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RICE-CUM-FISH FARMING SYSTEM

PACKAGE OF PRACTICES FOR INCREASING PRODUCTION

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FOREWORD

The country has a traditional system of Paddy-cum-Fish Farming practised largely in coastal paddy plots in the States of Kerala and West Bengal. But paddy-cum-fish culture in freshwater paddy fields is not in vogue in this country. There is considerable scope for this kind of production system especially in the States of West Bengal, Assam, Bihar, Eastern Uttar Pradesh as well as Orissa and Andhra Pradesh where we have extensive deep water paddy fields where only single crop using deep water paddy variety is cultivated. In order to optimise the utilisation of these resources the Central Inland Fisheries Research Institute has developed a technology specifically designed for these areas which makes it possible not only to have two paddy crops in a year but also a crop of fish. The technology developed by CIFRI facilitates cultivation of two crops of paddy @ 700-1,000 kg/ha kharif and 4,000-4,500 kg/ha rabi and a fish crop of 1,000 kg/ha.

The amnual gives various designs of paddy plots for integrated production system as well as a set of package of practices to achieve optimum production rate from this system. It is hoped that the present manual will be a useful guide to agriculturists, fish farmers, entrepreneurs, bank officials and would generate necessary fillip and interest among extension workers in the transfer of technology to users.

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PACKAGE OF PRACTICES FOR INCREASED PRODUCTION IN RICE-CUM-FISH FARMING SYSTEM

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1. INTRODUCTION

Rice-cum-fish culture practice has a long tradition in many of the South and South-East Asian countries for thousands of years. Its importance diminished after the advent of dwarf varieties of cereals and agricultural practices involving large scale application of pesticides. Integrating aquaculture with agriculture as an improved production system assures more return from unit arable land than from cultivation alone. But the integration is possible in present context only in low lying areas subject to high rainfall. This integrated system can be practised in Assam, Manipore, Tripura, West Bengal, Orissa, Northern Bihar and Eastern Uttar Pradesh as low lying water logged tracts are available convering an area of above 2.3 million hectares, the highest in the world. Normally, one crop using deep water tall variety of paddy is cultivated in these areas.

Rice-cum-fish culture system developed by CIFRI can be undertaken in redesigned plots with trenches or pools within the rice field. Under this system two crops of paddy (tall variety of rice in Kharif and high yielding variety of rice in Rabi) and a single crop of fish (covering nearly both the seasons) are raised. Package of practices developed by the CIFRI, Barrackpore on paddy-cum-fish culture are explained below.

2. SELECTION OF SITE

The site under high rainfall area(above 800 mm) but with poor drainage can be brought under this system.

Fields having almost uniform contour and high water retention capacity are preferred. Groundwater table and drainage system are important factors to be taken into consideration for slelection of paddy fields to integrate the system of fish culture.

Paddy is grown in almost all types of soil varying in texture from sandyloam to clay. The soil aggregates and in turn, the water retention capacity of plots, if required, is optimised by the application of either farm yard manure (FYM) @125 q/ha, straws of wheat and bajra or by bagasse with super-phosphate. Course textured upland soils may sometimes require puddling. Accordingly, soils are analysed and proper economic remedial measures are taken up.

3. TYPES OF RENOVATION FOR PADDY PLOT TO INTEGRATE FISH CULTURE

Renovation of the paddy plot can vary according to the land contours and topography :—

(i) **Perimeter type :** In this, the paddy growing area may be placed at the middle with moderate elevation and ground sloping on all sides into perimeter trenches to facilitate easy drainage (Text Fig. 1).

(ii) **Central pond type** : Paddy growing area is on the fringe with slopes towards the middle (Text Fig. 2).

