00
ii	Magur seeds	No.	450	225	7.00/ seed	1,575.00
iii	Feather-backs	No.	100	50 x 0.05 kg = 2.50 kg	150.00 kg^{-1}	375.00
iv	Lime (CaO)	Kg	500	250	15.00 kg^{-1}	3,750.00
v	Labour charges	No.	1	1	200.00day^{-1}	73,000.00
vi	Partial dewatering and desilting	-	-	-	-	4,000.00
vii	Cost of seeds, vegetative parts of plants (such as of tapioca), banana rhizomes	-	-	-	-	1,000.00
	Total					**1,06,200.00**

(b) Cost of pig production

Sl. No.	Item	Unit	Requirement per ha	Actual requirement	Rate (Rs)	Expenditure (Rs)
i	Piglets	No.	46 x 2 = 92	46	2000.00	92,000.00
ii	Pig feed	Kg	42,780	21,390	8.00	1,71,120.00
iii	Vaccines, medicines, disinfectants, minor medical aids and consultation fees of veterinary expert.	-	-	-	-	3,500.00
iv	Repairing of pigsty after disposal of the first batch of pigs	-	-	-	-	4,000.00
v	Cost of POL for water pump	Liter	-	55 (diesel) 4 (mobil)	54.00 150.00	2,970.00 600.00
vi	Repairing of the water pump and the *thela*	-	-	-	-	2,000.00
	Total					**2,76,190.00** **Say, Rs.2,76,200.00**

(B) Return Function:

(i) Fish:

Carps, @ 3,750 kg $ha^{-1}yr^{-1}$ = 1875 kg yr^{-1} x Rs.150.00 = Rs. 2,81,250.00

Magur, at 5% mortality and average harvest weight of 150 g = 32 kg x Rs.585.00 =Rs.18,725.00

Feather-backs, at 5% mortality and average harvest weight of 150 g = 7.13 kg x Rs.200.00 = Rs.1426.00

(ii) Pigs: At 5% mortality and with average

Finished weight of 70.0 kg : 3080 kg x Rs.110.00 = Rs. 3,38,800.00

(iii) Horticultural crops:

Banana: 1,500 kg x Rs. 35.00 = Rs. 52,000.00
Arhar: 150 kg x Rs. 60.00 = Rs. 9,000.00
Lemon: 1,500 nos. x Rs. 1.00 = Rs. 1,500.00
Gross income: Rs. 7,02,700.00

(C) Total Expenditure:

(i) Average yearly expenditure of non recurring expenses: =Rs. 16,200.00
(ii) Recurring Expenditure:
Pig farming: = Rs. 2,76,200.00
Fish farming: = Rs. 1,06,200.00

Total : Rs. 3,98,600.00
Interest (10%) : Rs. 39860.00
Total variable cost : Rs. 4,38,460.00

(D) Net income: Rs. (7, 02,700.00 - 4,38,460.00) = Rs. 2,64,240.00

Percent Profit e on the variable expanses =60.27%
Percent profit to turn over = 37.60
BCR = 1.64

5.01.12 Cost-benefit Structure: Variable costs, gross output and net income of integrated pig (breeding)-fish – horticultural crop production system:

Pond water area: 0.5 ha

(A) Cost Function

1. Non recurring expenditure

Sl. No.	Item	Total Expenditure (Rs)	Average yearly Expenditure (Rs)
i	Renovation of the pond, repairing of the dykes, widening of the pig farrowing pens sites Life expectancy: 15 years	40,000.00	2,666.00
ii	Cost of construction of farrowing pens, boar pens and piglet pens. Life expectancy: 20 years	1,20,000.00	6,000.00
iii	Purchasing of portable water pump. 5HP Life expectancy: 16 years	20,000.00	1,250.00
iv	Setting of a deep tube well Life expectancy: 20 years	18,000.00	900.00
v	Purchasing of a cooking vessel, made of cast iron. Life expectancy: 12 years	1,200.00	100.00
vi	Construction of a concrete feed mixing tub. 1.5 m x 1.0 m x 0.45 m. Life expectancy: 12 years	5,000.00	416.00
vii	Construction of a quarantine room. 3.5 m x 2.5 m Life expectancy: 20 years	10,000.00	500.00
viii	Purchasing of a wooden *thela* Life expectancy: 5 years	3,800.00	760.00
ix	Cost of 15 sows 5-6 months old (to be sold out after 26 months and no more purchase) @ Rs. 3500/sows	52,500.00	-
	Total	**2,70,500.00**	**12,592.00 Say, 12,600.00**

2. Recurring expenditure

(a) Pig breeding unit:

Sl. No.	Item	Unit	Requirement per ha	Actual requirement per ha	Rate (Rs.)	Expenditure (Rs)
i	Cost of 3 boars, 7-8 months old (to be sold out after 20 months and to be purchased again)	No.	6	3	5,000.00	15,000.00
ii	Pig feed	kg	46,990	23,495	8.00	1,87,960.00
iii	Vaccines, medicines, disinfectants and consultancy fees.	-	-	-	-	10,000.00
iv	Labour charges	No.	**1**	1	200.00 day^{-1}	73,000.00
v	Repairing of the pens after first farrowing	-	-	-	-	2,000.00
vi	Cost of POL for water pump	liter	-	80 (diesel) 5 (mobil)	54.00 150.00	4,320.00 750.00
vii	Repairing of the water pump and the *thela*	-	-	-	-	2,000.00
	Total					**2,95,030.00** **Say,2,95,000.00**

(B) Return Function:

(i) Fish:

Carps, @ 3,750 kg $ha^{-1}yr^{-1}$ = 1875 kg yr^{-1} x Rs. 150.00 = Rs. 2,81,250.00

Magur, at 5% mortality and average harvest weight of 150 g = 32 kg x Rs. 585.00 = Rs.18,725.00

Feather-backs, at 5% mortality and average harvest weight of 150 g = 7.13 kg x Rs.200.00 = Rs.1,426.00

(ii) Piglet Production:

Average production of 7 piglets / sow / litter

240 piglets yr^{-1} x Rs.2,000.00 = Rs. 4,80,000.00

(iii) Horticultural crops:

Banana: 250 kg x Rs. 35.00 = Rs. 8,750.00

Lemon: 1,500 nos. x Rs. 1.00 = Rs. 1,500.00

Gross income: = Rs. 7,91,650.00

C) Total Expenditure:

i. Average yearly expenditure of non recurring expenses = Rs. 12,600.00

ii. Recurring expenditure:

Piglet production: = Rs2,95,000.00

Fish production: = Rs. 1,06,200.00

Total: = Rs. 4,13,800.00

Interest (10%) = Rs 41,380.00

Total variable cost = Rs 4,55,180.00

D. Net Income: Rs. (7,91,650.00- 4,55,180.00) = Rs. 3,36,470.00

Percentage return on the variable expenses = 73.92

Percent profit to turnover = 42.50

BCR = 1.74

5.02 INTEGRATED FISH-POULTRY FARMING

In fish-poultry farming, the fish crop is raised using only poultry dropping or deep litter by rearing the poultry either directly over the pond or on the pond embankments.

5.02.01 Site selection

5.02.01.01General characteristics

As described in package 1(1.01.05). The salient suitable characteristics are: Minimum area - 0.07 ha, plain type layout, alluvial, impervious soil, organic carbon content less than 1% and soil pH 6.5-7.5.

5.02.01.02 Legal and social aspects

Together with the aspects dealt under package 1(1.01.05.03.05); socio- psychological aspects of poultry farming need be critically examined.

5.02.01.03 Availability of inputs

Availability of chicks of recommended breed, poultry feed, medicine, fish seed and lime need be ascertained.

5.02.01.04 Manpower

Must have trained manpower specially on poultry farming.

5.02.01.05 Road and transport

As described in the package 1(1.01.05.03.09).

5.02.01.06 Market

Must have good demand for eggs and fish.

5.02.01.07 Power supply

Provision of power supply is required more than in other technologies of fish farming as light and temperature are critical factors for poultry farming.

5.02.02 Pond requirements

As described in package 2(2.01.06). Minimum required facilities are at least one grow out pond of 0.05 -0.4 ha, one seed raising pond of 0.01-0.045 ha. Ponds should be preferably rectangular, water level 2.0-3.0 m, pH 6.5-7.5.

5.02.03 Models of integration

Two types of integrated fish-poultry farming are recommended.

5.02.03.01 Direct integration

A pre determined numbers of layer poultry birds are reared in pens over the pond. The floor of the pen being perforated, poultry dropping directly fall into the pond where fish crop is raised.

5.02.03.02 Indirect integration

Poultry birds are reared under deep litter or wire floor system in pens over the pond embankment. The fully built deep litter or the droppings are manually applied to the pond daily at a predetermined dose.

Layer birds of any good breed can be reared this system.

5.02.04 Farm design and construction

5.02.04.01 Design

5.02.04.01.01 Poultry house: The poultry house must have adequate accommodation, supply of light and air be reasonably cool during summer and sufficiently warm during winter, and should always remain dry. To ensure all these *Assam Type* (Gable or monitor type) is recommended. The specification of the house varies according to model of integration.

5.02.04.01.02 Poultry house for direct integration: The house is constructed over pond water at any convenient corner. The floor of the house is perforated (4-6 cm^2 mesh size) and should be installed at 1.2-1.5 m above the highest water level of the pond. Space requirement is 0.3-0.5 m^2 per bird. One third of the wall at the upper portion should be provided with lattice fencing/ wire netting.

5.02.04.01.03 Poultry house for indirect integration: The poultry house is constructed on any convenient embankment. Depending on choice and suitability two types of housing can be opted.

- *Deep litter system*: Space requirement per bird is 2.5 – 3.0 ft^2. The plinth should be 0.75 – 0.90 m higher than the out side elevation of the embankment. Proper rate proof measures should be taken at the time of construction.
- *Wire floor system*: Space requirement per bird is 1.25 ft^2. Floor of house is made of wire netting. The house can be multitier. Litter collecting chambers are provided below each floor. Depending on scale of operation house is designed.

5.02.04.02 Construction

5.02.04.02.01 Pond: As described in package 1(1.01.06).

5.02.04.02.02 Poultry pen:

- *Direct integration*: The poultry house should be erected by complete dewatering of the pond. The house can be made of thatch and bamboo. Asbestos may also be used for roofing. The floor should have half square inch perforation. The floor can be made of split bamboo, but durable wire netting may also be installed on solid beams. Construction should be completed 40 days before commencement of the actual integration.

- *Indirect integration*: In case of deep litter system, the poultry house should be constructed 1 year before the actual process of commencement of integration. In case of wire floor system in the indirect integration the house should be constructed 30 days before the actual process of integration.

  Electrical connection for heater, fan and light should be provided in all cases above.

5.02.04.03 Reclamation of ponds

As described in the package 2(2.01.08)

5.02.05 Preparation

5.02.05.01 Fish husbandry

5.02.05.01.01 Pond preparation: Same as described in package 2(2.01.11) eliminating the fertilization aspect. In direct integration, poultry birds are introduced in pens, 30 days prior to stocking of fish seeds. The droppings gradually build up the productivity of the ponds. In case of direct integration, poultry dropping or deep litter is applied 15 days prior to stocking at the rate of 750kg ha^{-1} in single installment for raising productivity. Desilting every year is mandatory.

5.02.05.01.02 Fish seeds: Species and size same as in package 2(2.01.12.02). Stocking rate is 6000 ha^{-1} with 10% increment to account mortality. Composition is detailed in table- 1

Table-1 Species combination and percentage composition for stocking in integrated fish poultry system.

Combination	Species	Percentage	Nos 0.28 ha^{-1}	Nos. ha^{-1}
6 Species	Silver carp	20	240	900
	Catla	20	320	1200
	Rohu	25	240	900
	Grass carp	10	160	600
	Mrigal	20	320	1200
	Common carp	5	320	1200
	Total	**100**	**1600**	**6000**

5.02.05.02 Poultry husbandry

5.02.05.02.01 Pen preparation: Complete disinfection. Brooding arrangement for deep litter system- bedding materials such as saw dust or paddy husk is required to cover the floor up to about 6 inches.

5.02.05.02.02 Breed:

Direct integration: Keystone Golden, Rhode Island or Kuroiler can be reared.

Indirect integration: Any good commercial breed.

5.02.05.02.03 Age

For direct integration: 6-8 weeks.

For indirect integration: Day old

5.02.05.02.04 Number: 500-600 birds for 1ha water area.

5.02.06 Farming Technology

5.02.06.01 Fish

5.02.06.01.01 Stocking: Best time is March-April. In direct integration system stocking is done 30 days after poultry birds are introduced in pens. In indirect integration system stocking is done 15 days after application of deep litter/poultry droppings.

5.02.06.01.02 Water management:

- *Liming*: Monthly. As described in package 2(2.01.11.03).
- *Supplementary feeding*: Only for grass carp. As described in package 2 (2.01.13.02).
- *Fertilization:* Chemical fertilization is not required. In direct integration, constant flow of poultry dropping sis allowed. In indirect integration, deep litter or fresh droppings is applied @ 50 kg ha^{-1}
- *Water depth:* Minimum: 1.5 m, Optimum: 2.0-3.0 m
- *Control of algal bloom*: On occurrence of algal bloom in direct system, a polythene sheet is carefully laid below the coop to prevent falling of droppings in water. In indirect integration, the application of dropping is suspended. Supply of fodder for grass carp during algal bloom period is suspended.

5.02.06.01.03 Health care: As described in package 2(2.01.16).

5.02.06.01.04 Harvest: Partial harvesting followed by complete harvesting as in package 2(2.01.17).

5.02.06.02 Poultry

5.02.06.02.01 Introducing chicks: In direct integration, birds are introduced 30 days prior to fish seed stocking and reared up to 18 months. In the wire floor system of indirect integration, the same schedule is followed. But in deep litter system of indirect integration, the flock is brought in at least one year before stocking of ponds.

5.02.06.02.02 Feeding: Balanced poultry feed under different trade names are available for different age group of poultry birds. Feed should be supplemented with vitamins and minerals. The feed is provided in feed hoppers. An ample supply of water in poultry drinkers is made available all the time.

5.02.06.02.03 Deep litter management: In deep litter system, the droppings of birds falling on the litter gradually combine with the materials used through the bacterial action. When the depth of the litter becomes less, more organic matter is added. In case the litter becomes dump, super phosphate or lime is added to keep it dry. The litter is stirred for aeration and to maintain its hygiene. In about 2 months it becomes deep litter and in about 10-12 months it turns to fully built litter. At this stage the litter becomes ready for application in ponds.

5.02.06.02.04 Health care: Birds should be vaccinated against *Ranikhet, Marek's* disease and *Fowl pox.* Hygienic condition should be maintained to prevent *Coccidiosis*, *Gamburu* etc. Sudden change in feeding is detrimental. Litter must be kept dry. Visitors should be discouraged.

5.02.06.02.05 Harvest: Egg collection 3-4 times a day. Stock should be replenished at the age of 18 months.

5.02.07 Production:

Fish : 4,500 kg $ha^{-1}yr^{-1}$

Eggs : 1, 20,000 per 600 birds yr^{-1}

Chicken : 690 kg per 600 birds $ha^{-1}yr^{-1}$

5.02.09 ECONOMICS

The variable cost and return functions of poultry-fish culture (Direct method,) operated by adopting the above package and calculated for 0.28 ha. are given in table 1. The table shows that an investment of Rs.2,66,800.00 assure a return of Rs. 3,82,700.00 . Percent return on variable cost is 43.44.

Table -1. Economics of poultry-fish culture (direct integration) in 0.28 ha pond.

VARIABLE COST			
Head of Expenditure	**Qty/No.**	**Rate (Rs.)**	**Cost (Rs.)**
Dewatering & desilting			6,000.00
Poultry coop (annual av. expenditure life span 5 years)			2500.00
Agricultural lime	602 kg	7.1kg	4200.00
Carried over seed	1760 nos	5 each	8800.00
Cost of harvesting			
Chicks (8 weeks old)	176 nos.	50 each	8800.00
Poultry feed	5500 kg	25 kg	137500.00
Medicine		10 each	1760.00
Insurance			
Labour wage	1	200 day^{-1}	73000.00
Misc. expenditure			1000.00
Total			**242560.00**
Interest		10.0%	24256.00
Total variable cost			2,66,816.00
			Say 2,66,800.00

RETURN			
Product	**Qty/No.**	**Rate (Rs.)**	**Sale proceed**
Fish	1250 kg	150.00 kg^{-1}	1,87,500.00
Eggs	32000 nos.	5each	1,60,000.00
Chicken	176 kg	200.00 kg^{-1}	35,200.00
Total return			3,82,700.00
Net income			1,15,900.00
Percent profit on variable cost			43.44
Percent profit to turn over			30.28
BCR			1.43

N.B. : Cost of fodder is not included

5.03 INTEGRATED THREE TIER FISH-PIG-POULTRY FARMING

5.03.01 Introduction:

In integrated fish-pig-poultry farming, the three components are raised in such a way that the pigs get supplementary nutrition from the poultry, while both pig and poultry excreta serve to raise the fish crop.

5.03.02 MERITS:

- Production of fish, egg, chicken and pork from same unit area.
- Reduction in the cost of pig farming.
- Other merits are mentioned in merits in general in package- 5.02.01.

5.03.03 SITE SELECTION:

The site is selected considering the factors as described in package -1(Refer Package 1.01.05) and package -5 (Refer Package 5.01.02).

5.03.04 POND REQUIREMENTS:

Required fisheries are at least on grow out pond (0.05- 0.4 ha), one seed raising pond (0.01-0.045 ha) with low organic deposit. Details as describe in package 2 (Refer Package 2.01.06).

5.03.05 MODEL OF INTEGRATION:

Direct integration. Fish crop reciprocal to pig waste and pig crop reciprocal to poultry waste.

5.03.06 FARM LAYOUT DESIGN AND CONSTRUCTION

5.03.06.01 LAY OUT

As describe in package 2 (Refer Package 2.01.07.02).

5.03.06.02. DESIGN AND CONSTRUCTION

As describe in package- 2 (Refer Package 2.01.07.02.01).

5.03.06.03 ANIMAL HOUSE:

Two tier house with poultry coop on the top and pig sty below. The pig sty is designed will all features as described in package 5(Refer Package 5.01.03.01.03.04) but in this case a poultry coop is constructed in place of the pig sty roof. The pig sty is connected with a drain to the pond as describe in package 5(Refer Package 5.01.03.01.03.04).The floor space of the poultry pen is determined on the basis of the number of poultry birds required. Lean to roof type poultry pen is preferred. Specification are same as described in package 5 (Refer Package 5.02.05.02.03) but in this case the height of the house from floor to roof is kept at 2 m only. The floor of the house is perforated (4-6 cm^2) and raised at 1.5-2.0 m above pig sty floor. A plain sheet is provided 20 cm below the floor at one end and 50 cm below at the other. The pig feed manger is constructed just below the terminus of the slanted end of the plain sheet.

5.03.07 CONSTRUCTION

5.03.07.01 Pond: As described in package- 1(Refer Package 1.01.06)

5.03.07.02 Animal house: As described in package -5 (Refer Package 5.01.03.01.03.04) and package-5 (Refer Package 5.02.05.02.03). Thatched roof is preferred.

5.03.08 RECLAMATION OF OLD PONDS

As described in package- 2(Refer Package 2.01.08).

5.03.09 PREPARATION

5.03.09.01 Fish husbandry

As described in package- 5 (Refer Package 5.01.06)

5.03.09.02 Pig husbandry

As described in package- 5 (Refer Package 5.01.06)

5.03.09.03 Poultry husbandry

As described in package- 5 (Refer Package 5.02.06.02)

Number of poultry birds is determined by the number of pigs at the proportion of 9-10 birds per pig.

