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CENTRAL INLAND FISHERIES RESEARCH INSTITUTE

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

BARRACKPORE • WEST BENGAL • INDIA

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Bulletin No.32
October, 1980

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Rearing of fish along with paddy is an age old practice in India and some of the South-East Asia and far eastern countries (Alikunhi, 1955). In most of these countries, rice being the staple food of the people, paddy fields occupy a great share of the arable land. In India, about 39 million hectares of land is presently under rice cultivation - the highest in the world. In recent years use of pesticides has greatly impeded fish culture in paddy fields. Despite these constraints there still exists scope for establishing a system of paddy-cum-fish culture in fields retaining sufficient water during monsoon. Prevalent practice of trapping fish and prawn in the tide-swept single crop areas (George, et al., 1968, Pillay and Bose, 1957) and freshwater paddy fields in riverine areas in several parts of the country are fully dependent on the natural ingress of fish seed along with water courses in the impounded paddy fields so far as production of fish is concerned. To accelerate the fish yield in such habitats, judicious stocking of selected species of fast growing fish have been increasingly adopted by fish farmers in various countries (Eapen, 1956, Ardiwinata, 1957).

Modern rice-fish culture is usually undertaken in renovated paddy plot having trenches or pools in the rice production area. Both deepwater (floating) paddy in 'Kharif' and high yielding varieties during 'Rabi' can be cultivated in an integrated system with economic returns. A brief account on the present status of paddy-cum-fish culture in India is given below.

DIVERSE METHODS OF FISH CULTIVATION IN PADDY PLOTS

The paddy-cum-fish cultivation practices prevalent in India adopt capture and culture methods as under :

Capture-cum-culture method in paddy plots

Trapping fish and prawns in the paddy field with tidal water through regulators in brackishwater areas.

Capture method in paddy plots

i) Harvesting the wild crop which may gain entry into the field in freshwater areas.

ii) Harvesting of fingerlings of fishes that breed in paddy plots.

Culture methods in paddy fields

Augmenting the fish yield by stocking with selected species in specially prepared paddy plot.

PADDY-CUM-FISH CULTURE IN BRACKISHWATER AREAS

Sequential system

The single crop paddy fields of the coastal regions of Kerala are used for paddy-cum-fish culture. The paddy field are used for the prawn fishery after 'pokali' harvest. The production rate of prawns in fields adjacent to backwater and subject to maximum tidal influence is more, than of those situated further away and yet under tidal influence. In addition to the usual rotational prawn fishery in the fields after rice harvest, an almost freshwater prawn fishery is met with in some fields, two or three months after the rice is sown. The catches in these freshwater paddy fields are comparatively less (Gopinath, 1955). The prawn industry also thrives well in an area of more than 5,000 ha paddy fields in the Vembanand lake region of Kerala State. Metapenaeus dobsonii, Metapenaeus monoceros and Penaeus indicus are the main species of prawn contributing to the catch in such fields after paddy harvest. The ecotope of the paddy plot bordered with criss-crossing canals and decaying paddy remains of the fields, serving as food by themselves, besides promoting diatoms' growth constitute excellent conditions for prawn growth. Apart from prawn, fishes encountered in the field are : Mugil spp. Etroplus suratensis, Etroplus maculatus, Chanos chanos, Platycephalus sp., Glossogobius sp. etc. The production of prawns in these fields is reported to vary between 300 and 1,000 kg/ha/4 months.

Synchronous system

In eastern part of the country, in the State of West Bengal, brackishwater fishes are cultivated along with paddy. These paddy fields have strong embankments all around and linked with canal system of varying size and design. On an average about 8% of the area of such fields is occupied by canals varying from 0.6 to 1.5 m in depth (Pillay and Bose, 1957). Unlike paddy fields of Kerala, most of these fields are utilized for culture of fish both prior to and during the period of paddy cultivation. Harvesting operation of 'Kharif' paddy generally commences in these fields in the month of November and is over by about January when the field as well as the canals are completely dry. From February or March onward tidal water is taken into the dyked canals at high tide. Till the onset of the monsoon the water level in the canals is maintained much below the level of the paddy field. The feeding of brackishwater into the canals is stopped by about June and when the South-West monsoon sets in the paddy is transplanted. By August, water level in the canal increases due to accumulation of rain water, when the paddy plots also get inundated. Salinity of canal water reduces appreciably and bunds along the canals are then cut so as to merge the water in the canals and the paddy plots. This enables the fishes to gain access into the paddy plot proper for further growth. The major species of fish and prawns cultivated in the paddy field for 4 months are Mugil parsia, Mugil tade, Mugil corsula, Lates calcarifer, Mystus gulio, Macrobrachium rosenbergii, Metapenaeus brevicornis, Penaeus monodon, Metapenaeus monoceros and Macrobrachium rude. Production of fish and prawns in these paddy fields ranges between 100 and 200 kg/ha/ 4 months.

Phase of culture system in swamp land reclamation

One of the major ecological features of the paddy fields in saline deltaic areas is the fluctuating salinity of the water in the adjoining canals. The mean salinity of the canal from February to November varies between 15.8‰ and 0.5‰ respectively. The low water level in paddy field and relatively high temperature is responsible for the growth of bottom biota which form the food of the fishes. Among benthic algae Oscillatoria, Lyngbia, Cladophora and Vaucheria are common. Among the

diatoms the dominant genera are Nitzschia, Pleurosigma and Gyrosigma. In addition, appreciable numbers of Surirella, Navicula, Amphipleura and Cymbella are also found in the field. The major zooplanktonic organisms found in the plankton are flagellates, copepods, rotifers and nauplius larvae.