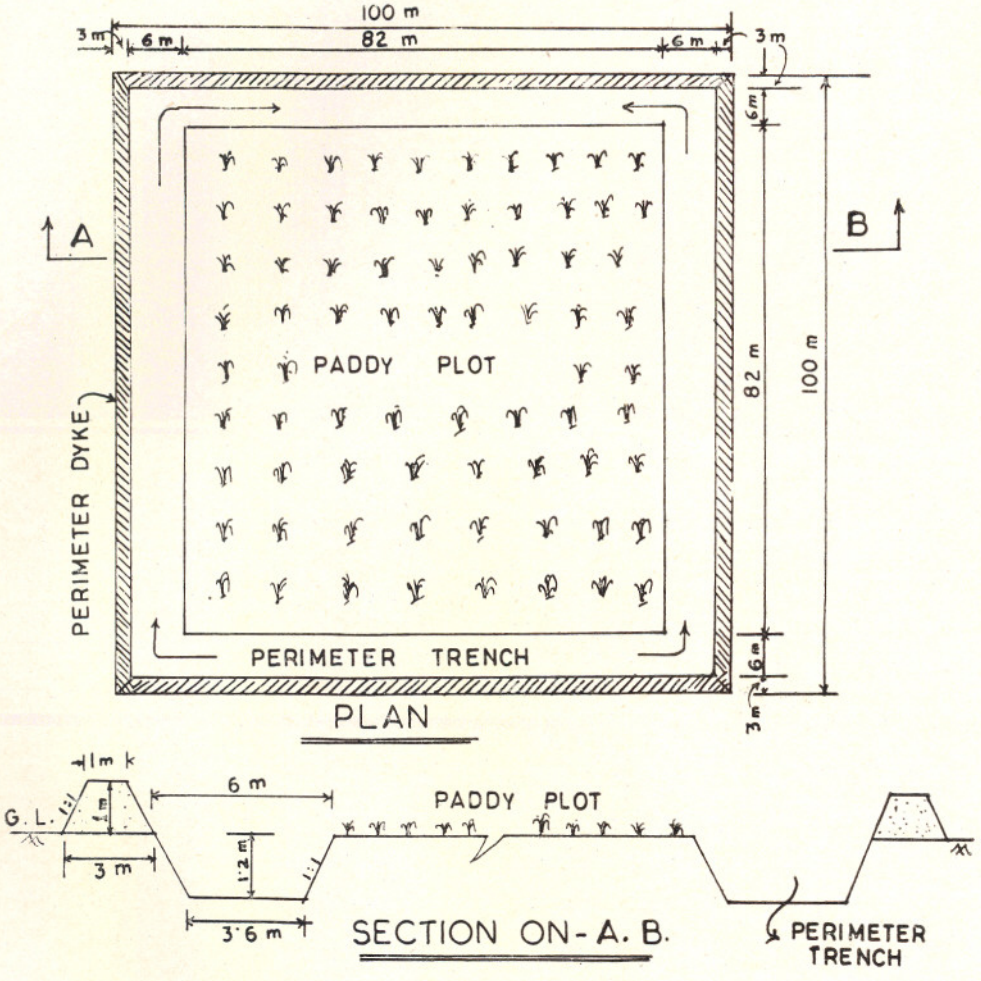
(iii) **Lateral trench type** : In this, trenches are provided on one side of the moderately sloping paddy field.

In some plots tow trenches/ponds are excavated at two sides of the plot *i. e.* North-South or East-West according to the size of the plot, Total water area of such renovation is about 1/3 of the land area (Text Fig. 3).