5.03.10 FARMING TECHNOLOGY

5.03.10.01. Fish

As described in package -5 (Refer Package 5.01.07.01).

5.03.10.02 Pig

As described in package- 5 (Refer Package 5.01.08). In this case, however, the pig feed is further economic by substituting half the quantity of standard feed with poultry droppings. The poultry droppings falling on the C.I. sheet below the poultry coop is semi-dried and is put in the pig manger with the help of a long handled bamboo broom. Initially the dropping is mixed with standard feed and kitchen waste. The pig gradually accepts the droppings even without mixing with any other feed.

5.03.10.03 Poultry

As described in package - 5 (Refer Package 5.02.07.02)

5.03.11 PRODUCTION

Fish : 6000-7000 kg $ha^{-1}yr^{-1}$

Pig : 3000-5600 kg $ha^{-1}yr^{-1}$

Egg : 7000 Nos. per 350 birds $ha^{-1}yr^{-1}$

Chicken : 283 kg $ha^{-1}yr^{-1}$ (An average of three years)

5.03.12 ECONOMICS

The variable cost and return function of the system calculated for 0.28 ha area is shown in table-1. The table shows that an investment of Rs. 2, 49,150.00 assures net income Rs.1,84,450.00. The percent return on variable cost is 74.03 .

Table-1: Economics of Three Tier Fish-Pig-Poultry Farming in 0.28 ha pond.

VARIABLE COST

Head of expenditure	Qty/No	Rate (Rs.)	Cost (Rs.)
Dewatering & de-silting			5000.00
Animal house(annual av. expenditure; Life span 5 years			2500.00
Agricultural lime	602 kg	7.00 kg^{-1}	4214.00
Carried over seeds	2354	5.00/ seed	11770.00
Cost of harvesting			1500.00
Piglets(2 months old)	16	2000.00 each	32000.00
Chicks(8 weeks old)	80	50.00/ chicks	4000.00
Feed for pig	2044 kg	8.00 kg^{-1}	16352.00
Feed for poultry	2916	25.00 kg^{-1}	72900.00
Medicine for pig		30.00 each	480.00
Medicine for poultry		10.00 each	800.00
Labour wage	1	200.00/ manday	73,000.00
Misc. expenditure			2000.00
Total			2,26,516.00 Say, 2,26,500.00
Interest 10%			Rs. 22,650.00
Total variable cost			**Rs.2, 49,150.00**

RETURN

Product	Qty (kg)	Rate (Rs.)	Sale Proceed (Rs)
Fish	1600	150.00 kg^{-1}	2,40,000.00
Pig	960	110.00 kg^{-1}	1,05,600.00
Chicken	80	200.00 kg^{-1}	16,000.00
Eggs	14400 Nos.	5.00/egg	72,000.00

Total return	**Rs. 4,33,600.00**
Net income	**Rs. 1,84,450.00**
Percent profit to turn over	**42.54**
Return on variable cost	**74.03**
BCR	**1.74**

N.B. : Cost of fodder not included

5.04 INTEGRATED DUCK-FISH CULTURE

In integrated Fish-Duck farming, the fish crop is raised using duck dropping received by rearing ducks over the pond.

5.04.01 MERITS

- Production of duck eggs, meat and fish from the same unit area.
- Duck get 50-75% of their total feed requirement from the pond.
- Duck keep the water clean.
- Ducks increase the DO level in pond water.

5.04.02 SITE SELECTION

5.04.02.01 General Characteristic

As described in package 1 (1.01.05). The salient suitable characteristics are: minimum area: 0.07 ha, plain type lay-out, alluvial impervious soil, organic carbon <1%, soil pH 6.5-7.5.

5.04.02.02 Legal aspects

As described in package 1(1.01.05.03.05).

5.04.02.03 Availability of inputs:

Availability of suitable breed of ducks (5.04.07.02.02) is the most crucial factor. Duck vaccines, duck medicines, fish seed and lime need be available.

5.04.02.04 Manpower

Skilled and trained manpower is a prerequisite.

5.04.02.05 Road and transport

As described in package 1(1.01.05.03.09)

5.04.02.06 Market

As described in package 1(1.01.05.03.12)

5.04.02.07 Power supply

As described in package 1(1.01.05.03.11)

5.04.02.08 Storage facilities

As described in package 2 (2.01.05.02.12)

5.04.03 POND REQUIRMENTS

As described in package 2(2.01.06).

5.04.04 MODEL OF INTEGRATEION

Predetermined numbers of ducks are raised for a stipulated time in perforated floor pens (fixed or movable) over the pond. Duck house wastes directly fall into the water where fish crop is raised without application of any other supplementary feed or fertilizers.

5.04.05 FARM LAYOUT, DESIGN AND CONSTRUCTION

5.04.05.01 Layout

Layout of the farm indicating the number of ponds, their position, levee, site for duck pen, fencing etc. should be drawn up after surveying the elevation, size and shape of the site. Survey method is as described in package 2(2.01.07.02)

5.04.05.02 Design

Ponds: As described in package 2(2.01.07.02).

Duck pen: The duck house should be roomy and well ventilated. When the flock size is less than 10, movable house may be constructed using empty oil barrels as floats. A fixed house over the pond is however more convenient. One third of the upper portion of the house should have lattice. The floor is perforated (4-6 cm^2 mesh). About 0.3 -0.5 m^2 floor space is required for each bird. In fixed house, the floor should be raised at 1.2m above the highest water level. Two bridges, one connecting the house and the pond embankment and the other from pond embankment to the water should be provided for movement of ducks. A duck proof fencing is erected around the pond to confine the duck in the pond area.

5.04.05.03 Construction

Pond: As described in package 1(1.01.06).

Duck house: All construction works must be complete while the pond remains dry. Indigenous materials such as bamboo and thatch can be used for construction. Concrete house can also be made using asbestos roof.

5.04.06 RECLAMATION OF PONDS

As described in package 2(2.01.08).

5.04.07 PREPARATION

5.04.07.01 Fish husbandry

5.04.07.01.01 Pond preparation: As described in package 2(2.01.11).

5.04.07.01.02 Fish seed: Species and size same as described in package 2 (2.01.12.02). Stocking rate is 5000-5500 ha^{-1} with 10% increment on mortality. Composition is detailed in table -1.

Table-1: Percent composition and stocking density for Fish Duck farming

Combination	Species	Percentage	No./0.28ha	No. ha^{-1}
6 species	Silver carp	20	320	1200
	Catla	20	320	1200
	Rohu	25	400	1500
	Grass carp	10	160	600
	Mrigal	20	320	1200
	Common carp	5	80	300
Total		100	1600	6000

5.04.07.02 Duck husbandry

5.04.07.02.01 Pen preparation: Preparation of duck house followed by complete disinfection before housing the ducks. Ducks are introduced 30 days before release of fish seeds in ponds.

5.04.07.02.02 Breed: F_1 hybrid of *Khaki cambell* and local *Pati* ducks, *Kamrupa* and *Chara Chameli* are suitable for integration with fish culture. All economic characters such as sexual maturity, age, weight and size of egg, rate of egg production, body weight *etc.* of these cross breed are ideal.

5.04.07.02.03 Breeding technique:

Hybridization is done between *pati* female and *khaki cambell* male ducks. One year old birds are maintained at 1:5 male female ratio under isolated conditions. Fertilized eggs are incubated for 2-3 weeks following conventional methods. Ducklings produced are graded ducks. These are reared with balanced nutrition, proper management and disease control. Vaccination against duck plague and duck cholera is mandatory.

5.04.07.02.04 Age: 5-6 months.

5.04.07.02.05 Number: 240-300 birds ha^{-1} water area at 1:5 male female ratio.

5.04.08 FARMING TECHNOLOGY

5.04.08.01 Fish

5.04.08.01.01 Stocking: Best time is March-April. Fish seed are stocked 30 days after the ducks are introduced in pens.

5.04.08.01.02 Water management:

- *Liming:* At monthly interval as described in package 2(2.01.11.03).
- *Supplementary feeding:* Only for grass carp as described in package 2(2.01.13.04.06).
- *Fertilization:* No other fertilization except disposal of the duck waste into the pond.
- *Depth:* Depth should be maintained at minimum of 1.5m. 2-3m is optimum.
- *Control of algal bloom:* On occurrence of algal bloom, polythene sheet is provided below the duck pen, preventing falling of duck droppings in the ponds. Feeding to grass carp during the algal bloom period is suspended. The polythene sheet is removed and feeding to grass carp is resumed only on complete disappearance of algal bloom. Other measures of algal bloom control are same as described in package 2 (2.01.15).

5.04.08.01.03 Health care: As described in package 2 (2.01.16).

5.04.08.01.04 Harvest: *P*artial harvesting followed by complete harvesting as described in package 2(2.01.17).

5.04.08.02 Duck:

5.04.08.02.01 Introducing birds: Birds are introduced into the pens 30 days prior to fish seed stocking

5.04.08.02.02 Feeding: Ducks are given a free range in the pond where they may find their natural food such as tadpoles, insects larvae, mollusks and aquatic weeds. In addition, the ducks are fed with standard ration (Table-2) at the rate of 100g $bird^{-1}day^{-1}$. Alternatively, the ducks may be fed with a mixture of standard poultry feed (layers mesh) and rice bran at 1:2 ratio. Feed should be supplied only in the duck pen twice a day. Water should be provided in flat waters.

Table-2 Composition of standard duck ration

Ingredient	Grower (%)	Layer (%)
Yellow maize	35.0	45.0
Rice polish	20.0	25.0
Rice polish (deoiled)	22.0	--
Soybean meal	8.0	9.0
Fish meal	7.0	7.0
Ground nut oil cake	5.0	8.0
Mineral mixture	2.0	2.5
Bone meal	0.5	0.5
Shell grit	--	3.0
Limestone	0.5	--
Vitamins	As directed	As directed
Total:	**100 kg**	**100**

5.04.08.02.03 Egg laying: The duck start laying eggs from the age of 7-8 months. Some straw is kept at on corner of the house for egg laying.

5.04.08.02.04 Health care: Birds should be vaccinated against Duck cholera (immunity last for only 2 months) in the duckling stage and against Duck plague at the age of 6 weeks and then annually. Proper hygiene should be strictly maintained.

5.04.08.02.05 Harvest: Egg collection is done everyday at around 9 am prior to which duck must not be released from pen. Ducks are reared up to 12-18 months after which they are disposed.

5.04.09 PRODUCTION

Fish : 4000 kg $ha^{-1}yr^{-1}$
Egg : 19000-22000 per 250 ducks yr^{-1}
Duck : 240-260 kg per 250 ducks yr^{-1} (Average of three years)

5.04.10 ECONOMICS

The variable cost and return function of the system calculated for 0.28 ha is shown in table 3. The table shows that an investment of Rs.1,60,800.00 assures a return of Rs.2,46,600.00. The percent return on variable cost is 53.86.

Table-3: Economics of Duck-Fish culture in 0.28 ha pond

VARIABLE COST			
Head of expenditure	**Qty/No**	**Rate (Rs.)**	**Cost (Rs.)**
Dewatering & desilting			5000.00
Duck house (annual av. Expenditure; Life span 5 years)			2500.00
Agricultural lime	300 kg	7 kg^{-1}	2100.00
Carried over seeds	1540 nos.	5 each	7700.00
Cost of harvesting			
Duckling (4 months old)	88 nos.	50 each	4400.00
Duck feed	2000 kg	25 kg^{-1}	50,000.00
Medicine			500.00

Labour wage		200 / manday	73000.00
Misc. expenditure			1000.00
Total			1,462,00.00
Interest		10.0%	14620.00
Total variable cost			1,60,820.00
	RETURN		
Product	**Qty/No**	**Rate (Rs.)**	**Sale proceed**
Fish	1200 kg	150.00 kg^{-1}	**1.80,000.00**
Eggs	6700 Nos.	6 each	40,200.00
Ducks	120kgs	220.00 kg^{-1}	26,400.00
Total return			2,46,600.00
Net income			85,800.00
Percent return on Variable cost			53.36
Percent profit to turn over			34.79
BCR			1.53

N.B.: Cost of fodder is not included

5.05 INTEGRATED CATTLE-FISH CULTURE

Integrated Cattle and Fish farming is an ideal method for assured fish production in small ponds (< 0.1 ha). In this technology, the fish crop is raised using the cattle dung obtained by raising the cattle on the pond embankment or any other suitable site of the farm.

5.05.01 MERITS

- ❖ A low cost technology for fish production
- ❖ Assured production from small ponds
- ❖ Other merits are mentioned in merits in general (Refer Package 5.02.01)

5.05.02 SITE SELECTION

5.05.02.01 Area:

5.05.02.01.01 Minimum: 0.05 ha

5.05.02.01.02 Maximum: 0.10 ha

5.05.02.02 Topography

As described in package – 1 (1.01.05.03.02)

5.05.02.03 Soil characteristics

As described in package – 1 (1.01.05.03.03)

5.05.02.04 Water table

As described in package – 1 (1.01.05.03.03.05)

5.05.02.05 Source of water

As described in package – 1 (1.01.05.03.04)

5.05.02.06 Maximum flood level

As described in package – 1 (1.01.05.03.06)

5.05.02.07 Legal and social aspects

As described in package – 1 (1.01.05.03.05)

5.05.02.08 Availability of input

Availability of good breed of cows, cow ration, cattle, medicine, veterinary facility, fish seed, are to be ascertained.

5.05.02.09 Man-power

Skilled labour and trained manpower on cattle farming is a prerequisite.

5.05.02.10 Road and transport

As described in package – 1 (1.01.05.03.09)

5.05.02.11 Market

Demand of milk is added advantage

5.05.02.12 Power supply

As described in package – 1 (1.01.05.03.11)

5.05.02.13 Storage facilities

As described in package – 2 (2.01.05.02.12)

5.05.03 POND REQUIREMENTS

5.05.03.01 Number

Grow out pond: one

5.05.03.02 Size : 0.05 -0.1 ha

5.05.03.03 Shape

Preferably rectangular

5.05.03.04 Depth

As described in package –2 (2.01.06.04)

5.05.03.05 Productive water conditions

As described in package – 1 (1.01.05.03.13)

5.05.04 MODEL OF INTEGRATION

One direct integration is recommended. The cattle is raised over the embankment. Fresh cowdung is applied in the pond at a predetermined dose.

5.05.05 FARM LAYOUT, DESIGN AND CONSTRUCTION

5.05.05.01 Layout:

Layout of the farming showing the position of ponds, levee, site for cattle farm, water supply, electrical set up, drain, fencing and area for fodder cultivation should be drawn after surveying the elevation, size and shape of the site as described in package -2 (2.01.07).

5.05.05.02 Design:

5.05.05.02.01 *Ponds*: As described in package -1 (1.01.06).

5.05.05.02.02 *Cattle shed*: For organized integration, intensive system of management in which cows are kept confined in the shed with adequate food is recommended. An outline for designing of cow shed for intensive farming of half bed cows is given below. The cow shed should be constructed at a stable and elevated site allowing direct sunlight to the platform, gutters and managers of the cattle shed. The floor should be concrete and should be slightly inclined leading to a drain which is connected to a soak pit. Provisions for floor space may be made for suckling calf, older calf and cow. A covered pit may be constructed nearby to store cow dung. Floor space requirement are as follows:

***Cross bred cow*:**

Standing space	:	1.2 m × 1.2 m per animal
Length	:	0.6 m per animal
Width	:	0.6 m per animal
Depth	:	30 cm
Gutter:		
Width	:	25-30 cm
Depth	:	2.5 cm with provision of gradient towards main drain

Suckling calf:

Pen size:

Cover area	:	1 m × 1 m per calf
Open area	:	2 m × 1 m per calf

Older calf:

Pen size:

Cover area	:	2 m × 1 m per calf
Open area	:	2 m × 2 m per calf

5.05.05.03 Construction

5.05.05.03.01 ***Pond:***

As described in package -2 (2.01.07.02.01)

5.05.05.03.02 ***Cattle shed*****:**

Construction should be done only when the site is stable. Thatch is the best roofing material but asbestos may also be used.

5.05.06 RECLAMATION OF PONDS

As described in package -2 (2.01.08)

5.05.07 PREPARATION

5.05.07.01 Fish husbandry

5.05.07.01.01 ***Pond preparation*****:** Same as described in package eliminating the fertilization aspect.

5.05.07.01.02 ***Fish seeds*****:**

- *Species:* As described in package -2 (2.01.12.02), 6 and 7 species combination
- *Size:* As described in package -2 (2.01.12.05), Length must not be less than 10 cm for carps
- *Number:* 5000-5500 ha^{-1}. Add 10 % allowance to account mortality. Composition detailed in 2.01.12.02.

5.05.07.02 Cattle farming

5.05.07.02.01 ***Breed*****:** The integration is best brought out by using dairy cattle. The ideal dairy character is best indicated by a clean cut, sphere open conformation and a strong refined appearance with freedom from coarseness and excess flesh throughout. The head should be clean cut and should blend smoothly. The withers should be sharp and well defined. The hips should be very prominent, sharp and well defined. The mammary vein should be prominent, large torturous and well branching. An ideal dairy cow should have the following features.

Potentiality to yield	: 1500 Iitre milk per cow
Birth weight	: 16.0 kg and above.
Weight at maturity	: 200-250 kg
Age at first service	: 20-24 months
Age at first calving	: 30-36 months
Service period	: 2-3 months
Dry period	: 2-3 months
Calving interval	: 12-13 months
Lactation period	: 10 months
Milk yield per day	: 5 Litre and above
Heat tolerance	: Good
Disease resistance	: Good

The best group of dairy cattle for integration is half bred (50% Jersey and 50% local).

5.05.07.02.02 ***Age*****:** 20-24 months when the cow attain maturity

5.05.07.02.02 ***Number*****:** Since this integration method is indirect, no limit is kept for the number of cows. For 0.1 ha water area, one cow with calf is sufficient. The number of cows is regulated depending on land/space available, other infrastructure for cattle farming and market demand for milk.

5.05.08 FARMING TECHNOLOGY

5.05.08.01 Fish

5.05.08.01.01 ***Stocking*****:** Raw cow dung is first applied in the pond at the rate of 2000 kg ha^{-1}. Fish seeds are stocked 20 days after application of fertilizer.

5.05.08.01.02 ***Water management*****:**

- Liming: Preparatory and monthly doses are applied as described in package -2 (2.01.11.03)
- *Supplementary feeding*: Only grass carp is provided with supplementary feed (hydrilla, napier, para, etc.) as described in package -2 (2.01.13.02)
- *Fertilization*: No chemical fertilization is necessary. Cattle dung is removed from all debris and casted all over the pond water at the rate of 70 kg/ha every morning. During the first 7-10 days, the algal biomass shows a decline but later it gets stabilized. Cattle dung contains 0.5% N, 0.1% P and 0.5% K. It serves as an excellent fertilizer to water.
- *Depth*: Must not be less than 1 meter at any stage.
- *Control of algal bloom*: Application of cowdung is immediately suspended on occurrence of algal bloom. Cow dung is applied again only when normal water quality is revived. Supplementary feeding to grass carp is immediately suspended during the algal bloom period. Other measures for controlling the algal bloom are same as detailed in package -2 (2.01.15).

5.05.08.01.03 ***Health care*****:** As described in package -2 (2.01.16)

5.05.08.01.04 ***Harvest*****:** Fishes attaining 750g and above are harvested 6-7 months after stocking. If the water level is on a reducing trend, the stock need not be replenished. Otherwise, the stock is replenished with of the same number of the same species harvested. Total harvesting is done at the end of 10 months rearing.