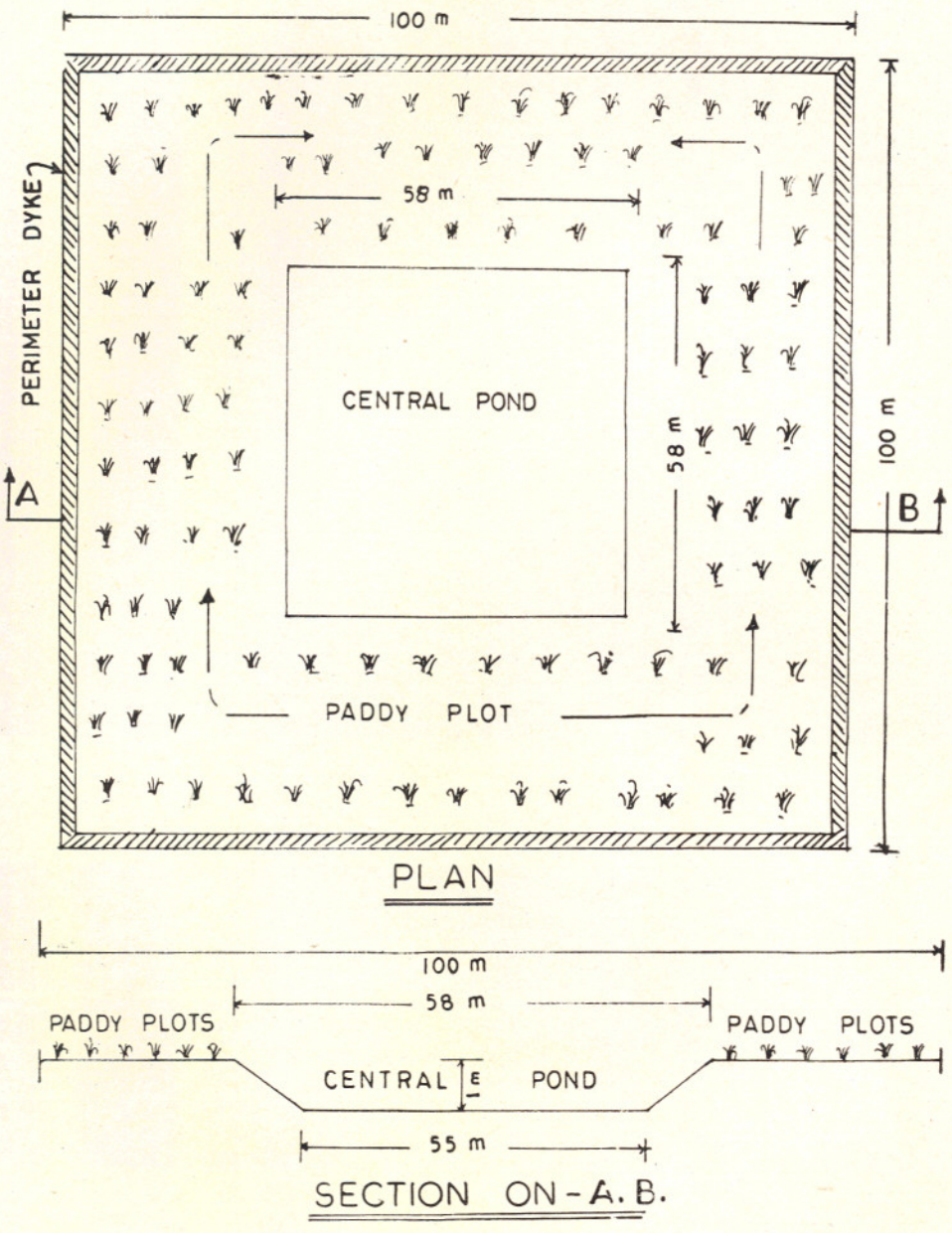
4. DESIGNS OF RENOVATED PADDY PLOTS FOR INTEGRATED FARMING

Paddy plot designing depends on the feasibility and suitability of holding water in various types of depressions within the field with minimum excavation.

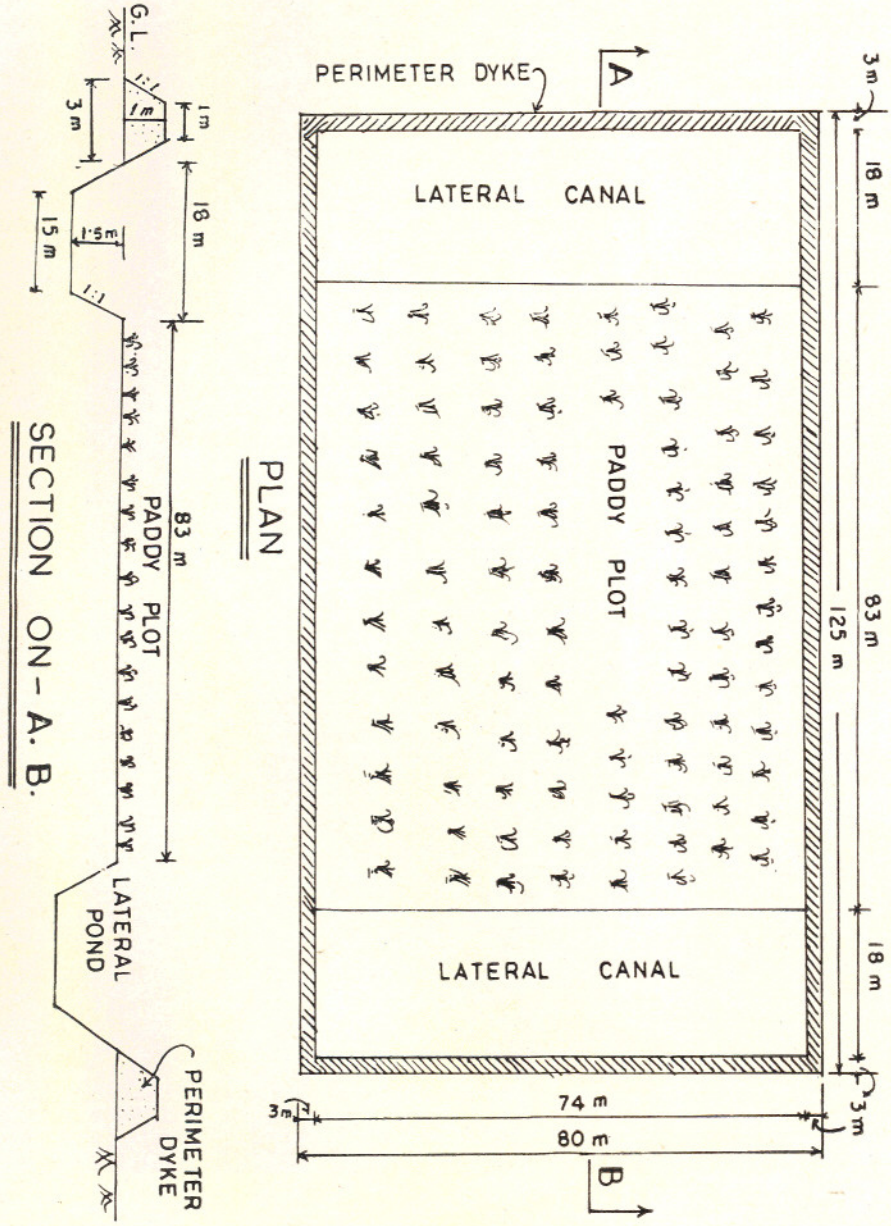
(i) **Perimeter trench system** : The design of frshwater paddy-cum-fish culture plot at Rahara Fish Farm of CIFRI incorporates the waterway trench at perimeter excavated within the plot



Design of a Paddy-cum-fish culture plot having perimeter trench system.



Design of a Paddy-cum-fish culture plot having central pond system.



Design of a Paddy-cum-fish culture plot having lateral trench system.

A sample haul of fish from perimeter canal type of paddy-cum-fish culture plot.

Transplanting Jaya variety of paddy as second crop in renovated paddy field.

Proportionate allocation of land/paddy plot under the above integrated system is as follows (Text Fig. 1) :

Total area of the plot	100 m × 100 m	=	1 ha.
Total area of land under paddy cultivation.	82 m × 82 m	=	0.67 ha.
Total area of perimeter trench	6 m × 352 m	=	0.21 ha.
Total area of perimeter dyke base	3 m × 388 m	=	0.12 ha.
(Area of perimeter dyke crest *i. e.* area under horticulture).	1 m × 388 m	=	0.04 ha.

Morphometric features of the perimeter trench and dykes are as under :—

Perimeter trench :	Top width	6 m
	Bottom width	3.6 m
	Depth (max.)	1.2 m
	Side slopes	1 : 1
	Total length	352 m

Total volume of water at full depth—2027.52 cu m.

Perimeter dyke :	Crest width	1 m
	Base width	3 m
	Height	1 m
	Side slopes	1 : 1

Trench construction : The trench may be of different size but its capacity is determined by taking into consideration the volume of the water required for fish culture and irrigation of the second crop of paddy during dry months. The trench will also hold sub-soil water in addition to rain water. A trapezoidal trench with a top width of 6 m, base width of 3.6 m and a full trench water depth of 1.2 m is ideal but may be proportionately varied according to the area of the land available, volume of water to be retained and density of fish stock to be cultured in the proposed rice-cum-fish culture system.

Dyke construction : Excavated earth from the canal has to be utilised for constructing a stable and strong perimeter dyke which should withstand the weather action. The height of the embankment should be decided by taking into consideration the inundation level of the particular area. The dyke will prevent the escape

of fish as well as inflow of pesticide washings from the adjoining paddy plots during rainy season. The outer slopes of the dyke has to be covered with turfing to check soil erosion.

(ii) **Central Pond system** : When topographical features of the plot exhibits central depression, the design for central pond type renovation of paddy plot is considered suitable. Square shaped central pond with 58 m sides and a full water depth of 1 m is sufficient to hold the stocked fish round the year for culture besides serving as a source for irrigation water during dry months.