5.05.08.02. Cattle farming

5.05.08.02.01 ***Introducing cattle*****:** Cows are brought to the farm matching the time in such a way that the required quantity of cowdung can be kept ready for application in the pond as the initial dose (2000 kg ha^{-1}). In practice, the cow should be brought about two months earlier to introducing fish into the pond.

5.05.08.02.02. ***Feeding*****:**

Milking cows**:**

Provide 30 -40 kg green fodder a day.
Feed 3-4 kg paddy straw every day.
Provide 2 kg concentrated feed a day.
For each 2 kg milk (above 3 kg) 1 kg production ration.

Ration formula for milking cows is as given below

Formula 1

Wheat bran	: 40 kg
Rice polish	: 37 kg
Ground nut cake	: 20 kg
Mineral mixture	: 2 kg
Common salt	: 1 kg
Total	: 100 kg

Formula 2

Maize crushed	: 15 kg
Rice polish	: 30 kg
Wheat bran	: 32 kg
Ground nut cake	: 20 kg
Mineral mixture	: 2 kg
Common salt	: 1 kg
Total	: 100 kg

***Dry/pregnant cow*:**

Along with green fodder and paddy straw provide 1 kg concentrate. From sixth month onwards the quantity of concentrate may be increased to 2 kg.

Calves: Feeding details are given below

Age group (Months)	**Concentrate (kg.)**	**Green fodder (kg.)**
3-4	1.3-1.6	4.5
4-6	1.6-2.0	4.5
6-12	2.0-2.5	10.0
12-maturity	1.5-2.5	20-30

Feed formula for calf starters and growers are given below:

Calf starter:

Maize ground	: 50 kg
Ground nut cake	: 30 kg
Fish meal	: 10 kg
Wheat bran	: 8 kg
Mineral mixture	: 2 kg
Total	: 100 kg

Vitamin A,B_2,D_2 (20g.), Common salt (0.5 kg.) and TM -5 (400 mg) should be added to 100 gm of ration.

***Growers ration*:**

Wheat bran	: 47 kg
Rice polish	: 30 kg
Ground nut cake	: 20 kg
Mineral mixture	: 2 kg
Common salt	: 1 kg
Total	: 100 kg

Rovi mix (200g) and Auto fac (20g) is added to 100 kg of the ration

5.05.08.02.03 Health care:

***General management*:**

Protect the animals from heat
Supply adequate water
Eliminates flies
Maintain hygiene
Avoid over crowding
Do not allow insemination within 60 days of calving

Adapt preventive measures by consulting veterinarian against coccidosis, parasitic infection, etc.

Immunization:

Anthrax spore vaccine, Haemorrhagic septicemia vaccine and black quarter vaccine. Consult veterinary expert for time schedule and vaccination.

***Milking*:**

Milk the cow daily at equal intervals at the same time every day. Provide a pre milking activity. Prepare the udder by washing and drying. Donot milk beyond 305 days in a location.

5.05.09 PRODUCTION

Fish -350 kg, Milk – 2400 l and a calf per annum from 0.1 ha farm.

5.05.10 ECONOMICS

The variable cost and return function of the system calculated for 0.1 ha is shown in table -1. The table shows that an investment of Rs. 74,470.00 assures a return of Rs. 1,18,500.00. The percent return on variable cost is 59.12.

Table -1: Economics of Integrated Cattle-Fish culture in 0.1 ha area

VARIABLE COST

Head of expenditure	Qty/No	Rate (Rs.)	Cost (Rs.)
Dewatering and desilting			2000.00
Cattle shed (low cost conventional type/lee to roof/av. Annual cost /5 years life span			2000.00
Agricultural lime	100 kg	7.00 kg^{-1}	700.00
Carried over seeds	550	5.00/seed	5500.00
Cost of harvesting			1000.00
Cow with calf (annual avg. for 5 years)	1 pair	20000.00	4000.00
Feed	1000kg	15.00 kg^{-1}	15000.00
Medicine			500.00
Labour wage	180 mandays	200.00	36000.00
Misc. expenditure			1000.00
Total			**67700.00**
Interest		10.0%	**6770.00**
Total variable cost			**74,470.00**

RETURN			
Product	**Qty/No**	**Rate (Rs.)**	**Sale proceed (Rs.)**
Fish	350 kg	150.00 kg^{-1}	52500.00
Milk	1500 l	40.00 l^{-1}	60000.00
Calf (av. for two years)	1	12000.00 each	6000.00
Total return			**Rs. 1,18,500**
Net income			**Rs. 344,030**
Per percent profit to turn over			**37.16**
Percent return on variable cost			**59.12**
BCR			**1.59**

N.B.: *Cost of fodder is not included*

PACKAGE -6

BEEL FISHERIES MANAGEMENT

6.01 PEN AQUACULTURE

The state of Assam has a large number of floodplain wetlands (locally known as *beel, era suti, mornai, anoa, haor, jan, doloni*, etc.) covering approximately one lakh hectares of water-spread area. Beel fisheries are considered as the most potential fisheries resource of Assam because of their large resource size and high fish production potential (1000-1500 kg $ha^{-1}yr^{-1}$). Pen aquaculture in marginal areas of beels is a useful tool for raising stocking materials for stocking them as well as for producing table-size fish. It is an "on bottom" aquaculture system wherein marginal/ shallow areas of the beels are enclosed with split-bamboo and/or net screens for fish culture.

6.01.01 MERITS

- Pen aquaculture technology is useful for *in situ* rearing of stocking materials in the water body, thereby overcoming the problem of shortage of fingerlings to stock in beels and other open water fisheries of Assam (e.g., reservoirs and large community tanks).
- The technology can also be used for producing table size fish especially in situations where large parts of these water bodies (e.g., marginal macrophyte-infested areas of beels) do not contribute to appreciable fish production in them.
- The technology is simple and uses locally available construction materials like bamboo and cheap mosquito nets –most open water user groups of the country.
- Since it mostly practiced as a semi-intensive aquaculture system (taking advantage of the inherent biological productivity of the water body), it is environmentally less demanding.
- Fingerlings raised *in situ* in pens – when released in to the main water body - grow fast with high survival rate.
- The technology helps in efficient utilization of marginal and shallow areas of open water bodies especially beels that usually remains unused.

6.01.02 SITE SELECTION

Success of pen aquaculture depends considerably on the selection of a suitable site. Important considerations in selecting a good site for pen aquaculture are as follows:

- The site should have a gentle slope with a water depth range of 1-2 m during the culture period spanning at least 3-4 months in a year.
- A mild water flow at the site is desirable since it will wash away left-over feed and excretory product from the pen.
- The site should be away from areas experience strong winds/ wave action/ water currents.
- It should not have dense terrestrial vegetation (to avoid soil and water quality deterioration through rotting of leaves).

- Soil at site should be sandy-loam or loamy with organic matter in the range of 1-2 %.
- Construction materials and labour should be easily available at the site.
- The site should have good road and market facilities and good social environment (e.g., areas having low poaching problem).

6.01.03 CONSTRUCTION OF PEN

6.01.03.01 Construction materials

- Pens can be constructed by using locally available and low-cost construction materials like bamboo, wood, low density polyethylene netting (LDPE), coir/ plastic ropes, etc.

6.01.03.02 Pen size

- Smaller pens measuring 500-1000 m^2 are easily manageable but less economical than larger pens (since the cost of pen construction per unit area is less in larger pens).
- Pen size of 2,500 m^2 has been found to be more economical.

6.01.03.03 Pen shape

- Square/ rectangular/ trapezoidal shaped pens are easier to be managed and facilitate easy harvesting.
- However, pens can be of any shape (e.g., semi-circular/ irregular) depending on the topography/ shape of the *beel's* shoreline) provided that such shapes help in reduction of pen construction costs and do not adversely affect their management.
- In beels have fingerlike projections, irregular shaped pens can be constructed by erecting a single split-bamboo screen to reduce pen construction costs.

6.01.03.04 Height of pen walls

- Normally, the height of pen walls should not exceed 2 m; otherwise the weight of the net-lined split-bamboo screens, bamboo frame, ropes and deposition of debris on the pen walls will exert additional load on the bamboo poles causing the pen to collapse in extreme cases.
- In case the height of pen walls have to be increased, additional support with angular bamboo poles should be used.

6.01.03.05 Weaving of split-bamboo screen (*bana*)

- The side walls for encircling the pen area is made by weaving long (2-2.5 m) and slender split-bamboo strips (8–10 mm thickness) with coir/ plastic ropes.
- Low-cost LDPE mosquito netting is stitched into the inner wall of the bamboo screens (locally called *bana*) to prevent movement of fishes to and from the pens.

6.01.03.06 Erection of pen

- A suitable area of the required size (usually 2,500 m^2) and shape is demarcated with mature, strong bamboo poles (5-8 cm diameter) driven into the beel sediments after every 1.5–2.0 m (depending on winds/water currents and pen height). The thicker ends of the poles are usually made pointed ones to facilitate easy insertion into beel sediments. At least 50 cm of the poles should remain above the water surface.

- The main frame of the pen is made by tying half-split or slender full bamboo (less than 5 cm diameter) on to the poles. The net-lined bamboo screens are driven into the beel sediment along the inner side of the main frame. These are tied on to the poles with the help of half-split bamboo and coir ropes.
- Additional supports are given to the main frame in beels having strong winds/water currents and/or in places where the height of screens exceed 2 m. These can be in the form of support poles driven into sediment from the outside at 45º angle and/or cross-tying of full/ half-split bamboo resembling the letter 'X' between adjacent poles.

6.01.04 PRE-STOCKING MANAGEMENT

- Aquatic macrophytes are cleared (manually/mechanically) from the pen enclosure before stocking.
- Predatory and unwanted aquatic organisms (e.g., fishes, frogs, crabs) inside the pen are removed by repeated netting with small mesh-sized nets. In case netting is ineffective, bleaching powder is applied as a piscicide @ 10 g m^{-3}.
- Bottom raking (by pulling a thick rope over the bottom) in the pen enclosure should be done to expel anoxic/ toxic gases.
- Liming is done for correcting soil acidity and also to improve the overall environmental conditions. Use of quick lime @ 400-650 kg ha^{-1} pen area (depending on the pH of soil/ water) is recommended with initial dose of @200-325 kg ha^{-1} followed by monthly installments @50-80 kg ha^{-1}.
- Quick lime is dissolved in water in the morning and the mixture uniformly applied over the water surface in afternoon.

6.01.05 FISH SEED STOCKING IN PENS

6.01.05.01 Selection of candidate species

- Fish species feeding at lower trophic levels (e.g., herbivores, detritivores and planktivores) and fishes living/ feeding at different depths (e.g., surface, column, and bottom) are preferred for polyculture in pen aquaculture.
- Exotic fishes are avoided in pens erected in seasonally open beels for environmental concerns relating to their possible escape from the pens. However, grass and silver carps can be stocked to control aquatic macrophytes and phytoplankton in pens erected in closed beels.

6.01.05.02 Species ratio

Species ratio recommended for carp polyculture in pens having different water depths are as follows:

Type of fish species reared	Water depth in the pens	
	Up to 2 m	More than 2 m
1. Surface feeder (e.g., Catla, Silver carp)	40%	50%
2. Column feeder (e.g., Rohu/ *Labeo gonius*, grass carp)	30%	30%
3. Bottom feeder (e.g., Mrigal, common carp)	30%	20%

6.01.05.03 Stocking density

Stocking density in pens depend on water exchange through the pens, carrying capacity of the pens as well as the type and rate of supplementary feeding practiced. Recommended stocking density in pens are as follows:

- For carp fingerling rearing: 30 - 50 fry (2-4 cm long) m^{-2}
- For growing table fish: 1 - 2 carp fingerling (10-15 cm long) m^{-2}.

6.01.05.04 Precautions to be taken at the time of stocking

- Stocking with reasonably good quality fish seed
- Conditioning of fish seed prior to transportation from seed farm
- Bath treatment of seed with potassium permanganate @ 5 mg l^{-1} for 1-2 minutes before stocking in the pen

6.01.06 POST-STOCKING MANAGEMENT

6.01.06.01 Feeding

- Stocked fishes are fed with supplementary feed to supplement natural fish food organisms present in the pens.
- **Feeding rate:** Initially @ 5% of total body weight of stocked fishes/ biomass, gradually reduced to 2%.
- **Feed type:** Commercially available fish feed (mesh/ pelleted) with 20-25% crude protein levels depending on natural fish food organisms present in the pens.
- For reducing feed costs, an improvised feed mixture comprising rice polish (50%), oil cake (40%), fish meal (9%) fortified with veterinary grade vitamin-mineral mixture (@1%) can be prepared at farm level. The mixture is mixed with hot water, cooled, mixed with vitamin-mineral premix, made in to dough/ feed balls.
- Fishes should be fed at least twice a day (morning and afternoon) at fixed times.
- Tray feeding (using aluminium/ GI trays or bamboo/earthen plates) is preferable to minimize wastage and to observe feeding intensity.
- Reared fishes are sampled fortnightly/ monthly to record their growth and observe health conditions. Daily feed ration is calculated after every sampling.

6.01.06.02 Management of water quality and unwanted organisms

- The pens are limed every month @ 100-150 kg CaO ha^{-1} depending on the pH of water.
- Salient water quality parameters affecting growth and survival of reared fishes (e.g., water pH, temperature, dissolved oxygen, free carbon dioxide, total alkalinity) should be periodically monitored if possible
- Periodical manual removal of macrophytes coupled with biological control with grass carp has been found to be cost-effective in pens.
- Crabs, snakes and predatory birds should be controlled/ scared away.

6.01.06.03 Additional management measures

- The condition of the pen should be monitored and holes/ gaps in the pen walls, if any, should be immediately repaired.
- Algae and other organisms growing on the pen walls should be periodically removed by mildly shaking/ brushing the walls to maintain water exchange through them.
- Floating dead fishes in the pen, if any, should be immediately removed.
- To overcome heating of pen waters during hot pre-monsoon months (with reduced water levels), a small patch of floating macrophytes may be kept barricaded as shelter in one corner of the pen.

6.01.06.04 Culture period and harvesting

- Pen aquaculture can be practiced throughout the year in closed beels that are not flooded during the monsoon season even though growth of reared fishes slows down considerably during the winter season (December to February).
- In most seasonally open *beels*, the pens are likely to be submerged by floods during the southwest monsoon season (June to September).
- Thus, two periods of the year viz., September to December and February to May are suitable for practicing pen aquaculture in most of the beels of the state.
- After rearing the fishes for the requisite period, they are harvested by repeated netting with drag nets.

6.01.07 FISH PRODUCTION AND ECONOMICS

6.01.07.01 Fish production rate

- For fingerling rearing: 75,000 fingerlings/0.25 ha/ crop (3 months).
- For growing table fish: 763 kg/ 0.25 ha/ crop (6,104 kg $ha^{-1}yr^{-1}$).

6.01.07.02 Unit costs

- Average capital costs for construction of a pen covering 0.25 ha is Rs. 54,529.00.
- Average total recurring costs for 0.25 ha per crop (3 months) for fingerling rearing is Rs. 76,186.00 (of which Rs. 50,000.00 was the cost of carp fry).
- For growing table fish, the average total recurring costs is Rs. 52,008.00 (per 0.25 ha/ crop).

6.01.07.03 Economics

- For carp fingerling rearing, the average total expenditure per pen (0.25 ha) per crop (3 months) was Rs. 53,878.00. It yielded gross return of Rs. 112,500.00 and net income of Rs. 58,622.00. The benefit-cost ratio has been worked out at 2.08.**(Table 1)**
- For growing table fish, average total expenditure was Rs. 38,975.00 (per 0.25 ha/ crop). It yielded gross return of Rs. 91,560.00 and net income of Rs. 52,585.00. The benefit-cost ratio was marginally higher (2.34) than that worked out for fingerling rearing.**(Table 2).**

Table 1. Economic analysis of carp fingerling rearing in pens erected in *beels*

Sl. No.	Item	Cost (Rs.)
I	Fixed/ capital costs	
1.1	Cost of bamboo	22,594.00
1.2	Cost of LPDE netting	7,252.00
1.3	Cost of ropes	2,732.00
1.4	Labour charges for pen construction	21,951.00
1.5	Sub-total of capital costs	54,529.00
1.6	Repairing/maintenance cost	2,203.00
1.7	Annual depreciation on fixed assets	15,085.00
1.8	Labour cost for pen construction/year	10,976.00
1.9	Interest on fixed cost	2,826.00
1.10	Fixed cost per year	31,090.00
1.11	Fixed cost per crop	15,545.00
II	Recurring cost	
2.1	Cost of carp fry (2.5-4 cm long) 125,000 @ Rs. 0.40/- fry	50,000.00
2.2	Cost of macrophyte control	3,200.00
2.3	Cost of controlling unwanted organisms	1,800.00
2.4	Cost of quick lime (60kg@Rs. 15/- kg^{-1})	900.00
2.5	Cost of supplementary feeding	13,000.00
2.6	Cost of prophylaxis/disease control	100.00
2.7	Miscellaneous costs	500.00
2.8	Sub-total of recurring costs	69,260.00
2.9	Interest on recurring cost (@10%)	6,926.00
2.10	Total recurring cost per year	76,186.00
2.11	Total recurring cost per crop	38,093.00
3.	Total cost per crop (1.11+2.11)	53,878.00
4.	Gross revenue (75,000FL @ Rs. 1.50/-FL)	112,500.00
5.	Net income (4-3)	58,622.00
6.	B:C ratio	2.08

Note: All calculations are made for rearing period 3 months and pen size 2,500 m^2.

Table 2. Economic analysis of table fish production in pens erected in *beels*

Sl. No.	Item	Cost (Rs.)
I	Fixed/ capital costs	
1.1	Cost of bamboo	22,594.00
1.2	Cost of LPDE netting	7,252.00
1.3	Cost of Coir rope	2,732.00
1.4	Labour charges for pen construction	21,951.00
1.5	Sub-total of capital costs	54,529.00
1.6	Repairing/ maintenance cost	2,203.00
1.7	Annual depreciation on fixed assets	15,085.00
1.8	Labour cost for pen construction/year	10,976.00
1.9	Interest on fixed cost	2,826.00
1.10	Fixed cost per year	31,090.00
1.11	Fixed cost per crop	15,545.00
II	Recurring cost	
2.1	Cost of carp FL (10-15 cm long) 5,000 FL@ Rs. 5/- FL	25,000.00
2.2	Cost of macrophyte control	3,200.00
2.3	Cost of controlling unwanted organisms	1,800.00
2.4	Cost of quick lime (80kg@Rs. 15/- kg^{-1})	1200.00
2.5	Cost of supplementary feeding	10,800.00
2.6	Cost of prophylaxis/disease control	100.00
2.7	Miscellaneous costs	500.00
2.8	Sub-total of recurring costs	42,600.00
2.9	Interest on recurring cost (@10%)	4,260.00
2.10	Total recurring cost per year	46,860.00
2.11	Total recurring cost per crop	23,430.00
3.	Total cost per crop (1.11+2.11)	38,975.00
4.	Gross revenue 763kg × 120/-	91,560.00
5.	Net income (4-3)	52,585.00
6.	B:C ratio	2.34

Note: All calculations are made for rearing period 3 months and pen size 2,500 m^2.

6.01.08 Problems encountered/ anticipated

- Using the entire beel for pen aquaculture may cause social (e.g., conflict with fishers/ other beel uses) and/or long-term environmental (e.g., eutrophication) problems; so a portion of the beel should be left undisturbed.
- Predatory birds, snakes, turtles, etc. may feed upon stocked fishes at certain places. These can be controlled using scientific methods (e.g., use of large meshed net covers/ walls) as well as traditional knowledge of beel user communities like use of old photography/ tape-recorder films (to scare away predatory birds) and night-hunting with light (for water snakes), surface-set large-meshed gill nets (for turtles).
- Early floods may submerge the pens during the later part of the pre-monsoon season (April- May) in seasonally open beels. Loss of stocked fishes can be prevented by putting net enclosures over and above the net-lined bamboo screens duly supported by bamboo poles (in case emergency harvesting is not possible).