Proportionate allocation of land/paddy plot under such integrated system is as follows (Text Fig. 2).

Total area of the plot	100 m × 100 m	=	1 ha.
Total area of land under paddy cultivation.	41. 5m × 234 m	=	0.65 ha.
Total area of central pond	58 m × 58 m	=	0.33 ha.
Total area of perimeter dyke	0.5 m × 398 m	=	0.02 ha.

Details of measurements of central pond and dyke are as under :—

Central pond	: Top measurements	58 m × 58 m
	Bottom measurements	55 m × 55 m
	Depth (Max.)	1 m
	Side slopes	1.5 : 1

Total volume of water at full depth—3194.5 cu m.

Perimeter dyke	: Crest width	20 cm
	Base width	50 cm
	Height	30 cm
	Side slopes	0.5 : 1

(iii) **Lateral trench system** : In another design adopted at CIFRI's Rahara Experimental Fish Farm plot has lateral trenches on both sides. The trenches are trapezoidal in shape with top width of 18 m, base width of 15 m and a full trench water depth of 1.5 m. The whole area is protected by stable earthen dykes on all sides.

Land allocations under the plot lay-out of 1 ha are as follows (Text Fig. 3).

Total area of the plot	125 m × 80 m =	1 ha
Total area of land under paddy cultivation	83 m × 74 m=	0.61 ha
Total area of lateral trenches	2×18 m × 74 m=	0.27 ha
Total area of perimeter dyke base	3 m × 398 m=	0.12 ha
(Area of perimeter dyke crest under horticulture).	1 m × 398 m=	0.04 ha

Details of measurements of lateral trenches and dykes are as under :—

Lateral trenches (each)	: Top width	18 m
	Bottom width	15 m
	Depth (Max.)	1.5 m
	Side slopes	1 : 1
	Length	74 m

Total volume of water at full depth—3663 cu m.

Perimeter dyke	: Crest width	1 m
	Base width	3 m
	Height	1 m
	Side slopes	1 : 1

5. PADDY CULTIVATION PRACTICES

Kharif cultivation of paddy under the present system of integrated farming is mainly monsoon dependant and the advent of monsoon in the predominantly paddy growing areas of the country varies according to geographical location, latitude and monsoon wind direction. Therefore, sowing and harvesting periods of paddy as well as fish differ to an extent in different states.

(i) Fertilization schedule

The renovated and redesigned paddy plots are enriched with FYM or compost @ 30 t/ha as a basal dose. The nutrient uptake of deep water paddy being very high, the rate of inorganic fertilizers recommended are N @ 120 kg/ha, P_2O_5 @ 60 kg/ha and K_2O @ 60 kg/ha. Nitrogen and phosphorus, both are to be applied in three phases *viz.* at planting, tilling and flowering initiation.

(ii) **Selection of deep water rice varieties**

The most promising deep water varieties chosen for different States are **PLA**-2 (Andhra Pradesh); EB-1, EB-2, Ar-1, Arc353-146 (Assam); BR-14, Jaisuria (Hishar); Ar-61-25B, Ptb 16 (Kerala), TNR-1, TNR-2 (Tamil Nadu) ;Jalamagn (Uttar Pradesh) Jaladhi-1, Jaladhi-2 (West Bengal) ; Thothabi (Manipore). In addition 'Monohorsali' variety is commonly sowed in paddy fields stocked with fish in Aasam during Kharif season.

The paddy plot is to be made ready by April-May. Having prepared the plot, deep water variety of paddy is selected for direct sowing in low lying areas after the first shower of monsoon rain. With the onset of monsoon, water starts accumulating first in the trench and then spreads over the paddy plot as the monsoon advances, making the entire area a single sheet of water. With the increase in the water column, the deep water paddy also grows rapidly keeping pace with the accumulation of water.

(iii) **Pesticide use**

No pesticide is sprayed during Kharif cultivation, due to presence of fish in the system. The Kharif crop is harvested during November/December when the water recedes leaving the paddy plot free from water. Production of deep water paddy ranging between 800 and 1200 kg/ha is achieved from Kharif cultivation.

After harvesting the Kharif crop, the same paddy plot is fertilized with 400 kg/ha of super-phostphate, 66.6 kg/ha of muriate of potash and 66.6 kg/ha of urea for cultivation of another crop of paddy during Rabi using high yielding variety of paddy *viz.*, Ratna, Jaya, Pusa etc. Seedlings grown in a specially prepared nursery bed is transplanted by January. Two more doses of urea *i. e.*, 106.6 kg/ha and 53.3 kg/ha are applied; one, soon after the transplanted seedlings have taken root and the other during flowering stage of paddy. Rabi paddy may be irrigated regularly from the perimeter trench by '*Donga*' or Doon commonly used for lift irrigation. Pesticides are sprayed, if and when infestation of paddy pests are detected. But before application of pesticide, a low earthen ridge along with periphery of the paddy plot is erected on soil surface to prevent drainge of pesticide washings into the perimeter/lateral trench or central pond harbouring the fish. Rabi paddy becomes ready for harvesting within four months and the production ranges from 4000 to 5000 kg/ha.

(iv) **Pest control**

To overcome pesticide problems, integrated pest control system may be introduced and pesticides less toxic to fish may be used in low doses, if absolutely necessary,

during Kharif season when fishes are reared along with paddy. Pesticides like, carbamates and selective organophosphates is only to be used. Furadon when applied at the root zone of paddy plant 7 days prior to fish stocking proved to be safe.

6. FISH CULTURE

(i) Clearance of predators and aquatic weeds

At the onset of monsoon, the floating and emergent weeds are removed manually Since the waterways get dried up during summer, removal of predatory fishes will be automatic. However, mohua oilcake @ 250 ppm should be applied during June when rain water starts accumulating in the waterways as this brings in trash and weed fishes.

(ii) Fertilization schedule

The organic manure which is added during preparation of paddy field should be applied also for the waterways, along with the inorganic fertilizers to facilitate growth of plankton and benthos before fish stocking. Again during the period from December to March when the fishes are confined to the waterways, regular manuring is essential. In silty clay retentive soil with pH 7.0-7.4, cow dung (5000 kg/ha), ammonium sulphate (70 kg/ha) and single super-phosphate (50 kg/ha) may be applied in three equal instalments during the four months rearing period.

(iii) Species mix and stocking rate

In the month of July when the rain water starts accumulating in the paddy plot and the depth of water in the waterway becomes sufficient, the fishes : rohu, catla, mrigal, common carp or minor carps are stocked at the rate in the range of 4000-6000/ha.

Species ratio may be 25% surface feeders, preferably catla which is readily available, 30% column feeders *i. e.* rohu and 45% bottom feeders *i. e.* mrigal or common carp. *Labeo bata*, *Macrobrachium rosenbergii* and *Puntius javanicus* have also been observed to grow well in paddy-cum-fish culture plots when stocked along with major carp.

(iv) Supplementary feed schedule

To augment growth, supplementary feed comprising mustard oil cake and rice bran at 1 : 1 ratio may be given to fishes, daily = 3-5% of fish biomass particularly after the harvest of Kharif paddy.

(v) **Harvesting**

In this culture system, the fishes have access for a period of 5-6 months to the entire area (paddy plot and waterway) and the next 4-5 months to the waterway only. After havesting of deep water paddy when the plot gets gradually dried up, the fishes take shelter in the waterway. Partial harvesting by drag netting starts soon after the Kharif season, and fishes attaining 400-500 g are taken out at fortnightly intervals. At the end of operation when the water in the waterway is used up for irrigating Rabi paddy, the remaining fishes are hand picked. Production rates in the range of 700-1000 kg/ha/yr are normally achieved.

(vi) **Survival**

Survival rate of fish in renovated paddy plot can be increased by 60% as compared to fish culture in ordinary paddy plots. Assessment made on the survival of fish stocked in ordinary paddy fields has been found to be poor. In addition to high temperature and shallow water depth of the paddy fields causing mortality to fishes in summer, the fishes are also subjected to predation by snakes, birds and otters.

7. HORTICULTURE

The dykes constructed for preventing the escape of fish from the integrated system, may be used for growing vegetables and other fruit bearing plants like, papaya and banana to generate higher return from the integrated system.

8. ECONOMICS

Operating and capital costs and return calculated on the basis of one hectare on paddy-cum-fish culture system adopted at Rahara (West Bengal), at current prices (1985) are stated below, taking into consideration only the minimum production of paddy and fish that can be obtained under the system.