6.02 CAGE CULTURE

Cage culture is a promising technology in raising fish in large open water bodies especially in Beels of Assam. Cage is an enclosure, which can be of any shape or size wherein raising of fry to fingerlings/ fingerlings to table size/ table size to marketable size is being practiced in captivity.

6.02.01 MERITS

- Suitable to a wide range of open water bodies especially wetlands
- Efficient utilization of marginal areas of water bodies and thereby reducing pressure on other resources
- Provides private ownership in public waters
- Simple and affordable technology
- Cost of construction and operation is very less due to use of locally available resources
- Easy management of cultured fish stock
- High rate of survivality and recovery
- Most effective tool for fry rearing in flood affected areas.
- No crop loss during flood and drought like situation
- Easy harvesting and almost without any cost
- High return on investment in short period.

6.02.02 SITE SELECTION

The potential sites where fixed cages are to be installed should be selected depending on the size and shape of the water body. The following criteria are considered in selecting the site –

- The depth of the water column should be at least 3 m.
- Water quality and circulation should be good, free from local and industrial pollution.
- In large and medium-sized wetlands, sites should be in sheltered areas for protection from strong winds.
- Site should be safe from human interference and grazing animals.
- Site should be free from algal bloom
- The water body should be free from dense aquatic macrophytes and over populations of wild fish, which can cause oxygen stress
- Easy access to land and water transportation

6.02.03 DESIGN AND CONSTRUCTION

6.02.03.01 Cage construction materials

Depending on the ingenuity of the farmers and availability of the materials a farmer can use any type of material to construct the cage, viz., bamboo, coir rope, nylon nets, high density polyethylene etc.

6.02.03.02 Construction and placement of cage

6.02.03.02.01 Fabrication of frame:

The frame of the cage can be made from locally available bamboo, which is a cheaper option than wood, steel or polyvinyl chloride (PVC) and last for at least 5 years, with 5-10% of the poles replaced as needed. The frame is required to hold the cage walls firmly. Fully grown, seasoned bamboos are best suited to make frames and wall supports can be made with high durability high density Polyethylene net available in the market.

Size of a cage can be varied based on requirement. The size of the cage depends on the species to be cultured, period of rearing and scale of operation. However, a smaller unit with an area of about 10-12 m^3 is considered as ideal for easy operation.

A standard size of 4 m X 2 m X 1.5 m (L x B x D) rectangular bamboo cages (unit area= 12 m^3) may be specially designed by using locally available matured *Jati* bamboo, high density polyethylene net (HDPE), plastic ribbon and nylon ropes which facilitate high intensity light penetration and effective water circulation.

6.02.03.02.02 Installation of cages

Cages are installed in clean weed free marginal areas of the beel horizontally. Nylon cages of same dimension of bamboo cage are fixed inside tightly. A plastic tray perforated on the sides is used as feeding tray.

The **depth** of the cage may vary from 1-3 m especially for inland water. A series of cages are spaced in a battery for better operation and high economic return. Fixed cages are more suitable for a water depth of less than 3.0 m and for a water depth of greater than 5.0 m generally floating cages are preferable.

6.02.04 CULTURE TECHNOLOGY

6.02.04.01 Species selection

IMC (Catla, Rohu, Mrigal), Exotic carps (Silver carp, Grass carp, Common carp), Minor carps (Bhangon, Koliajara, Kurhi), and air-breathing fishes (*Sol, Goroi, Magur, Singi, Koi)*

6.02.04.02 Combination and Stocking density

Stocking density depends on the species and size of the fish to be stocked.

Percent composition: A composition of 2.0 cm - 3.0 cm carp fish fry of Catla-30%, Rohu-20%, Mrigal-10%, Silver carp-30%, Grasscarp-10% should be stocked in each cage at a stoking density of 200-350 numbers per cubic meter of the cage area. Depending on the size of fish stoking density to be maintained in the cage is given below-

Size of fish seed (length in cm)	Stocking density (no. per cubic meter)
2.0-3.0	350
3.0-4.0	250
4.0-5.0	200

6.02.04.03 Feeding

The fishes were fed regularly with supplementary feeds like rice polish and mustard oil cake in 1:1 ratio @ 3.0% of the total body weight of the fishes for 45 days regularly. Mineral mixture like Agrimin forte @ 0.03% body weight of the fishes should be mixed together with the feed and supplied in the form of balls in the feeding trays regularly once in a day. Most encouraging results were found where rice polish and MOC along with 1% fishmeal mixed together and boiled.

Caged fish may be fed with floating pelleted feed. Usually large fingerlings can accept ¼ inch pellets. Small fingerlings and species with small mouths may need to be started on 1/8 inch pellets.

The feeding trays should be kept hanging in the middle of the net cage by nylon ropes through its neck shaped mouth.

6.02.04.04 Water quality management

- Water quality parameters like DO, pH, free ammonia, phosphate should be analysed periodically.
- Cages should be cleaned with soft brush fortnightly to remove algae and other debris and organisms.
- Dead fish should be removed from the cage immediately.
- Floating macrophytes that waves sometimes push against cages should be removed.
- Routine checking. Loose twine, mesh torn by predators, anchors and sinkers must be checked routinely and immediately mended or replaced as needed.
- Routine checks of fish health.

6.02.04.05 Harvesting

Harvesting is done after every 45 days duration in seed raising practice.

6.02.04.06 Production

In 45 days of time period 2.0 cm - 4.0 cm carp fry recorded a phenomenal growth in terms of length up to 9.0 cm – 19.0 cm in size where Grass carp> Catla> Silver carp>Rohu> Mrigal>Minor carps.

6.02.04.07 Economics

The economic analysis of cage fish farming practice is given in Table-3. The analysis reveals that an annual investment of Rs. 18720.00 assures a net return of Rs. 29,280.00 from one cage (for 4 batches). The BCR is found to be 2.56.

Table-3: Economic analysis of raising fish seeds in bamboo cages

Unit size and area of a cage : 4.0 m x 2.0 m x1.5 m = 12 m^3
Stocking density : 250 nos. m^{-3}
Total no. of fish fry stocked : 3000
Percentage of recovery : 80
Total no. of fish seeds harvested : 2400

A. Capital cost

Construction of bamboo cage (1 no.) and installation: **Rs.2000.00**
Life expectancy 4 years

B. Recurring cost (for 45 days)

Sl. No.	Head of expenditure	Quantity	Unit cost (Rs)	Total cost (Rs)
1	Fish fry of 3.0-4.0cm	3000 nos.	300.00/1000 nos.	900.00
2	Supplementary feed			
	Mustard oil cake	50.00kg	20.00 kg^{-1}	1000.00
	Rice polish	50.00kg	10.00 kg^{-1}	500.00
	Agrimin forte	¼ packet	120.00/packet	30.00
3	Miscellaneous			300.00
	Total			**2730.00**

C. Total costs

i. Recurring cost for 4 operations = Rs.2730.00 x 4 = Rs.10920.00
ii Interest 10% = Rs.1092.00
= Rs. 12,000.00

Total cost = 2000.00 + 12000.00 = Rs. 14,000.00

D. Gross Income

Selling 2400 nos. fish seeds @ Rs5.00/piece = Rs. 12000.00
Gross income from 4 such seed raising operations = Rs.48,000.00

E. Net income (D-C) = Rs. 48,000.00 - Rs.12000.00 = Rs. 36000.00

Percent return on investment: 257 %
BCR = 3.43

6.03 FISH STOCK ENHANCEMENT PROTOCOLS FOR *BEELS*

Floodplain wetlands (locally known as *beel, anoa, haor, mornai, era suti*, etc.) are considered as one of the most potential inland fisheries resource of Assam on account of their high fish production potential (1000-1500 kg $ha^{-1}yr^{-1}$) and large resource size (*c* one lakh ha). These wetlands are amenable to development of capture fisheries and various forms of fisheries enhancements including aquaculture and can play an important role in increasing fish production besides generating additional employment and income. Fisheries enhancements cover a wide range of practices, which are intermediaries between culture-enhanced capture fisheries and intensive aquaculture. They are often adopted in a stepwise manner leading to a progressive increase in fish production per unit area through increasing human control on parameters governing fish assemblages. Among the various fisheries enhancement techniques, fish stock enhancement (i.e., supplementary stocking with fingerlings of economically important fast growing species like the Indian major carps) - to utilize all the available food niches - is an effective management tool to increase fish yield from the beels of the state.

The ICAR-Central Inland Fisheries Research Institute, Regional Centre, Guwahati has carried out extensive field studies on the fish stock enhancement practices followed in 20 beels of Brahmaputra and Barak valleys of Assam during 2002-07. It was followed by intensive studies on standardization of fish stock enhancement protocols for the beels based on field studies in 27 nos. of beels located in different districts of Assam during 2007-12. Pilot-scale validation of the fish stock enhancement protocol was undertaken in Mer beel, Nagaon District of Assam in collaboration with the Assam Fisheries Development Corporation (AFDC) Limited, Guwahati during 2013-14, wherein fingerlings reared in four pens covering one ha area was released in the beel (water-spread area 19 ha) to enhance its fish production. The refined protocol is currently being demonstrated in Sarbhog beel, Barpeta District of Assam in collaboration with AFDC Ltd. (since November, 2015) and in four beels of BTAD areas in collaboration with Bodoland Territorial Council, Kokrajhar. The standardized fish stock enhancement protocols is briefly outlined in the following.

6.03.01 MERITS

- Fish stock enhancement is a very simple and low-cost management tool (involving only supplementary stocking) for increasing fish yield rates from beels.
- It is an economically viable management option for beels since there is no cost of supplementary feeding and fertilization here.
- Since no supplementary feeding and fertilization is practiced, this option causes minimum environmental damage to the beel ecosystem.
- Selective stock enhancement of commercially important/ fast-growing fish species is necessary to prevent less economic/ small/ slow-growing fishes like glass fishes from flourishing in the beel by utilizing the available food sources.
- It compensates for disruption of recruitment of commercially important major fish species (e.g., IMC) from the parent rivers in most closed beels and seasonally open beels.

- Unlike aquaculture, natural fishes occurring in the beel are not eliminated here, thereby causing minimum damage to indigenous fish species occurring in the beels.
- It helps in achieving optimal fish production from the beels through efficient utilization of unused trophic and spatial niches of the beel ecosystems.
- Fish seed released into the beel ecosystem grow fast with high survival rate because of large water-spread area and varied natural foods available there.
- The benefits of stock enhancement in beels are shared by the riparian community unlike in pond aquaculture where the benefit reaches a few individuals.
- Because of the large resource size of beels in Assam (approx. one lakh ha) and high fish production potential (1000-1500 kg $ha^{-1}yr^{-1}$), large-scale fish stock enhancement programmes are likely to enhance fish production of the state significantly.

6.03.02 PRE-STOCKING MANAGEMENT

6.03.02.01 Control of aquatic macrophytes

- Excessive growth of aquatic macrophytes is controlled from the beel before stocking. Aquatic macrophytes that adversely affect penetration of sunlight into the *beel's* waters – including free-floating (e.g., water hyacinth) and rooted emergent (e.g., water lily) should be totally cleared (manually/mechanically).
- Submerged macrophytes that contributes to the *beel's* food web is controlled (manually/mechanically) only when they adversely affect water quality of the *beel* including phytoplankton growth (usually when they cover more than 50% area).
- In closed *beels* (*beels* that have lost riverine connection) that present negligible risk of escape of stocked fishes to their parent/ adjoining rivers, Submerged macrophytes can be controlled and converted to additional fish production by stocking herbivorous fishes like grass carps and silver carps.

6.03.02.02 Control of predatory and undesirable fishes

- Presence of sizeable populations of predatory fishes especially the freshwater shark (*Wallago attu*) adversely affects the survival of stocked fish seed in *beels* by devouring them.
- Small-sized and undesirable/ less economically valuable fishes (e., glass-fishes, minnows, etc.) may adversely affect the growth and survival of stocked fishes by competing with them for food and space. Further, harvesting of small fishes is often difficult in *beels* having moderate to heavy infestation of aquatic macrophytes (especially submerged).
- Repeated netting using shore seines, boat seines and as well as selective fishing with gill nets (of appropriate mesh size), long lines, traps, etc. are normally employed for controlling undesirable fish populations in *beels*.
- Allowing the fishers a greater share in the catch of undesirable fishes is a good management decision for encouraging selective fishing of such species.
- Biological control of such small undesirable fishes by keeping a limited population of predatory fishes having moderate-sized mouth (e.g., *Chitala chitala*, *Sperrata aor, S. seenghala*, etc.) is another option. These riverine species do not normally breed in closed beels and therefore, their population can be kept under control.

6.03.03 SUPPLEMENTARY STOCKING IN *BEELS*

6.03.03.01 Important considerations while stocking a *beel*

- The species selected for stocking should have fast growth rate and should preferably feed at lower trophic levels (e.g., herbivores, detritivores and planktivores).
- The stocked species should find the beel suitable for its survival and growth.
- Fishes feeding on different types of natural foods (e.g., phytoplankton, zooplankton, aquatic macrophytes, detritus, insects, mollusks) should be stocked to minimize food overlap.
- Fishes living/ feeding at different depths (e.g., surface, column, and bottom) are preferred to reduce competition for food and space.
- The stocking density should be determined in such a way that all the food resources available in the *beel* are fully utilized and the densest possible fish population consistent with normal growth is maintained.
- Fish seed of the desired species should be readily available in the locality so that the cost of stocking is not very high.
- Cost of stocking and managing the species must be less than the additional profit obtained from stocking and subsequent management.
- Exotic fishes are not recommended for stocking in seasonally open *beels* since there is a possibility of their escape from the *beels* in to adjoining rivers during floods. However, exotic grass, silver and common carp can be stocked to effectively utilize aquatic macrophytes, phytoplankton and detritus respectively in closed *beels*.

6.03.03.02 Candidate species

6.03.03.02.01 For closed *beels*

- Indian major carps (catla, rohu and mrigal),
- Minor carps (*Labeo gonius*, *L. bata*),
- Clown knife fish (*Chitala chitala*).

6.03.03.02.02 For seasonally open *beels*

- IMCs (rohu, catla and mrigal),
- Minor carps (*L. gonius*, *L. bata*),
- Major exotic carps (Grass Carp, Common Carp and Silver Carp),
- Exotic silver barp (*Puntius gonionotus*)
- Clown knife fish (*C. chitala*).

6.03.03.03 Species ratio

Species ratio recommended for beels having different water depths are as follows:

Type of fish species reared	Water depth in the pens	
	Up to 2 m	More than 2 m
1. Surface feeder (e.g., Catla, Silver carp)	40%	50%
2. Column feeder (e.g., Rohu/ *Labeo gonius/ L. bata*, grass carp)	30%	30%
3. Bottom feeder (e.g., Mrigal, common carp)	30%	20%

6.03.03.04 Stocking density

6.03.03.04.01 Factors determining stocking density in *beels* for supplementary stocking

- Estimated fish production potential (1,000-1,500 kg $ha^{-1}yr^{-1}$) or the Production target (say, 1,000 kg $ha^{-1}yr^{-1}$).
- Fish yield rate being obtained in the *bee*l from natural/ auto-stocked fishes (say, 200 kg $ha^{-1}yr^{-1}$).
- Size at stocking and the estimated/ anticipated fish mortality rates in the *beel*.
- Size at harvesting and the estimated/ anticipated fish growth rates in the *beel*.

6.03.03.04.02 Calculation of stocking density

- Determination of optimal stoking density is essential to avoid under or over-stocking in *beels.*
- It should be determined for individual *beels* or a group of them sharing common characteristic (e.g., riverine connection, size, presence of natural fish populations, predation pressure, minimum marketable size, etc.).
- The main considerations in determining the stocking rate are growth rate of individual species stocked, mortality rate, size at stocking and the growing time.

6.03.03.04.03 Modified simple formula for determining stocking density in beels

$$\text{Rate of stocking (No. ha}^{-1}\text{)} = \frac{\text{Targeted additional fish yield rate (kg ha}^{-1}\text{)}}{\text{Individual growth rate (kg)}} + \text{Mortality loss (\%)}$$

Here, the targeted additional fish yield rate is calculated by subtracting the actual/ estimated average fish yield rate from natural/ auto-stocked fishes from the beel from the targeted yield rate/ estimated potential yield rate.

Though the above formula is easy to understand and calculate, it is not very accurate for calculating stocking density in beels. This is because it difficult to assume loss of stocked seed due to mortality in large and seasonally open *beels*.

6.03.03.04.04 Formula adopted by Govt. of India for determining stocking density in open waters

The Government of India has adopted the following formula to calculate the stocking rate for small reservoirs which can also be used for floodplain wetlands.

$$S = \left[\frac{q.P}{W}\right] e^{-z(t_c - t_o)}$$

Where, S = Number of fish to be stocked (in numbers ha^{-1}), P = Additional annual yield to be obtained from the wetland, q = Proportion of the yield that can be come from the species in question, W = Mean weight at capture, t_c = Age at capture, t_o = age at stocking and Z = Co-efficient of total mortality

6.03.03.04.04 Optimal stocking density estimated for *beels* of Assam (based on relationship between stocking density and fish yield in 27 stocked *beels* of the state)

- **For closed *beels*:** 3,000 fingerlings ha^{-1}
- **For seasonally open *beels*:** 3,600 fingerlings ha^{-1}.

6.03.03.05 Optimum size at stocking

- Stocking of carried-over seed (15-20 cm size) was found to be most suitable for stock enhancement programs in the beels of Assam in terms of survival rate (>80%).
- For fresh seed, survival rate was very good (>70%) in case of advanced fingerlings of more than 10 cm for seasonally open wetlands and 8-10 cm in case of closed ones.

6.03.03.06 Precautions to be taken at the time of stocking

- Stocking with reasonably good quality fish seed.
- Conditioning of fish seed prior to transportation from seed farm.
- Bath treatment of seed with potassium permanganate @ 5 mg l^{-1} for 1-2 minutes before stocking in the *beel.*

6.03.04 POST-STOCKING MANAGEMENT

6.03.04.01 Protection of stocked fishes

- Seasonally open *beels* that are usually flooded during the south-west monsoon season (June-September), are usually stocked immediately after the rainy season (September) and harvested before the onset of floods (April-May) to avoid loss of stocked fishes.
- Beels that are connected to other *beels*/ rivers through connecting channels, net-lined split-bamboo screens (*bana*) are erected in the channel with strong support from bamboo poles for stock protection.

6.03.04.02 Management of water quality and unwanted organisms

- Salient water quality parameters affecting growth and survival of reared fishes (e.g., water pH, temperature, dissolved oxygen, free carbon dioxide, total alkalinity) should be periodically monitored if possible
- Periodical manual removal of free-floating and emergent macrophytes coupled with biological control of submerged plants with grass carp.
- Fish health and mortality in the *beel* should be periodically observed and suitable remedial actions taken if required.

6.03.04.03 Fertilization

- Since most of the beels of Assam receive a lot of nutrient inputs from their catchment areas and usually have large organic matter reserves, external fertilization is unwarranted.
- Instead of external fertilization, plant nutrients trapped in the beel sediments may be made available to the phytoplankton population through bottom raking in order to increase the growth of fish food organisms.
- Another alternative strategy to channelize the generally high productivity of the *beel* ecosystem to enhanced fish production is eradication/control of aquatic macrophytes (especially free-floating and emergent ones), which compete with phytoplankton for plant nutrients but do not contribute significantly to fish production.

6.03.04.04 Feeding

- The aim of fish stock enhancement in beels is to obtain optimal fish production from them by utilizing the available natural food resources. Therefore, no supplementary feeding to the stocked fishes is recommended.