Gross output, paid-up cost and net farm income for paddy-cum-fish culture in perimeter trench system per unit area of one hectare are as follows :—

I. (A) **Fixed capital costs :**

Item	*Actual cost*	*Economic life*	*Annual depreciation*	*Annual interest @ 10%*
	Rs.	Rs.	Rs.	Rs.
1. Cost of land (1 ha)	40,000	—	—	4,000
2. Earthwork	10,000	20	500	1,000
	50,000		500	5,000

Contd.....

I. (B) **Variable operational costs :**

(a) *For Kharif paddy in* **0.67** *ha* :

(i) Seed	60 kg	@ Rs. 2.00/kg	Rs. 120.00
(ii) Labour	30 man-days	@ Rs. 14/ man-day.	Rs. 420.00
			Rs. 540.00

(b) *For Rabi paddy in* **0.67** *ha* :

(i) Seed	50 kg	@ Rs. 2.50/kg	Rs. 125.00
(ii) Super phosphate	400 kg	@ Rs. 2.15/kg	Rs. 860.00
(iii) Muriate of Potash	66.6 kg	@ Rs. 0.85 /kg	Rs. 57.00
(iv) Urea	220 kg	@ Rs. 2.50/kg	Rs. 550.00
(v) Pesticide			Rs. 80.00
(vi) Labour	50 man-days	@ Rs. 14/ man-day.	Rs. 700.00
			Rs. 2372.00

(c) *For fish culture in* **1** *ha, then in* **0.21** *ha* :

(i) Seed	6000 nos.	@ Rs. 20/100	Rs. 1200.00
(ii) Cow dung	5000 kg	@ Rs. 20/tonne	Rs. 100.00
(iii) Ammonium sulphate	70 kg	@ Rs. 1.15/kg	Rs. 80.50
(iv) Single superphosphate	50 kg	@ Rs. 1.10/kg	Rs. 55.00
(v) Feed MOC	360 kg	@ Rs. 2.00/kg	Rs. 720.00
RB	360 kg	@ Rs. 0.50/kg	Rs. 180.00
(vi) Labour	365 man-days.	@ Rs. 14/ man-day.	Rs. 5110.00
			Rs. 7445.50

(d) *For Horticulture in* **0.04** *ha of dyke crest area* :

(i) Seed			Rs. 15.00
(ii) Inorganic manure			Rs. 10.00
(iii) Labour	20 man-days.	@ Rs. 14 per man-day.	Rs. 280.00
(iv) Hire charges for power tiller to operate for 3 hours/year.			Rs. 30.00
			Rs. 335.00

.....*Contd.*

(e) *For farm equipments and implements* :

(i)	Hire charges for fishing gears and tools	Rs. 100.00
(ii)	Hire charges of the equipments for ploughing, soil dressing, mowing, etc. (for 2 paddy crops).	Rs. 100.00
(iii)	Hire charges for reaping, thrashing, winnowing, etc. for 2 paddy crops.	Rs. 50.00
(iv)	Hire charges of tool for the horticulture	Rs. 50.00
		Rs. 300.00

Annual variable operational cost—Rs. 10,992/-

I (C) **Annual investment :**

(a)	Annual depreciation on fixed cost	Rs. 500.00
(b)	Annual interest @ 10% on fixed capital cost	Rs. 5000.00
(c)	Annual variable operational cost	Rs. 10,992.00
(d)	Annual interest on working capital @ 15%	Rs. 1648.00
		Rs. 18,140.70

II. **Annual Turnover :**

(a)	Sale of 5500 kg paddy (from 2 crops)	@ Rs. 2/kg	Rs. 11,000.00
(b)	Sale of 5610 kg hay	@ Rs. 1/3 kg	Rs. 1,870.00
(c)	Sale of 700 kg carp	@ Rs. 12/kg	Rs. 8,400.00
(d)	Sale of vegetables, fruits, etc.		Rs. 500.00
			Rs. 21,770.00

III. **Summary :**

(a)	Annual turnover	Rs. 21,770.00
(b)	Annual investment	Rs. 18,141.00
(c)	Annual profit	Rs. 3,629.00
(d)	Profit to turnover	16.7%
(e)	**Return over investment**	20.00%
(f)	**Return on fixed capital cost (Rs. 50,000)**	7.3%