6.03.05 FISH PRODUCTION AND ECONOMICS

6.03.05.01 Fish yield rates

- Fish yield rates in selected stocked *beels* under the Assam Fisheries Development Corporation (AFDC) Limited ranged from 541.0 kg $ha^{-1}yr^{-1}$ (Bihdia beel, 50 ha area, Golaghat District) to 2,126.7 kg $ha^{-1}yr^{-1}$ (Fakali *beel*, 15 ha, Nagaon District) with higher yield rates recorded in small-sized, closed *beels* that were properly stocked.
- Mer *beel* (seasonally open, Nagaon District), where pilot-scale validation of fish stock enhancement protocols was undertaken by CIFRI in collaboration with the AFDC Limited, Guwahati during 2013-14 recorded fish yield rate of 1,501.1 kg $ha^{-1}yr^{-1}$.

6.03.05.02 Unit costs

Total recurring costs for stocking 10 ha *beel* with advanced carp fingerlings (10-15 cm) is as follows:

- For closed *beel*: Rs. 200,000.00 (approx.) including miscellaneous costs (of which Rs. 180,000.00 is the cost of carp fingerlings).
- For seasonally open *beel*: Rs. 250,000.00 (approx.) including cost of stock protection (of which Rs. 216,000.00 is the cost of carp fingerlings).

6.03.05.03 Economics

- For growing table fish in a seasonally open *beel*, total annual expenditure was Rs. 18,43,600.00 (for 19 ha yr^{-1}). It yielded gross return of Rs. 38,50,200.00 and net income of Rs. 20,06,600.00. The benefit-cost ratio was 2.08 (Table 1).

Table 1. Economic analysis of fish stock enhancement

Sl. No.	Details	Cost (Rs.)
I	Fixed/ capital costs	
1.1	Cost of stock protection (erection of net-lined split-bamboo screens	50,000.00
1.2	Cost of stock protection per year (including annual repairs)	15,000.00
1.3	Cost of wooden boat	20,000.00
1.4	Annual depreciation on boat (including annual repairs)	4,000.00
1.5	Annual depreciation on fixed costs	19,000.00
1.6	Interest on fixed annual costs	1,900.00
1.7	Fixed cost per year	20,900.00
II	Recurring costs	
2.1	Cost of carp FL (10-15 cm long) 68,400 FL@ Rs. 6/- FL	4,10,000.00
2.2	Annual lease value	9,50,000.00
2.3	Watch & ward	2,40,000.00
2.4	Annual cost of macrophyte control	20,000.00
2.5	Cost of constructing camp house/ watch towers	6,000.00
2.6	Miscellaneous costs	31,000.00
2.7	Sub-total of recurring costs	16,57,000.00
2.8	Interest on recurring cost (@10%)	165,700.00
2.9	Total recurring cost per year	18,22,700.00
3	Total cost per year (1.7+2.9)	18,43,600.00
4	Gross revenue (28,520 kg @ Rs. 135.00 kg^{-1})	38,50,200.00
5	Net income (4-3)	20,06,600.00
6	B:C ratio	2.08

Note: All calculations are made based on actual costs for a seasonally beel having 19 ha water-spread area as per 2013-14 prices.

6.03.06 Problems encountered/ anticipated

- Early or late floods may submerge the *beel* during the south-west monsoon season (June- September) in seasonally open *beels* and even in certain closed *beels* in extreme cases. Loss of stocked fishes should be prevented by adequate stock protection measures and/ or by following appropriate/ adaptive stocking and harvesting schedule.
- In *beels* having large quantities of organic deposits, there is a risk of occasional summer fish kills. Periodical bottom raking coupled with water quality management should be undertaken in such *beels*.

PACKAGE -7

FISH HEALTH MANAGEMENT

Aquaculture is the fastest growing food production sector in the world and provides a significant supplement to and substitute for wild fish and plants. However, disease has become a primary constraint to aquaculture growth and is now responsible for the severe impact on both the economic and socio-economic development in many countries of the world.

Even though disease in aquaculture is inevitable, it is difficult to detect the occurrence of disease in its initial stage as fish lives in water and if is detected too, it becomes very difficult to treat the ailing fish without disturbing the production regime. Therefore, prophylaxis rather therapy is more desirable in fish husbandry practice.

7.01 Prophylaxis:

7.01.01 Physical

- Culture operation should be carried out in scientifically constructed ponds (Refer Package 1.01.06). Shape preferably should be rectangular; size should not exceed more than 1.0 ha for effective prevention and treatment of diseases.
- Interlinking of ponds should be avoided as possible
- Inlets and outlets should be properly guarded with effective filter material.

7.01.02 Managerial

- Culture operation should be practiced by strictly adhering to the respective Package of Practices. (as package - 2.01.11)
- To keep the pond environment free from obnoxious gases and other harmful organisms, bottom should be cleared of accumulated organic load and silt every year. (as described in package- 2.01.08.04 to 2.01.08.06)
- Where complete draining of the pond is not possible, pond should be thoroughly disinfected by applying either bleaching powder (package- 2.01.08.03.01) or quick lime (package- 2.01.11.03).
- Recommended number and size of stocking material should be adopted.
- Only disease free stocking material should be used. Dip treatment with 1ppm $KMnO_4$ solution should be given while stocking.
- Liming and fertilization schedules should be followed strictly as described in package 2.01.11.03.01 to 2.01.11.04.05
- In case of composite culture of carps and barbs, supplementary feeding should be regularly done as mentioned in package 2.01.13.04 to 2.01.13.04.05 as necessity arises, feeding should be suspended.
- Aquatic weeds should be controlled. Excessive growth be avoided (package 2.01.08.02)
- Farm implements and fishing gears should be disinfected properly before and after use. Fishing nets should be treated with 1ppm potash ($KMnO_4$) solution or by sun drying. Higher dose of $KMnO_4$ may corrode the net.
- Entry of wild aquatic organism such as unwanted fish, amphibians, molluscs and annelids should be prevented.

- The cultured fish be handled carefully so that continuity of the mucus covering does not get broken
- Netting be restricted during winter months.
- Any dead/moribund organisms should be immediately scooped out.
- Farm hygiene should be maintained properly.

7.02 HEALTH CHECK UP

- Periodical netting: Periodic check on the status of health by intermittent netting. Few fish be scooped out randomly to observe presence of any abnormality or presence of parasite and pathogens on the mouth, eye, operculum, gills, fins and fin bases, body surface and abdomen.
- Reflexes: Observation of normal behavior reflexes particularly at dawn. Any abnormal behaviour such as surfacing, schooling, jumping, restlessness, scratching on rough substratum etc indicate outbreak of disease.

7.03 FISH DISEASES OF ASSAM

Most common fish diseases observed in Assam are discussed in succeeding five categories as below,

7.03.01. Parasitic Fish Diseases

7.03.01.01. Argulosis

Causes:

The disease is caused by *Argulus* spp., a macroscopic crustacean parasite, commonly called fish lice.

Symptoms:

- Initially small red spots occur on the body surface. On careful observation, almost oval small milky white creatures may be seen crawling on the body surface of the infested fish.
- Copius mucus is produced
- Cytolytic activity occurs around the scale pocket, loosing of the scales leading to their loss and later affected region becomes ulcerated.
- Fish lose appetite, normal growth is retarded.
- The body cavity of severly infected fishes are filled with yellow-pink fluid.

Treatment:

- Application of malathion @ 0.25-0.5 ppm, 3-4times at weekly interval .
- Dip treatment in 1% Malathion.
- Bath treatment for 30 minutes in 2.0% salt solution.
- Cleaner @30 ml/ bigha water spread area.
- Use hard substrate (planks/ bamboo) in pond water for attachment of eggs of *Argulus*. Remove at interval and get sun dried to kill the eggs.

7.03.01.02. Ligulosis:

Causes: It is caused by *Ligula intestinalis.*

Symptom:

- Affected fishes are dark in colour, abdomen is distended because of the presence of large number of pleurocercoid larvae.

Prevention :

- Control methods are limited, entry of Ichthyophagus birds should be restricted. Provision should be made for biofencing.

7.03.01.03. Lerneaosis:

Causes: Commonly known as anchor worm disease caused by *Lernea* spp. mostly found in ornamental fishes and in Catla

Symptoms:

- Fish become restless, parasites penetrates into the scale and attach to the nostril; keep hanging from the body with egg sac; clearly visible to the naked eye and attachment site shows ulceration.

Treatment:

- Dip treatment of DDT @ 10 ppm for 30 seconds or NaCl @ 3-5% short bath.

7.03.01.04. Black spot disease:

Causes: The disease caused by *Diplostomum* sp.

Symptoms:

- Black ovoid patches are visible on the body surface and then are pigmented overlaying cysts of the metacercarial larvae. Number of cysts may be few to hundreds.

Prevention :

- Removal of the resident molluscan population (1^{st} intermediate host) and aquatic birds (2^{nd} intermediate host) around it.

Treatment:

- Use of molluscides

7.03.01.05. Trichodiniasis:

Causes: *Trichodina* sp. is responsible for the disease.

Symptoms:

- Greyish blue veil like coating over the body surface and gills, colour of the gills turns pale, becomes sluggish and shows asphyxia.

Treatment:

- Application at a concentration of 2-3% solution of sodium chloride (salt) bath till the fishes is stressed.
- Application of Formalin @ 15-25 ml l^{-1} in pond water, in morning hours.

7.03.01.06. White scale spot disease:

Causes: The disease is caused by *Myxobolus* spp.

Symptoms:

- Body surface and gills are covered with whitish cysts.

Treatment:

- Bath treatment of NaCl in 3-5% solution or mahua oil cake and lime should be applied in the pond as advised dosage.

7.03.01.07. White spot disease (Ich)

Causes: The disease is caused by protozoan ciliates *Ichthyophthirius multifiliis*.

Symptoms:

- Presence of small whitish cysts on the skin, gills and fins.
- Hyperplasia of epidermal cells around the site of infection.
- Reddish color of gills fades away.
- Fish becomes very weak and emaciated.

Therapy:

- One hour dip treatment in 2% NaCl solution for more than 7 days.
- Destroy the infected fish either by burning or digging in soil.
- Bath treatment of fish with 2-3% common slat solution for 7 consecutive days.

7.03.01.08. Gyrodactylosis/ Dactylogyrosis

Causes: The disease are caused by *Gyrodactylus* spp., and *Dactylogyrus* spp. respectively.

Symptoms:

- Gills colour fade
- Dropping of scales.
- Affected fishes are restless

Therapy:

- Bath for 3-5 minutes in 200-250 ppm formalin.
- Application of $KMnO_4$ in pond water @ 5 ppm.
- Bath in 10 ppm $KMnO_4$ for 1-2 hours.

7.03.02. Bacterial Fish Diseases:

7.03.02.01 Fin rot and tail rot disease:

Causes:

- It is a bacterial disease, may be caused by *Aeromonas* spp. *Pseudomanas* spp. are also suspected.

Symptoms:

- The first symptom is whitening on the outer margin of the fin.
- Whitening progresses towards the base of the fin.
- Lesions develop on the outer margin of the fin.
- Fin margin becomes frayed due to disintegration of the soft rays.

Therapy:

- Treat pond water with $KMnO_4$ @ 5 ppm.
- Bath treatment in 1:2000 Copper sulphate for 1-2 minute.
- Sulfonamide to be fed @ 3g kg^{-1} feed for 12-19 days.
- Oxytetracyclin to be fed @50-75 mg $fish^{-1}day^{-1}$ for 10-12 days or incorporate 1.8 g kg^{-1} feed and fed for 10-12 days.

7.03.02.02. Haemorrhagic septicaemia

Causes: The etiology of Haemorrhagic septicaemia is bacteria viz. *A. hydrophila* along with other pathogenic *Aeromonas* spp. and *Pseudomonas* spp., which are frequently encountered in the ulcers.

Symptoms:

- Red hemorrhagic spots on the body surface.
- Dropsy, glisters, abscesses and scale protrusion.
- Oozing of blood through base of the anal fin.

Therapy:

- Application of $KMnO_4$ in pond at the rate of 1ppm
- Bath treatment for 15-30 seconds in 2.5% NaCl solution
- Liming of the pond based on pH

7.03.02.03 Dropsy:

Causes: Disease is caused by *Aeromonas hydrophila*.

Symptoms:

- Accumulation of fluid in epidermis and body cavity leading to bulging of belly
- Scales protrude out from pockets.
- Prevailing severe aneamic condition.

Therapy:

- Treatment of pond water with $KMnO_4$ @ 1-3 ppm
- Liming of the pond

7.03.02. 04 Eye Disease of catla:

Causes: This is caused by *Aeromonas liquefaciens.*

Symptoms:

- The eye looks reddish due to vascularisation and subsequently turns milky white and becomes opaque.
- Protrusion of eyeballs is observed.

Therapy:

- Treat the pond with $KMnO_4$ @ 4-5 ppm in pond water as chemotherapeutic measures or 1 ppm in pond as prophylactic measures.
- Liming is necessary in pond according to the pH.

7.03.02.05. Ulcer Disease:

Causes: *Aeromonas* spp., *Pseudomonas* spp., *Edwardsiella tarda* and *Streptococcus iniae* are responsible for ulcer disease.

Symptom:

- Initially small pimple like reddish areas appear on the body surface and later ulcer formation takes place.

Therapy:

- $KMnO_4$ @ 4-5 ppm in the pond water.
- Liming is necessary in pond according to the pH.

7.03.03. Fungal Diseases:

7.03.03.01 Saprolegniasis (Cotton Wool Disease):

Causes: The disease is caused by *Saprolegnia parasitica*, a fungal pathogen.

Symptoms:

- The pathogen grows over any necrotic tissue of the host imparting a cotton wool like appearance.
- White to brown cotton like growth consisting of fungal mycelium which appear as small to large patches on various parts of the body like fins, gills, mouth, eyes or muscle.

Therapy:

- The water surface should be sprayed with 0.15 ppm of malachite green. The treatment is repeated 3 times at interval of 3 days.
- Treatment of pond water with 20-24 ppm of Potassium dichromate.
- Swabbing the affected region with solution of 5-10% malachite green, 5% potassium dichromate and 5% iodine.
- Dip treatment with 3% common salt solution.
- Application of malachite green @ 0.10 ppm for 2-4 times at weekly interval.

7.03.03.02 Epizootic Ulcerative Syndrome

Epizootic Ulcerative Syndrome (EUS) is the most dreadful disease in Assam

Causes: Disease is caused by fungus (*Aphanomyces invadans*) and associated pathogens.

Symptoms:

- Initially lesions starts as small grains to pea sized haemorrhageic spots over the body which ultimately turns into big ulcers of the size of a coin with sloughing of scales and degeneration of epidermal tissue
- Later ulcer becomes deep haemorrhagic and necrotic often with black melanistic rim
- Affected fishes with mild lesions may not show clinical symptoms.
- All individual fish species get infected at a time within a very short period.
- Outbreak mostly takes place during winter.

Prophylaxis:

In addition to general prophylactic measures, the following specific preventive measures are required to be adopted before onset of winter.

- Maintenance of water pH at around 8.0 steadily throughout the winter season.
- Avoid netting as far as possible during the winter months.
- Scoop out the dead and moribund fishes and burry them at a distant place mixing with quick lime.

Therapy:

Two effective methods of treatment have been evolved.

Treatment-1

- Temporary suspension of manuring and fertilization.
- Application of additional lime to increase the water pH to 8.0-8.5.
- Disinfection of pond water with $KMnO_4$ @1.0 ppm
- Dip treatment if 500 ppm $KMnO_4$ to the highly infected fishes.
- Application of a mixture of 10 kg lime with 1kg turmeric per bigha water surface.
- Dilution of 130ml "CIFAX" and spread over one bigha water surface.
- For the effective treatment of the ulcered fish, mix $CuSO_4$ and $KMnO_4$ at the rate of 1:1 by weight, make a paste and apply and wash the fish.
- Ensure supplementary feeding.

Treatment-II

- The severely ulcered moribund fishes are to be scooped out of the pond followed by application of $KMnO_4$ @2 ppm. The chemical is dissolved in the clean water and sprayed evenly on water surface.
- Quick lime (CaO) is applied on the next day @ 50kg ha^{-1} water spread area which is to be repeated after an interval of 1 week.
- Application at a concentration of 3-4% sodium chloride (salt) dip treatment of affected fish at initial stage of the disease.

7.03.03.03 Gill rot disease:

Causes: *Branchiomyces* sp., a fungal pathogen is responsible for occurrence of the disease.

Symptoms:

- Gasp for air at the surface water.
- Yellow brownish discoloration of the gill filaments which at a later stage becomes grayish white and may finally drop off altogether leaving cartilaginous support exposed.

Therapy:

- Maintainance of water pH at 8.5.
- Application of Copper Sulphate@ 12kg ha^{-1} subdivided into 4 doses or @0.1ppm 2-4 times at weekly interval.
- Application of lime @ 10kg/bigha in affected pond.
- Drain the affected pond and sundry and apply lime at the bottom.
- Maintain the strict hygiene in hatcheries.
- Sodium Chloride (NaCl) bath of the affected fishes @ 3-5% for 1-2 min.

7.03.04 Occasional Diseases:

7.03.04.01 Acidosis/ Alkalosis

Causes: When water becomes very acidic (pH below 4.8) or very alkaline (pH above 10.8), these diseases occur.

Symptoms:

- A brown coating on the gills, consisting of necrotic epithelium. The tips of filaments are particularly affected. The coating becomes thicker as exposure goes on, but eventually breaks up and sloughs off.
- The skin assumes a muddy appearance and shed layers of thick mucus.
- Soft abdominal area becomes reddish and eventually sloughs off.
- A weak opacity of the skin and fraying of fins are the symptoms of alkalosis.

Therapy:

pH adjustment usually by judicious application of lime (Package- 2.01.11.03.01.01)

7.03.04.02 Nutritional Disease:

If the fishes are deprived of nutritionally complete diet with optimum amount of protein, carbohydrates, fats, vitamin and minerals, fishes may suffer from several diseases such as scoliosis, lordosis, copius mucus on gills causing difficulty in respiration, clubbed gills, erosion of lower jaw and fins etc. Nutritional deficiencies also make the cultured fishes very prone to attack of several pathogens. Therefore in addition to manuring, fishes are to be fed regularly with proper diet to their appetite capacity.

7.03.04.03 Leech:

Causes: Leech infestation is caused by fish pathogenic hirudineans (family Piscicolidae and family Glossiphonidae). Get entry through animals, transportation of fish and water entry from the wild sources

Symptoms:

- Weaken the small fishes
- Mechanical injury at the site of attachment
- Haemorrhagic conditions on the body surface
- Sunken eyes of the affected fish

Treatment:

- Drying and disinfection of the leech infested pond by application of lime. While drying care must be taken not to leave any moist patches on the pond bed.
- Application of Lysol @ 2 ppm in affected pond.
- Application of CaO into the pond water or Lysol @ 0.2 ppm

7.03.04 .04 Gas bubble disease:

Causes: Supersaturation of oxygen and nitrogen in pond water.

Symptoms:

- Tiny bubbles at the periphery of eyes, near the scales and on the gills. The abdomen gets swollen like dropsy.

Prevention:

- Stop application of fertilizers and feeding immediately, and add freshwater to the pond without disturbing the water fresh.
- Stop the leakages in pipe systems.

7.03.04.05 Algal toxicosis:

Causes: *Microcystis* and *Anabaena* sp.

Symptoms:

- Surfacing of fish with erratic movement and cause mortality in many cases due to clogging of gills.

Treatment:

- $CuSO_4$ @ 0.5 ppm in pond in acidic water and 1.0 ppm in pond in alkaline water or cowdung @ 200 kg ha^{-1} sprinkled over the surface.

7.03.04.06 Asphyxiation

Cause: Cause due to depletion of dissolved oxygen (DO) below 4.0 ppm. Such situation may occur because of the followings,

- Very high stocking density.
- High algal bloom or extensive aquatic macro weed infestation.
- Cloudy weather.
- High organic load.
- Brief heavy shower.

Symptoms: Fishes gasp for air at the surface water. Such a situation occurs particularly during the period proceeding dawn and immediately after sun set. It can occur at any time during continuous cloudy weather or after a short heavy rainfall. All the fish might die *en-masee*. Recurrent sub lethal oxygen deprivation may not lead to mass mortality but stressful enough to bring about appetite loss, increase susceptibility to other infection.

Therapy:

- Spraying water over the water surface of the pond by using water pump. Where such action is not possible, the surface of the pond water should be agitated to facilitate oxygen uptake. While doing so, care must be taken not to disturb the bottom deposit.
- Removal of excessive decayed or half decayed organic matter and aquatic weeds.
- Precipitation of suspended organic matter is also helpful and can be assisted by judicious application of lime.
- If the population density is high, immediately partial harvesting is suggested.
- If the situation occurs due to abundant algal bloom, the bloom should be removed immediately by netting or using barrier.

7.04 GUIDELINES FOR EXTERNAL TREATMENT

- Starvation for 12-48 hrs depending on water temperature prior to treatment reduces oxygen consumption and ammonia production and improves resistance to scale loss during handling.
- Treatment should be carried out at a comparatively cooler weather.
- The health of gills should be checked. If there is evidence of parasitism this should be treated first.
- Treatment should be avoided during flood, because suspended solids, specially organic material arising from floods or poor pond hygiene can also absorb chemicals for treatment reducing its active concentration and hence its efficiency.
- The pH and Hardness of water are a major influence on efficiency for treatment of chemical. As a general rule, lower the pH, the more acidic the water; the more toxic the chemicals. and the more effective the treatment.
- A treatment trial on a small representative group of fish must be performed prior to the main treatment under identical condition and waiting period of 12-24 hrs is essential for the possible appearance of distress before the treatment of the full stock.
- Dose calculation should be carefully made and get cross checked.
- DO concentrations should be monitored throughout the course of the treatment.
- Use plastic buckets, never use galvanized containers.

7.05 SAMPLE COLLECTION FOR DIAGNOSIS

- For proper diagnosis an expert help is often needed. Unless the sample is accompanied by relevant information, it becomes difficult to diagnose the disease. A prescribed proforma for sending information about the sample are given below.

Information proforma

	Particulars	Information
1	Name of the farmer	Shri ……..
2	Full Address	Vill…….. Post…… Pin…… Dist……..
3	Description of the pond water body	Locality……. Length…… Breadth……. Depth…… Extent of weed infestation…… Extent of organic load……
4	Date of collection of sample	…….
5	Description of the sample	Fish species …….. Soil …… Water ……
6	Required examination	For fish …….. Soil ……

		Water ……
7	Fish culture details	Date of stocking……. Rate of stocking …….. Liming ……. Manuring ……. Supplementary feeding …… Growth rate ……. Any other …….
8	Outbreak record of disease (last 2 years)	……..
9	Behavioral reflex observed	……
10	Physical disorder	Eye……. Pectoral fin…….. Pelvic fin……. Dorsal fin…….. Caudal fin……. Operculum…….. Gills…….. Body surface…… Other organs…… Body colour……. Any other……
11	Details of chemical applied in pond	……..
12	Details of water entered/ supplied from outside	…….
13	Other species affected	…… ……. ……..
Report of the expert ……. ……. ……. Date…….. Signature Designation…….		

PACKAGE -8

PREPARATION OF VALUE ADDED FISH PRODUCTS

8.01 PREPARATION OF HYGIENIC DRY FISH:

Appreciable quantity of miscellaneous varieties of fish is being sundried after recession of recurring flood and during Jeng fishing in the state. The method followed for drying of fish is mostly traditional, unhygienic and lack of proper packaging. Even through locally prepared dry products fail to attract urban population, such products are being sold in Jagiroad dry fish market as well as in local retail markets. Drying of fish is gaining importance as a cheapest means of preservation in our state. Quality of dry fish can be improved by following scientific methodology.

Fishes used: small and miscellaneous varieties (2-3 inch)

Site for dry fish activities; Elevated open land away from populated area

8.01.01 Steps of Hygienic Dry Fish Preparation:

1. Selection of raw material (Fresh and wholesome)
2. Washing the fish with good quality water
3. Segregation of fish-size wise, species wise
4. Discard of damaged/spoiled fish
5. Washing again in good quality water for 2-3 times
6. Dip treatment in salt solution (15-20%) for 10-15 minutes
7. Rinsing superficially using good quality water
8. Spreading uniformly in the drying racks of a solar polythene tent drier
9. Intermittent upside down of fish is essential for uniform drying
10. Drying for 3 to 4 days depending on weather condition
11. Spreading the dried fish in a clean elevated structure inside the room for 30 minutes
12. Packing in PP packets
13. Store at room temperature in dry place

8.01.02 Solar tent dryer:

8.01.02.01 Components:

1. Wooden platform (1 ft height from the ground) nailed with a black painted aluminum plain sheet or black PVC sheet.
2. Two fish drying racks place one above the other. Racks are made up of wood and good quality netting materials
3. Triangular wooden frame made up of transparent polythene with provision for air inlet and vapour outlet.

8.01.02.02 Materials Required:

1. Wood
2. PP (Transparent)
3. Nylon net
4. Ply
5. PVC sheet (Black painted)
6. Other construction materials

8.01.02.03 Merits:

1. No energy required
2. Simple equipment
3. Easy to operate
4. Shorter drying period
5. Contamination of sand/dust can be prevented
6. Protection from insects, preying birds
7. Structure can be folded and kept in safe place in off-season
8. Hygienic product

N.B. a. Bamboo can be used instead of wood to reduce the cost.
b. There is a provision of doors in this dryer for easy operation during drying process.
c. General sanitary practices are to be followed during drying operation.

8.01.02.04 Cost Involved:

Approximate cost in construction of solar polythene tent dryer of size 12 ft x 10 ft x 7 ft would be Rs. 40,000.00 – Rs. 50,000.00 for bulk fish drying.

8.01.02.05 Dimension of the structure:

	Frame (Ft)	**Rack-1 (Ft)**	**Rack-2 (Ft)**
Length	12	10	7
Width	10	6	4
Height	7	2	1

8.01.03 Economics:

A. Fixed Capital Cost:

Sl. No.	**Items**	**Quantity**	**Cost (Rs)**
1	Construction of Solar polythene tent dryer. Size 12 ft x 10 ft x 7 ft	1	40,000.00
2	Sealing machine and utensils		2,000.00
	Total		**Rs. 42,000.00**

B. Recurring Expenditure for one operation (3 days)

Sl. No.	**Ingredients**	**Quantity required**	**Rate (Rs)**	**Total amount (Rs)**
1	Raw Fish	40Kg	40.00	1600.00
2	Labour	3 mandays	Rs.200/manday	600.00
3	Miscellaneous including packaging and maintenance			800.00
	Total			**Rs. 3000.00**

- Atleast 7 operation can be done in one month. In 3 months (Suitable period for fish drying) atleast 21 such operation can be carried out

C) Annual investment:

a) Annual depreciation on fixed capital cost (10%) : Rs. 4,200.00
b) Annual interest on fixed capital cost (10%) : Rs. 420.00
c) Annual variable recurring cost in 21 operations : Rs. 63,000.00
d) Annual interest on working capital @ 10% : Rs. 6,000.00

Total Annual investment **Rs: 73,920.00**

Say, Rs. 73,900.00

D) Gross Income:

Dry fish: 13 Kg (drying yield approx. 33%) per operation, thus
In 21 operation drying yield 273 Kg @ Rs. 500.00/Kg :**Rs. 1,36,500.00**

E) Net Income (D-C) **: Rs. 62,600.00**

Return on annual investment : 84.70%
Profit to turn over : 1.85

8.02 PREPARATION OF FISH PICKLE

Pickling is the safest means of preservation of fish. Pickles produced from fish are gaining acceptance in recent days. Besides being highly nutritious, fish pickles are good appetizers also. At present there is an expanding export and domestic market for fish pickles.

Size of the processing hall (14 ft × 16 ft) should have proper drainage system, good water supply and fly proof.

8.02.01 Materials required:

1. General frying utensils, gas connection
2. Raw materials and sub materials (shown in table)

Sl. No.	Items	Recipe weight (g)
1	Fish	1000
2	Menthi	4
3	Mustard seed	4
4	Garlic (peeled) } PASTE -I	100
5	Ginger } PASTE -I	25
6	Green Chilli } PASTE -I	30
7	Turmeric } PASTE -II	5
8	Cumin powder } PASTE -II	30
9	Chilli powder } PASTE -II	25
10	Garam masala	10
11	Salt	60
12	Mustard oil	300 ml
13	Sodium benzoate	0.25
14	Vinegar	200 ml

8.02.02 Steps of preparation of fish pickle:

1. Fish required (Small miscellaneous varieties/ bigger fish)
2. Washing in potable water
3. Weighing
4. Dressing to remove head, scales, fins, viscera etc.
5. Washing in potable water
6. Cutting in convenient size (1 cm^3)
7. Weighing
8. Marinating using salt for 60 minutes and draining
9. Fry fish pieces in mustard oil till brown colour appears
10. Remove the fried pieces, transfer in a clean dry tray and keep it covered
11. Pour more oil in the frying pan and fry Indian menthi and mustard seeds
12. Add paste – I and fry for a while
13. Add paste-II and fry at low flame
14. Add fried fish pieces to the mixture and then add remaining quantity of salt
15. Stir the content gently taking care not to break the fish pieces
16. May add garam masala, mint leaves (for better flavour) and stir
17. Add tartaric acid and vinegar

18. Cool the contents at room temperature and add sodium benzoate
19. Packing and sealing
20. Labelling and storage at room temperature

N.B. a) Bigger fishes are dressed, beheaded, filleted cut into convenient sizes and used.
b) Sealed pickles are kept for 1 month for maturing and then sold.
c) General sanitary practices are to be followed during the whole process.

8.02.03 ECONOMICS:

A. **Fixed Capital Cost:**

Sl. No.	Items	Quantity	Rate (Rs.)	Cost (Rs.)
1	Dressing table	**1**	**4000.00**	**4000.00**
2	Knives	**5**	**100.00**	**500.00**
3	Aluminum tray	**5**	**600.00**	**3000.00**
4	Frying Pan	**2**	**1500.00**	**3000.00**
5	Plastic bucket	**4**	**500.00**	**2000.00**
6	LPG connection	**1**	**-**	**5000.00**
7	Khanti	**2**	**250.00**	**500.00**
8	Spoon (big and small)	**5**	**100.00**	**500.00**
9	Sealing machine			**1000.00**
10	License			**500.00**
			Total	**20,000.00**

B. Recurring Expenditure

Sl. No	Ingredients	Recommended Dose for 1000g fish	Quantity required	Rate (Rs.)	Total amount(Rs.)
1	Fresh fish	1000g (dressed)	130 kg(whole fish) = dressed weight100 kg	120.00	15600.00
2	Methi	4g	0.4 kg	10/100g	40.00
3	Mustard seed	4g	0.4 kg	10/100g	40.00
4	Garlic	100g	10.0kg	100 kg^{-1}	1000.00
5	Ginger	25g	2.5 kg	80 kg^{-1}	200.00
6	Green Chilli	30g	3.0kg	50 kg^{-1}	150.00
7	Cumin	30g	3.0 kg	400 kg^{-1}	1200.00
8	Chilli powder	25g	2.5 kg	230 kg^{-1}	575.00
9	Turmeric powder	5g	0.5 kg	200 kg^{-1}	100.00
10	Table salt	60g	6.0kg	10 kg^{-1}	60.00
11	Garam masala	10g	1.0 kg	560 kg^{-1}	560.00
12	Mustard oil	400ml	40 litre	100 l^{-1}	4000.00
13	Sodium Benzoate	0.250g	25 g	20/ 25 g	20.00
14	Plastic container with aluminum foil	-	600 bottles (cap. 200g)	10 $bottle^{-1}$	6000.00
15	Labelling (multicolour)	-	600 nos.		2400.00
16	Gas cylinder	1			700.00
17	Labour		8 man days	250/ manday	2000.00
18	Misc.				500.00
					35145.00 Say, 35000.00

C) Annual investment:

a) Annual depreciation on fixed capital cost (10%)	: Rs. 2000.00
b) Annual interest on fixed capital cost (10%)	: Rs. 200.00
c) Annual variable recurring cost	: Rs. 35,000.00
d) Annual interest on working capital@ 10%	: Rs. 3500.00
Total Annual investment	**: Rs. 40,700.00**

D) Gross Income:

Sale of 600 pickle bottles (cap. 200gm) x @ Rs. 100.00	: Rs.60,000.00
E) Net Income (D-C)	: Rs. 19,300.00
Return on annual investment	: 47.42%
Profit to turn over	: 32.17%
Cost of production per bottle	: Rs.67.83
BCR	**: 1.47**

8.03 PREPARATION OF FISH WAFERS

Potato wafers are very common and available in the market all over India. These products are liked by all age group of people. These wafers can be made more tasty and nutritious by adding mince from low cost fish. Shelf life of fish wafer is 45 days at room temperature.

8.03.01 Materials required:

1. Fish meat
2. Sago (*Sabudana*)
3. Salt
4. Sugar
5. Water
6. Pans (Utensils)
7. Packing machine
8. Polyethylene packs

8.03.02 Recipe:

Sl. No.	Ingredients	Quantity
1.	Fish meat	100 gm
2.	Sago (*Sabudana*)	300 gm
3.	Salt	5 gm
4.	Sugar	5 gm
5.	Water	500 ml

8.03.03 Procedure:

Boil the fish meat for 20 min and make paste

↓

Take *sabudana* in 1 lit water in a pan and boil it till it becomes sticky (thick)

↓

Add salt, sugar, fish meat and cook for 10 min.

↓

Kept it for cooling at room temperature.

↓

Take a plastic sheet and make different kinds of wafers.

↓

Dry in sun light.

↓

Pack in air tight polyethylene bags

↓

Store it in dry place at normal temperature

8.03.04 Economics:

Sl. No.	Ingredients	Quantity	Rate (Rs.)	Amount (Rs.)
A.	**Non recurring**			
1.	Pan (Utensils)	1no.		1,000.00
2.	Sealing machine	1no.		600.00
	Expenditure (A)			**1,600.00**
B.	**Recurring**			
1.	Fish meat	500 g	180 kg^{-1}	90.00
2.	Sago (*Sabudana*)	1500 g	65 kg^{-1}	97.65
3.	Salt	25 g	10 kg^{-1}	0.25
4.	Sugar	25 g	45 kg^{-1}	1.10
5.	Water	2500 ml	--	0.00
6.	Polythene packs	20 nos.	5.00 pack	100.00
	Expenditure (B)			**289.00**
	Expenditure (A: Depreciation cost, 15 years)			**107.00**
	Total Expenditure (A+B)			**396.00**
	Total income from fish wafers	1800 g	50.00/100g	**900.00**
	Net Income			**504.00**
	B:C ratio			**2.27**

8.04 PREPARATION OF FISH CUTLET

Cutlet is a popular product all over India. Fish cutlet is one such product that is rich in nutritive value and suit the taste of consumers. It is prepared by mixing several ingredients along with fish meat followed by shaping, battering and breading. The nutritional value of cutlet is increased by addition of fish meat. Raw cutlets can be stored in deep freezer and when required, can be fried in oil and served.

8.04.01 Materials required:

1. Fish meat
2. Salt
3. Potato
4. Corn flour
5. Garlic
6. Egg
7. Ginger
8. Bread crumbs
9. Green chilli
10. Black pepper powder
11. Onion
12. Turmeric
13. Garam masala
14. Mustard oil

8.04.02 Recipe:

Sl. No.	Ingredients	Quantity
1	Fish meat	1 kg
2	Boiled potatoes	500 g
3	Garlic chopped	25 g
4	Ginger chopped	25 g
5	Green chillies chopped	15 g
6	Onion chopped	250 g
7	Salt	25 g
8	Eggs	10 nos.
9	Bread crumbs	250 g
10	Black pepper powder	6 g
11	Turmeric powder	6 g
12	Garam masala	6 g
13	Mustard Oil	300 ml
14	Corn flour	60 g

8.04.03 Procedure:

Boil the fish meat and potatoes for 20 min and mash the potatoes

↓

Now take a pan and put 50 ml oil in it

↓

Add onion, ginger, garlic, green chillies chopped, salt and fry the mixture

↓

Add black pepper powder, turmeric powder and garam masala and make a paste

↓

Add mashed potatoes and fish meat in it and keep for cooling and make small oval shape cutlet (25 g each).

↓

Take egg white and add corn flour in it and make a paste

↓

Dip the oval shaped cutlet in the paste and apply bread crumbs on it and fry. Product can be served hot

8.04.04 Economics:

Sl. No.	Ingredients	Quantity	Rate (Rs.)	Amount (Rs.)
A.	**Non recurring**			
1.	Utensils (Frying pan, spoon)	LS		1,500.00
2.	LPG connection	LS		5,000.00
	Expenditure (A)			**6,500.00**
B.	**Recurring**			
1.	Fish	1.5 kg	180 kg^{-1}	270.00
2.	Potatoes	500 g	25 kg^{-1}	12.50
3.	Garlic	30 g	120 kg^{-1}	3.60
4.	Ginger	30 g	80 kg^{-1}	2.40
5.	Green chillies	20 g	100 kg^{-1}	2.00
6.	Onion	300 g	25 kg^{-1}	7.50
7.	Corn flour	60 g	50 kg^{-1}	3.00
8.	Salt	25 g	10 kg^{-1}	0.25
9.	Eggs	10 nos.	5/no	50.00
10.	Bread crumbs	250 g	20 /200g	25.00
11.	Black pepper powder	6 g	175/100g	10.50
12.	Turmeric powder	6g	25/100 g	1.50
13.	Garam masala	6 g	70/100 g	4.20
14.	Mustard oil	300 ml	110/litre	22.00
15	LPG cylinder	1 no	640/refill	20.00
	Expenditure (B)			**434.45**
	(A: Depreciation cost, 15 years))			**433.30**
	Total Expenditure (A+B)			**867.75**
	Total income from fish cutlets	75 nos	25/no	**1,875.00**
	Net Income			**1,007.25**
	B:C ratio			**2.16**

8.05 PREPARATION OF VALUE ADDED FISH PRODUCT (FISH SEVU)

Fish sevu is a popular snack in many states of India. By adding fish mince, the amount of protein content can be increased as fish is good source of animal protein. Especially children are very fond of this type of product which will ultimately help in increasing the intake of animal protein and provides many health benefits. Shelf life of the fish sevu is 3 months at room temperature.

8.05.01 Materials used:

1. Fish meat
2. Rice flour
3. Bengal gram flour
4. Ginger
5. Garlic
6. Chilli powder
7. Soda
8. Salt
9. Molding machine
10. Polyethylene bags

8.05.02 Recipe:

Sl. No.	Ingredients	Quantity
1.	Fish meat	500 g
2.	Rice flour	300 g
3.	Bengal gram flour	200 g
4.	Ginger paste	5 g
5.	Garlic paste	5 g
6.	Red chilli powder	10 g
7.	Soda	5 g
8.	Salt	13 g
9.	Mustard oil	1 litre

8.05.03 Procedure:

Boil the fish meat and make a paste

↓

Add rice flour, Bengali gram flour, ginger paste, garlic paste, red chilli powder, salt and soda in it

Make dough of required consistency

↓

Add the dough in molding machine and directly fry the sevu

↓

Allow the sevu to cool at room temperature and then pack in air tight polyethylene bags

↓

Store it in dry place at normal temperature

8.05.04 Economics:

Sl. No.	Ingredients	Quantity	Rate (Rs.)	Amount (Rs.)
A.	**Non recurring**			
1.	Molding machine	1no.	450.00/no	450.00
2.	Sealing machine	1no.		600.00
3.	Utensils (Pan)	LS		1,000.00
	Expenditure (A)			**2,050.00**
B.	**Recurring**			
1.	Fish meat	1000 g	180.00 kg^{-1}	180.00
2.	Rice flour	600 g	35 kg^{-1}	21.00
3.	Bengal gram flour	500 g	140 kg^{-1}	70.00
4.	Ginger	15 g	80 kg^{-1}	1.20
5.	Garlic	15 g	120 kg^{-1}	1.80
6.	Red chilli powder	20 g	30.00/100 g	6.00
7.	Soda	10 g	50 kg^{-1}	0.50
8.	Salt	25g	10 kg^{-1}	0.25
9.	Mustard oil	1.5 lit	110 l^{-1}	165.00
10	Polyethylene bags	100g	200 kg^{-1}	20.00
	Expenditure (B)			**465.75**
	(A:Depreciation cost, 15 years)			**136.70**
	Total Expenditure (A+B)			**602.45**
	Total income from fish sevu	2 kg	55.00/ 100g	**1100.00**
	Net Income			**497.55**
	B:C ratio			**1.82**

Appendix-A

Photographs of Cultivable Fish Species of Assam with their common/Local names

Scientific Name: *Labeo rohita*
Common name: Rohu/Row/Rau

Scientific Name: *Catla catla*
Common name: Bhakua/Bahu/Dhekera

Scientific Name: *Cirrhinus mrigala*
Common name: Mirika

Scientific Name: *Hypophthamichthys molitrix*
Common name: Silver Carp

Scientific Name: *Ctenopharyngodon idella*
Common name: Grass Carp

Scientific Name: *Cyprinus carpio* Var. *communis*
Common name: Common Carp

Scientific Name: *Puntius javanicus*
Common name: Java puthi

Scientific Name: *Labeo bata*
Common name: Bhangon/Naro/Bango

Scientific Name: *Labeo gonius*
Common names: Kurhi/Kuria

Scientific Name: *Clarias magur*
Common name: Magur

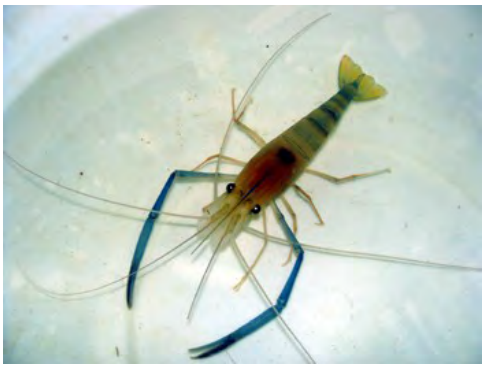
Scientific Name: *Anabas testudineous*
Common name: Koi/Kawai

Scientific Name: *Heteropneustes fossilis*
Common name: Singhi

Scientific Name: *Puntius sarana*
Common name: Cheni Puthi, Muraputhi, Bhokaputhi

Scientific Name: *Chitala chitala*
Common name: Chital

Scientific Name: *Notopterus notopterus*
Common name: Kandhuli



Scientific Name: *Macrobrachium rosenbergii*
Common name: Misha maach

APPENDIX-B

MODEL BANKABLE PROJECTS

I. Title of the Project: FISH PRODUCTION THROUGH ADOPTION OF COMPOSITE FISH CULTURE

Sl. No	Particulars	Information furnished by the applicant
1	Name of the applicant S/o D/o W/o	
2	Address for communication Telephone/mobile:	
3	Details of land where fish culture activity is proposed to be taken up: Enclose land title document	
	i) Name of the revenue village	
	ii) Name of block	
	iii) P.O	
	iv) Dist. -	
	v) Pond/s area (in ha):	1.3 ha
	vi) Total water spread area (in ha):	1.0 ha
	vii) Whether assistance for this purpose has been obtained under any other scheme of the Central/ State Government? If so, please provide details:	
	viii) Detailed estimate for the proposed scheme	Enclosed
	ix) Estimates regarding input costs and economics of operations, certified by a Fisheries professional: Enclose	
	x) Source of funds: Bank loan – Enclose bank consent letter	
4	Total project cost	**Rs.12, 06, 500.00**
5	Bank loan (80%)	**Rs. 9, 65,000.00**
6	Margin money (20%)	Rs. 2,41,500
7	Rate of interest (%)	10
8	Repayment period (years)	5

1. Introduction

Culture of several compatible carp species of different feeding types and modes together in an aquatic system aiming at fuller utilisation of productivity at all ecological niches is called composite carp culture. Carp culture is a highly economic and profitable enterprise. Among many fish farming practices, the composite fish culture is one which can be adopted by common fish farmers easily. The common practice of composite culture includes 6 species of carps (3 indigenous- Catla, Rohu, Mrigal, and 3 exotic fishes- Silver carp, Grass carp and Common carp).

2. Techno-economic parameters:

Total area of the fish farm	:	1.30 ha (10 bighas)
Total water spread area of fish pond	:	**1.00 ha**
Type of fish culture	:	Semi-intensive carp culture

Technical programme:

a) Construction of pond:

- Pond should be constructed as per engineering guidelines depending on the topography and agro-climatic condition of the area.
- Shape : Rectangular
- Depth: 2.5 to 3.0 m depth with capacity of holding at least 1.5 m water depth throughout the year maintainig proper side slope and strong embankment

b) Pond Management: Pond Management plays a very important role in fish farming before and after the stocking of fish seed. Various measures that are required to be undertaken in pre and post stocking practices are-

i) Pre stocking-

Application of lime: The soils which are acidic in nature are less productive than alkaline ponds. Lime is used to bring the pH to the desired level, to kill the germs of parasites, to increase mineralization process etc.

- Dry bottom is treated with powdered lime. In case of water filled ponds, lime is dissolved in water in a container and dispersed over the water surface.
- Lime should be applied in split-up dose. One third of total quantity is applied during pond preparation either on the dry bottom or in water after ploughing or bottom raking as the case may be.
- The remaining quantity of the lime is applied in equal monthly installments.

Application of Fertilizer/Manure:

Fertilization should be done after 7-10 days of lime application. Manuring should be done with cowdung, poultry manure, pig dung etc. Inorganic fertilization should be done with Urea and SSP at proper dose depending on productivity status of soil. Inorganic fertilization is done after 7-10 days of organic fertilization. The fertilization programme has to be suitably modified depending on the physic-chemical conditions of the pond and climatic conditions.

ii) Stocking:

Ponds are generally stocked with 8000-10000 fingerlings (10-15 cm) or carried over seeds of carps of different species at proper ratio and numbers. Species combination under six species of carp culture should be as –

Sl. No.	Species	Percent composition	Nos. ha^{-1}
1.	Silver carp	15	1500
2.	Catla	25	2500
3.	Rohu	25	2500
4.	Grass carp	10	1000
5.	Mrigal	15	1500
6.	Common carp	10	1000
		Total =	10,000.00

Combination with Minor carps, Barbs and Magur can also be adopted by the entrepreneurs as recommended in POP.

iii) Post stocking

Feeding: Supplementary feeding is done with rice polish and mustard oil cake at the ratio of 1:1.

Health monitoring**:** Fish health should be monitored at regular interval and proper water quality should be maintained either with the help of POP or in consultation with fishery experts

Fertilization: Application of lime, organic and inorganic fertilizer should be done at regular interval depending on soil and water test.

Harvesting**:** Harvesting is generally done at the end of 1 st year, when the fishes attain average weight of 800 g to 1.25 kg. With Proper management a production of 4-5 t ha^{-1} can be obtained in a year.

The recommended POP given at Package-2 (Composite fish culture) should be followed to know the technology in details.

Net cash investment of the project

A. Capital Cost:

i)	Pond construction (Earthwork for deepening the pond 6 feet and depositing the excavated soil in the embankment all around the pond maintaining the side slope 1:1.5)		9,50,000.00
ii)	Fishing gear (nylon net)	2 nos	10,000.00
iii)	Water pump 5 HP including electricity connection	1 no.	40,000.00
	Sub-total :		**10, 00,000.00**

B. Recurring Expenditure

Items	Amount	Unit cost(Rs)	Total cost (Rs)
i)Lime (Quick lime)	1000kg	15.00	15000.00
ii) Raw cowdung	10000 kg	0.60	6000.00
iii)Urea	250 kg	10.00	2500.00
iv)SSP	350 kg	10.00	3500.00
v) Fingerlings (3")	10000 nos.	3.00/no.	30000.00
vi) Supplementary feed:			
Rice polish	2150 kg	10.00	21500.00
Mustered oil cake	2150 kg	20.00	43000.00
vi) Vitamin/minerals	50 kg	140.00	7000.00
vii) Labour	1	200/mandays	73,000.00
viii) Miscellaneous			5000.00
Sub-total:			**2, 06,500.00**

Total net cash investment of the project (A+B) = Rs. 12, 06, 500.00

ECONOMIC ANALYSIS OF THE PROJECT

C) Annual investment

Fixed capital cost

Items	Actual cost (Rs)	Economic life (Years)	Annual depreciation (Rs)	Annual **interest@10%** (Rs)
Earthwork	9, 50,000	20	47,500	95,000
Fish gears	10,000	5	2000	1000
Water pump	40,000	16	2500	4000
	10, 00,000		**52,000**	**1,00,000.00**

a) Annual depreciation on fixed capital cost : Rs. 52,000.00

b) Annual interest on fixed capital cost : Rs. 1,00,000.00

c) Annual variable recurring cost : Rs. 2, 06,500.00

d) Annual interest on working capital@ 7 % : Rs. 20,650.00

Total Annual investment **:** Rs. 3, 79,150

Say, Rs. 3,79,000.00

D) Annual Turnover

Sale of 4500 kg fish @ Rs.150.00 kg^{-1} **: Rs 6,75,000.00**

E) Annual profit **: Rs.3,70,000.00**

F) Percentage return to annual investment **: 78.10**

G) Profit to turnover **: 43.85**

H) Cost of production per kg fish **: Rs.84.22**

CASH FLOW ANALYSIS

Sl. No	Particulars	Year				
		1	2	3	4	5
1	**Cost**					
	Capital cost	10,00,000	-	-	-	-
	Recurring cost	2,06,500	2,06,500	2,06,500	2,06,500	2,06,500
	Total cost	**12,06,500**	**2,06,500**	**2,06,500**	**2,06,500**	**2,06,500**
2	**Benefit/income**	6,75,000	6,75,000	6,75,000	6,75,000	6,75,000
3	Net Benefit/income	-5, 31,500	4,68,500	4,68,500	4,68,500	4,68,500
4	Discounted Factor @15%	0.870	0.756	0.658	0.572	0.497
5	Discounted cost @15%	10,49,655	1,56,114	1,35,877	1,18,118	1,02,630
6	Discounted benefit @15%	5,87,250	5,10,300	4,44,150	3,86,100	3,35,475
7	NPV @ 15%	7,00,881				
8	BCR @15%	1.45				
9	IRR	79.69%				

The project appraisal tools – NPV, BCR and IRR clearly indicated that the scheme is financially viable and can be considered for bank loan.

ESTIMATED BANK LOAN AND REPAYMENT SCHEDULE

Total investment of the project : **Rs.12, 06, 500.00**

Composite Term Loan (80%) : Rs 9, 65,200.00

Say : Rs. 9, 65,000.00

Repayment schedule : 5 years at 10% interest per anum

Year	**Bank loan**	**Gross surplus**	**Yearly repayment to bank(Rs)**			**Surplus**
			Principal	Interest	Total	
1	9, 65,000	6,75,000	1,93,000	96,500	2,89,500	3,85,500
2	7,72,000	6,75,000	1,93,000	77,200	2,70,200	4,04,800
3	5,79,000	6,75,000	1,93,000	57,900	2,50,900	4,24,100
4	3,86,000	6,75,000	1,93,000	38,600	2,31,600	4,43,400
5	1,93,000	6,75,000	1,93,000	19,300	2,12,300	4,62,700
		33,75,000	9, 65,000	2,89,500	12,54,500	21,20,500

This tentative estimate is given as a guideline for making choice depending upon the resource availability of the entrepreneur. The data provided in the above project are for reference purpose only and uses standard assumptions. For customized project report one can contact fisheries experts and bank personnel.

Prepared by----

Declaration by the Applicant

I …… …… …….. ..... son/daughter/wife of …… …… …… …… ……hereby declare that the information furnished above is true to the best of my knowledge and belief. I am fully aware that if it is found that the information furnished in the application is false or there is any kind of deviation/violation of the conditions under which assistance is provided to me by the Bank, any action as deemed fit for violation of this condition may be taken against me.

Date: Place: Signature of the applicant

II. Title of the Project: SEED PRODUCTION OF CARPS THROUGH CHINESE CIRCULAR HATCHERY/ ECO-HATCHERY

Sl. No	Particulars	Information furnished by the applicant
1	Name of the applicant S/o D/o W/o	
2	Address for communication Telephone/mobile:	
3	Details of land where fish culture activity is proposed to be taken up: Enclose land title document i) Name of the revenue village ii) Name of block iii) P.O iv) Dist. - v) Pond/s area (in ha): vi) Total water spread area (in ha): vii) Whether assistance for this purpose has been obtained under any other scheme of the Central/ State Government? If so, please provide details: viii) Detailed estimate for the proposed scheme ix) Estimates regarding input costs and economics of operations, certified by a Fisheries professional: Enclose x) Source of funds: Bank loan – Enclose bank consent letter	
4	Total project cost	**Rs. 32,50,000.00**
5	Bank loan (80%)	**Rs. 26,00,000.00**
6	Margin money (20%)	Rs. 6,50,000
7	Rate of interest (%)	10
8	Repayment period (years)	5

Introduction

Carp seed production in commercial scale is one of the economically promising enterprises for the North East Region. With the growing requirement for quality carp seed, there is increasing need for establishment and expansion of fish seed production farm in the region to meet the demand. Proper planning along with calculative step for scientific designing and construction of a fish seed production farm is very important for developing it as a productive and economically sustainable enterprise.

Techno-economic parameters:

A hatchery is the most vital component of modern fish farm. The main components of the hatchery are-

1. Overhead tank
2. Circular tank/pool
3. Hatching tank/pool
4. Spawnery

Technical programme

The detailed technical programme for construction of hatchery components and management should be followed as given in package – 1

1. Production economics of Chinese Eco-hatchery

(For production of carps spawn)

A. Capital Cost

Item	Cost(Rs.)
1. Construction of eco hatchery complex including- ix. Circular breeding pool of 8 m diameter x. 3 Hatching pools of 3m diameter xi. Overhead tank of 5000 gallons capacity xii. Shallow tube well 8"x 6"x200' xiii. Pumpset (5HP) xiv. Brood stock pond, Nursery pond, Rearing pond xv. Brood stock-5 tonnes xvi. Contingent expenses for nets, equipments, hapas etc.	15,00,000.00

B. Recurring cost

For seed production (upto spawn stage)

i.	Feeding of brood stock (5000kg) @ 2% body weight for 90 days @Rs. 30/kg of feed (100kg feed X 90 days X Rs. 30/kg feed)	2,70,000.00
ii.	Synthetic Hormone required for 5000kg fish=1250 ml @ Rs. 400/10ml	50,000.00
iii.	POL @ Rs. 1500/operation for 50 operation	LS 75,000.00
iv.	Worker, 750 mandays @ Rs. 200	1,50,000.00
v.	Miscellaneous including packing materials	80,000.00
vi.	Depreciation over the capital cost @ 5%	75,000.00
	Total cost	**7,00,000.00**

Production per operation = 40 lakh spawn
Production from 50 operation =2000 lakh spawn
Revenue earn selling spawn @ Rs. 600/lakh = Rs. 12,00,000.00
Total operational cost = Rs. 7,00,000.00
Profit: Rs.12, 00,000.00 – Rs. 7,00,000.00 = Rs. 5, 00,000.00
Profit over operational cost = 71.43%

CASH FLOW ANALYSIS

Sl. No	Particulars	Year				
		1	2	3	4	5
1	**Cost** Capital cost	15,00,000	-	-	-	-
	Recurring cost	7,00,000	7,00,000	7,00,000	7,00,000	7,00,000
	Total cost	**22,00,000**	7,00,000	7,00,000	7,00,000	7,00,000
2	**Benefit/income**	12,00,000	12,00,000	12,00,000	12,00,000	12,00,000
3	Net Benefit/income	-1000,000	5,00,000	5,00,000	5,00,000	5,00,000
4	Discounted Factor @15%	0.870	0.756	0.658	0.572	0.497
5	Discounted cost @15%	1913043	530303	460526	400000	348258
6	Discounted benefit @15%	1043478	909091	789474	685714	597015
7	NPV @ 15%	372642				
8	BCR @15%	1.10				
9	IRR	34.90%				

ESTIMATED BANK LOAN AND REPAYMENT SCHEDULE

Total investment of the project : **Rs.22,00,000.00**

Composite Term Loan (80%) : **Rs.17,60,000.00**

Repayment schedule : 5 years at 10% interest per annum

Year	**Bank loan**	**Gross surplus**	**Yearly repayment to bank(Rs)**			**Surplus**
			Principal	Interest	Total	
1	17,60,000	12,00,000	3,52,000	1,76, 000	5,28,000	6,72,000
2	14,08,000	12,00,000	3,52,000	1,40,800	4,92,800	7,07,200
3	10,56,000	12,00,000	3,52,000	1,05,600	4,57,600	7,42,400
4	7,04,000	12,00,000	3,52,000	70,400	4,22,400	7,77,600
5	3,52,000	12,00,000	3,52,000	35,200	3,87,200	8,12,800

This tentative estimate is given as a guideline for making choice depending upon the resource availability of the entrepreneur. The data provided in the above project are for reference purpose only and uses standard assumptions. For customized project report one can contact fisheries expert and bank personnel.

Prepared by----

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Date: Place: Signature of the applicant

III. Title of the Project: INTEGRATED PADDY- FISH CULTURE

Sl. No	Particulars	Information furnished by the applicant
1	Name of the applicant S/o D/o W/o	
2	Address for communication Telephone/mobile:	
3	Details of land where fish culture activity is proposed to be taken up: Enclose land title document i) Name of the revenue village ii) Name of block iii) P.O iv) Dist. - v) Pond/s area (in ha): vi) Total water spread area (in ha): vii) Whether assistance for this purpose has been obtained under any other scheme of the Central/ State Government? If so, please provide details: viii) Detailed estimate for the proposed scheme ix) Estimates regarding input costs and economics of operations, certified by a Fisheries professional: Enclose x) Source of funds: Bank loan – Enclose bank consent letter	
4	Total project cost	**Rs. 3,45,835.00**
5	Bank loan (80%)	**Rs. 2,76,000.00**
6	Margin money (20%)	**Rs. 69,835.00**
7	Rate of interest (%)	10
8	Repayment period (years)	5

1. Introduction

Type of integration considered for this project **is Perennial system of rice-fish farming.** In perennial rice fish farming system, a single crop of fish is raised along with two crops of paddy viz. *Ahu* & *Sali* covering nearly both the seasons. The system is particularly suitable for very low lying areas. Excavation of a big pond or a trench and construction of a perimeter dyke both covering around 1/3rd of the total plot area are distinctive features for plot renovation under this system

2. **Techno-economic parameters:**

Perimeter trench model is considered for this project. In this design a perimeter trench is dug and the earth excavated is used to further elevate the middle plot and for construction of a dyke at the outer periphery of the trench. The size of the trench should be

one-fifth of the plot area. The depth of the trench should be kept at 1.2m, but may be increased depending on land situation.

The area for the perimeter dyke base is to be kept within the range from 1/8th to 1/9th of the plot area. The height of the dyke should be minimum 1m, but may be increased depending on the inundation level of the plot. Land allocation and design is given below.

- ❖ Total area of the plot (100 m ×100 m) : 1 ha

- ❖ Trench:

Total length of the perimeter trench	: 352 m
Top width	: 6 m
Bottom width	: 3.6 m
Depth of the trench	: 1.2 m
Total trench area (6 m × 352 m)	: 0.21 ha

- ❖ Dyke:

Total length of the dyke	: 388 m
Base width	: 3 m
Crest width	: 1 m
Average height	: 1 m
Total dyke area (388 m × 3m)	: 0.12 m

- ❖ Paddy plot:

Breadth of the paddy plot	: 82 m
Total paddy area (82 m × 82 m)	: 0.67 ha

Technical programme:

Paddy cultivation

Paddy is grown in about 2/3rd area of the plot. The normal crop sequence of Assam i.e. *Ahu* followed by *Sali* can be practiced..

Fish culture

Three species of IMC (Rohu, Catla and Mrigal) two species of exotic carps (Silver carp and Common carp) are reared in this system. Minor carps like bata (*L. bata*) and other fishes like tawes (*P. javanicus*) may also be stocked along with it.

The package of practices for both the crops as recommended in the POP should be adopted.

Paddy cultivation area	**: 0.67 ha.**
Trench and dyke area	**: 0.33 ha.**
Total cultivable area	**: 1.0 ha**

4. Net cash investment of the Project

A. Capital Cost

Sl. No.	Item	Total Expenditure (Rs)
i	Plot preparation: Earthwork in excavation for construction of perimeter trench and depositing the excavated earth in the form of bundh all around the paddy plot maintaining sideslope1: 1.5	2,15,000.00
ii	Construction of a bamboo bridge	5,000.00
	Total	**2,20,000.00**

B.Variable Cost

Sl. No.	Head of expenditure	Qty./No.	Rate (Rs.)	Cost (Rs.)
1	Ahu crop	-	-	7000.00
2	Sali crop	-	-	7000.00
3	Agril.lime	340 kg	7 kg^{-1}	2380.00
4	Fish seed	7700 no	5 each	38,500.00
5	Cowdung	925kg	0.6 kg^{-1}	555.00
6	Urea	20 kg	10 kg^{-1}	200.00
7	SSP	16 kg	10 kg^{-1}	160.00
8	Mustard oil cake	1720kg	20 kg^{-1}	34,400.00
9	Rice Polish	1720 kg	10 kg^{-1}	17,200.00
10	Harvesting cost	-	-	5000.00
11	Misc. expenditure	-	-	2000.00
	Total			Rs. 1,14,395.00
	Interest		10.0%	Rs. 11,440.00
	Total variable cost			**Rs. 1,25,835.00**

Total net cash investment of the project = Rs. 2,20,000.00+ Rs. 1,25,835.00
= Rs. 3,45,835.00

ECONOMIC ANALYSIS OF THE PROJECT

- **Estimation of annual Fixed capital cost**

Sl. No.	Item	Actual cost (Rs)	Economic life (in years)	Annual depreciation (Rs)	Annual interest (10%)
i	Pond preparation	2,15,000.00	20	10,750.00	21,500.00
ii	Construction of a bamboo bridge	5,000.00	5	1000.00	11000.00
	Total	**2,20,000.00**		**11,750.00**	**32,500**

C) Annual investment

a) Annual depreciation on fixed capital cost : Rs. 11,750.00
b) Annual interest on fixed capital cost : Rs. 32,500.00
c) Annual variable recurring cost : Rs.1, 25,835.00
d) Annual interest on working capital@ 10% : Rs. 12,583.00
Total Annual investment : Rs. 1,82,668.00
Say= Rs.1,82,700.00

D) Annual Turnover/Income

Sl. No.	Product	Rate (Rs. Kg^{-1})	Turn Over
Paddy	3760kg	11.25 kg^{-1}	Rs. 42300.00
Hay	4350kg	2.00 kg^{-1}	Rs. 8700.00
Fish	1450kg	120 kg^{-1}	Rs. 1,74,000.00
Total			**Rs, 2,25,000.00**

E. Net Income (D – C): Rs. 42,300.00

SUMMARY

a) Annual turnover : Rs. 2,25,000.00
b) Annual investment : Rs.1,82,700.00
c) Annual profit : Rs. 42,300.00
d) Percentage returns on annual investment : 23.15%
e) Profit to turnover : 18.8%

CASH FLOW ANALYSIS

Sl. No	Particulars	Year				
		1	2	3	4	5
1	**Cost**					
	Capital cost	2,20,000.00	-	-	-	-
	Recurring cost	1,25,835.00	1,25,835.00	1,25,835.00	1,25,835.00	1,25,835.00
	Total cost	**3,45,835.00**	1,25,835.00	1,25,835.00	1,25,835.00	1,25,835.00
2	**Benefit/income**	2,25,000.00	2,25,000.00	2,25,000.00	2,25,000.00	2,25,000.00
3	Net Benefit/income	-1,20,835.00	99,165.00	99,165.00	99,165.00	99,165.00
4	Discounted Factor @15%	0.870	0.756	0.658	0.572	0.497
5	Discounted cost @15%	3,00,876.00	95,131.00	82,800.00	71,978.00	62,540.00
6	Discounted benefit @15%	1,95,750.00	1,70,100.00	1,48,050.00	1,28,700.00	1,11,825.00
7	NPV @ 15%	1,41,100.00				
8	BCR @15%	1.23				
9	IRR	72.88 %				

The project appraisal tools – NPV, BCR and IRR clearly indicated that the scheme is financially viable and can be considered for bank loan.

ESTIMATED BANK LOAN AND REPAYMENT SCHEDULE

Total investment of the project : **Rs. 3,45,835.00**

Composite Term Loan (80%) : Rs 2,76,668.00

Say : Rs. 2,76,000.00

Repayment schedule : 5 years at 10% interest per annum

Year	Bank loan	Gross surplus	Yearly repayment to bank(Rs)			Surplus
			Principal	Interest	Total	
1	2,76,000	2,25,000	55,200	27,600	82,800	1,42,200
2	2,20,800	2,25,000	55,200	22080	77,280	1,47,720
3	1,65,600	2,25,000	55,200	16560	71,760	1,53,240
4	1,10,400	2,25,000	55,200	11040	66,240	1,58,760
5	55,200	2,25,000	55,200	5520	60,720	1,64,280

This tentative estimate is given as a guideline for making choice depending upon the resource availability of the entrepreneur. The data provided in the above project are for reference purpose only and uses standard assumptions. For customized project report one can contact fisheries expert and bank personnels

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Date: Place: Signature of the applicant

IV. Title of the Project: INTEGRATED PIG-FISH-HORTICULTURAL CROP PRODUCTION

Sl. No	Particulars	Information furnished by the applicant
1	Name of the applicant S/o D/o W/o	
2	Address for communication Telephone/mobile:	
3	Details of land where fish culture activity is proposed to be taken up: Enclose land title document i) Name of the revenue village ii) Name of block iii) P.O iv) Dist. - v) Pond/s area (in ha): vi) Total water spread area (in ha): vii) Whether assistance for this purpose has been obtained under any other scheme of the Central/ State Government? If so, please provide details: viii) Detailed estimate for the proposed scheme ix) Estimates regarding input costs and economics of operations, certified by a Fisheries professional: Enclose x) Source of funds: Bank loan – Enclose bank consent letter	
4	Total project cost	**Rs.10, 53, 400.00**
5	Bank loan (80%)	**Rs.8, 42,720.00**
6	Margin money (20%)	**Rs. 2,10,680.00**
7	Rate of interest (%)	10
8	Repayment period (years)	5

1. Introduction

In this system, fish farming is done using pig dung and spilled feed; silt of the pond bottom deposited due to continuous addition of pig manure is used as the manure for growing seasonal vegetables, banana, tapioca, arhar, lemon, dhaincha and fodder crops etc. on pond embankments, slopes and the open spaces of the farm. Bio-wastes of these crops are used in pig and fish farming directly as well as indirectly.

2. **Techno-economic parameters:**

Total area of the fish farm	:	0.75 ha
Total water spread area of fish pond	:	0.5 ha

3. Technical programme:

3.1 Construction of ponds and pigsty

Construction of ponds and pigsty should be done according to the Package of Practices -

3.2Fish Husbandry

Species: Catla, rohu, mrigal, silver carp, grass carp, common carp, magur and feather-backs (to be used as biological agent to control weed fishes).

Size: Not less than 12.0 cm. Magur not less than 5.0 cm. Major carps stunted seeds of previous year are preferred.

Number: Stocking rate 9000-10000 nos. ha^{-1} for yearly harvesting system. Magur up to 5% of the total density.

Species composition:

Species	Percentage
Catla	20
Rohu	25
Mrigal	20
Grass carp	10
Silver carp	20
Common carp	5

Stocking:

Stocking after 10-12 days of application of liquid pig dung,when water takes slight greenish colour. Silver carp should stock after one month of stocking of other carps, particularly catla. Stocking should preferably be done in March-April, however with a minimum water depth of 1.5 m.

Water Management: Water quality parameters should be properly managed as given in POP

Harvesting: Partial harvesting of silver carp and grass carp can be done after 6-7 months.

Others with 600-750 g weight can also be harvested. Final harvesting should be done on the 12th

3.3Pig Husbandry

Breed: Hampshire, Large black, Landrace, Large white Yorkshire are suitable. Crossed varieties are better for fattening. For breeding, the boar should preferably be of pure breed.

Age: 2-3 months old weaned piglets, average weight not less than 12.0 kg for fattening. For breeding, 5-6 months old female juveniles, 7-8 months old boar. The boar should not be procured from the same farm.

Number:

(i) 40-45 piglets ha^{-1} water area for six months fattening.

(ii) 30 (Female) + 6 (male) = 36 pigs ha^{-1} initially for breeding farm.

Rearing of pigs for fattening:

The first batch is introduced at least 15 days ahead of stocking of the pond. After 6 months when they attain slaughter maturity of 60- 70 kg are disposed. Necessary repairing of the pigsty is done and the second batch is brought in. Pigsty should be properly disinfected and kept vacant for 15-20 days.

Pig feed:

Pigs can be fed with balanced pig mash concentrate (PMC). The composition of the PMC:

Ingredient	Amount (kg)
Rice bran	30
Rice polish	15
Wheat bran	27
Maize broken	10
Ground nut oil cake	10
Fish meal	4
Mineral mixture	3
Common salt	1
Total	**100**

Feeding should be done as per the POP given.

Health Care: Proper health care should be maintained as given in the POP

Harvesting: Every six months when average weight reaches 60-70 kg.

3.4 Horticultural crop farming:

Most preferred horticultural crops are banana, lemon, tapioca, papaya, arhar, dhaincha and fodders like hybrid napier and paragrasss in addition to the seasonal cash crops. Expert aid for raising these crops may be obtained from horticulturists. Pond silt will be available only when old ponds are renovated, otherwise cultivation is to be started with extraneous supply of organic manure and inorganic fertilizers. Once pond silt becomes available, cultivation can be done using only pond silt.

4. Net cash investment of the Project

A. Capital Cost

Sl. No.	Item	Total Expenditure (Rs)
i	Pond construction.	4,75,000.00
ii	Construction of the pigsty for 23 pigs	1,10,000.00
iii	Purchasing of a readymade drag net.65 m x 5 m x3cm.	10,000.00
iv	Purchasing of a water pump 5 HP including electricity connection	40,000.00
v	Setting of a deep tube well.	18,000.00

vi	Purchasing of a cooking vessel, made of cast iron.	1,200.00
vii	Construction of a concrete feed mixing tub(1.5 m x 1.0 m x 0.45 m)	5,600.00
viii	Construction of a quarantine room(3.0 m x 2.25 m.)	8,000.00
ix	Purchasing of a wooden *thela*	3,500.00
	Total	**6,71,300.00** **Say Rs.6,71,000.00**

B. Recurring Expenditure

(a) For fish and horticultural crop farming

Sl. No.	Item	Unit	Actual requirement	Rate (Rs)	Expenditure (Rs)
i	Carp fingerlings	No.	4,500	5.00/ seed	22,500.00
ii	Magur seeds	No.	225	7.00/ seed	1,575.00
iii	Feather-backs	No.	50 x 0.05 kg = 2.50 kg	150.00 kg^{-1}	375.00
iv	Lime (CaO)	Kg	250	15.00 kg^{-1}	3,750.00
v	Labour charges	No.	1	200.00day^{-1}	73,000.00
vi	Partial dewatering and desilting	-	-	-	4,000.00
vii	Cost of seeds, vegetative parts of plants (such as of tapioca), banana rhizomes	-	-	-	1,000.00
	Total				**1,06,200.00**

(b) For pig farming

Sl. No.	Item	Unit	Actual requirement	Rate (Rs)	Expenditure (Rs)
i	Piglets	No.	46	2000.00	92,000.00
ii	Pig feed	Kg	21,390	8.00	1,71,120.00
iii	Vaccines, medicines, disinfectants, minor medical aids and consultation fees of veterinary expert.	-	-	-	3,500.00
iv	Repairing of pigsty	-	-	-	4,000.00

	after disposal of the first batch of pigs				
v	Cost of POL for water pump	Liter	55 (diesel) 4 (mobil)	54.00 150.00	2,970.00 600.00
vi	Repairing of the water pump and the *thela*	-	-	-	2,000.00
				Total	**Rs. 2,76,200**

i) Total Recurring cost (a +b) = Rs. 3,82,400.00

ii) **Total net cash investment of the project**

= Rs. 6,71,000.00+ Rs. 3,82,400.00

= Rs. 10, 53, 400.00

ECONOMIC ANALYSIS OF THE PROJECT

- **Estimation of annual Fixed capital cost**

Sl. No.	Item	Actual cost (Rs)	Economic life (in years)	Annual depreciation (Rs)	Annual interest (10%)
i	Pond construction.	4,75,000.00	20	23,500.00	47,500.00
ii	Construction of the pigsty for 23 pigs	1,10,000.00	20	5,500.00	11000.00
iii	Purchasing of a readymade drag net.65 m x 5 m x3cm.	10,000.00	4	2,500.00	1000.00
iv	Purchasing of a water pump. 5 HP.	40,000.00	16	1,250.00	4000.00
v	Setting of a deep tube well.	18,000.00	20	900.00	1800.00
vi	Purchasing of a cooking vessel, made of cast iron.	1,200.00	12	100.00	120.00
vii	Construction of a concrete feed mixing tub(1.5 m x 1.0 m x 0.45 m)	5,600.00	12	466.00	560.00
viii	Construction of a quarantine room(3.0 m x 2.25 m.)	8,000.00	20	400.00	800.00
ix	Purchasing of a wooden *thela*	3,500.00	5	700.00	350.00
	Total	**6,71,000.00**		**35,316.00**	**67,130.00**

C) Annual investment

a) Annual depreciation on fixed capital cost : Rs. 35, 316.00
b) Annual interest on fixed capital cost : Rs. 67,130.00
c) Annual variable recurring cost : Rs. 3,82,400.00
d) Annual interest on working capital@ 10% :Rs. 38,240.00
Total Annual investment : Rs.5,23,086.00
Say, Rs. 5,23,000.00

D) Annual Turnover/Income

Fish:

Carps, @ 3,750 kg $ha^{-1}yr^{-1}$ = 1875 kg yr^{-1} x Rs.150.00 = Rs. 2, 81,250.00
Magur, at 5% mortality and average harvest weight of 150 g = 53.5 kg x Rs.350.00
= Rs.18,725.00
Feather-backs, at 5% mortality and average harvest weight of 150 g = 7.13 kg x Rs.200.00
= Rs.1426.00

Pigs: At 5% mortality and with average
Finished weight of 70.0 kg : 3080 kg x Rs.110.00 = Rs. 3,38,800.00

Horticultural crops:

Banana: 1,500 kg x Rs. 35.00 = Rs. 52,000.00
Arhar: 150 kg x Rs. 60.00 = Rs. 9,000.00
Lemon: 1,500 nos. x Rs. 1.00 = Rs. 1,500.00
Gross income: Rs. 7,02,700.00

E) Annual profit (D- C) : Rs.1,79,700.00
F) Return over annual investment : 34.36 %
G) Profit to turnover : 25.57%

CASH FLOW ANALYSIS

Sl. No	Particulars	Year				
		1	2	3	4	5
1	**Cost**					
	Capital cost	6,71,000				
	Recurring cost	3,82,400	3,82,400	3,82,400	3,82,400	3,82,400
	Total cost	**10, 53, 400**	3,82,400	3,82,400	3,82,400	3,82,400
2	**Benefit/income**	**7,02,700**	**7,02,700**	**7,02,700**	**7,02,700**	**7,02,700**
3	Net Benefit/income	-3,50,700	3,20,300	3,20,300	3,20,300	3,20,300
4	Discounted Factor @15%	0.87	0.756	0.658	0.572	0.497
5	Discounted cost @15%	9,16,458	2,89,094	2,51,619	2,18,733	1,90,053
6	Discounted benefit @15%	6,11,349	5,31,241	4,62,377	4,01,944	3,49,242
7	NPV @ 15%	4,90,195				
8	BCR @15%	1.26				
9	IRR	83.23%				

The project appraisal tools – NPV, BCR and IRR clearly indicated that the scheme is financially viable and can be considered for bank loan.

ESTIMATED BANK LOAN AND REPAYMENT SCHEDULE

Total investment of the project : **Rs.10, 53, 400.00**

Composite Term Loan (80%) : **Rs.8, 42,720.00**

Say : **Rs.8, 42,700.00**

Repayment schedule : 5 years at 10% interest per annum

Year	**Bank loan**	**Gross surplus**	**Yearly repayment to bank(Rs)**			**Surplus**
			Principal	Interest	Total	
1	8,42,700	7,02,700	1,68,540	84,270	2,52,810	4,49,890
2	6,74,160	7,02,700	1,68,540	67416	2,35,956	4,66,744
3	5,05,620	7,02,700	1,68,540	50,562	2,19,102	4,83,598
4	3,37,080	7,02,700	1,68,540	33,708	2,02,248	5,00,452
5	1,68,540	7,02,700	1,68,540	16,854	1,85,394	5,17306

This tentative estimate is given as a guideline for making choice depending upon the resource availability of the entrepreneur. The data provided in the above project are for reference purpose only and uses standard assumptions. For customized project report one can contact fisheries expert and bank personnel.

Prepared by----

Declaration by the Applicant

I …… …… …….. ..... son/daughter/wife of …… …… …… …… ……hereby declare that the information furnished above is true to the best of my knowledge and belief. I am fully aware that if it is found that the information furnished in the application is false or there is any kind of deviation/violation of the conditions under which assistance is provided to me by the Bank, any action as deemed fit for violation of this condition may be taken against me.

Date: Place: Signature of the applicant

PACKAGE OF PRACTICES FOR CARP SEED PRODUCTION AND MANAGEMENT

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PACKAGE OF PRACTICES FOR INDUCED BREEDING, SEED PRODUCTION AND RAISING UPTO FINGERLING STAGES OF CARPS

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PACKAGE OF PRACTICES FOR BREEDING AND CULTURE OF *PUNTIUS SARANA*

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ANNEXURE A: Cultivable fish species with their common names

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ANNEXURE B: BANKABLE MODEL PROJECTS

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