In deltaic areas of West Bengal, reclamation of swampy land which gets completely inundated during high tide has received attention since very early times. The reclamation of these areas involves the raising of the level of the land and the removal of the salt content of the soil to make it suitable for the cultivation of rice. Because of the large capital outlay required for the quick conversion of these land into rice fields, a slow process of reclamation which involves less expenditure and enables the production of appreciable quantities of fish during reclamation period has been evolved by way of brackishwater fish culture in impounded swamps (bheris) and paddy-cum-fish culture practices followed (Pillay, 1958).

Many fields in Hasnabad, Sandeshkhali, Bashirhat in the 24-Parganas of West Bengal, after being reclaimed, are utilized for culture of fish along with rice. Such culture method has been discussed above. It is more profitable for the farmers to culture export quality prawns i.e. Penaeus monodon and Macrobrachium rosenbergii, simultaneously with paddy during 'Kharif' season instead of converting the plot for paddy cultivation alone so long facilities are available for favourable ingress of tidal brackishwater rich in prawn and fish seed during lunar periods into the protected canal areas of the paddy field. But due to rapid siltation of estuarine creeks, tidal streams and distributaries of rivers, some paddy fields gradually get detached from brackishwater sources and, therefore, utilized only for paddy cultivation.

In some such fields at Haroa, Khusighat etc. of 24-Parganas, near Kulti river mouth, Calcutta municipal waste water, from adjoining sewage flow channel is taken inside the paddy plots having trenches at the middle for maintaining higher water column. Commercially important euryhaline brackishwater fish and prawn seed are usually collected from adjoining creeks and canals and stocked in the integrated system using domestic sewage as fertilizer. Intake of dilute wastewater also helps in maintaining favourable water column in the paddy field for rearing fish during lean period. Fish growth in such ecosystem is faster than ordinary paddy fields.

So in brackishwater areas of 24-Parganas district, West Bengal, reclamation of inundated saline swamps under tidal influence gradually gives rise to four system of culture as under :

i) Fish culture in brackishwater impoundments (Bheris)

ii) Paddy-cum-fish culture simultaneously in 'Kharif' and additional crop of fish during 'Rabi'

iii) Paddy-cum-fish culture simultaneously during 'Kharif' and 'Rabi' using municipal wastes

iv) Paddy cultivation alone during 'Kharif' and 'Rabi'

The compatability of these four systems of culture in an area in terms of yield considerations especially crop Vs fish, soil and water quality, water management etc. needs scientific study and evaluation. As for example, inundation of brackishwater impoundments (bheries) from post-monsoon months by saline water, required for fish culture may affect cultivation of paddy in adjoining plots due to lateral seepage of saline water through pervious or wornout dykes of fishery plots. Similarly the fishery plots in the region may be affected from pesticides from the adjoining paddy plots.

The fisheries acquisition Act, enacted in 1958 in West Bengal gave adequate protection to the agriculturist from injurious effect of saline water inundation in agricultural plots from fishery plots. But no law is inforce to protect the pisciculturists in the area against indiscriminate use of pesticides by agriculturists, resulting in mass fish kill in fishery/bicommodity plots.

PADDY-CUM-FISH CULTURE IN FRESHWATER AREAS

Harvesting wild crop which may gain entry in paddy plots in freshwater areas

In eastern parts of India, indigenous species of fish are usually found in flooded paddy fields and the farmers usually collect the same when the water

level subsides and the paddy is harvested. Irrigated paddy fields in east Godavari District in Andhra Pradesh get naturally stocked with fish seed from the Godavari River system and as they grow to fingerling size, the farmers collect the same in traps fixed at the inlets and outlets of the fields. Such paddy fields with an immundation period of 3-8 months give a yield of about 3 kg or more fish per hectare (Jhingran, 1975). In Malaysian paddy fields, solely dependent on natural production of fish fry, income from fish constituted 22-60% of the paddy income of farmers in the single cropping region (Tan, 1979). In some areas around Balabhadrapuram in Andhra Pradesh some rice cultivators have converted a few paddy fields into fish pond for raising fish seed because fish seed production was found three times more remunerative in returns as compared to paddy.

Paddy plots provide breeding ground for many air-breathing swamp fishes. Considerable seed resources of swamp fishes are available for exploitation in the States of West Bengal, Assam, Tripura and Manipur. Terrace paddy plots in Ranchi, Manipur and Tripura provide ideal habitat for successful breeding and nursery for swamp fishes and utilisation of this seed resource is at present far from satisfactory.

Augmenting fish yield by judicious stocking

In West Bengal about 280 ha paddy field were stocked with fingerlings of Indian major carps (1.9 - 6.4 cm) at the rate of 1,500/ha in 1945. After a rearing period of 3-4 months the stocked fishes attained a size of 12.7-13.5 cm. The total yield was estimated to be 112 kg/ha. Iyenger (1962) carried some experiments in 12 paddy plots each measuring 25.5 m^2. Ophiocephalus striatus fingerlings in three stocking densities 400, 300 and 200 per plot were tried. Fish yield was estimated as 28 kg/ha/4 months and maximum increase in paddy yield was 227 kg/ha. In 1958 Tilapia mossambica and Cyprinus carpio were stocked in paddy plots of the Central Rice Research Institute, Cuttack @ 2,500 kg/ha. Tilapia was reared for 3 months and an average fish yield during the period was found to be 77 kg/ha of which tilapia constituted 40%.

In 1977 the 'Mashuri' paddy plot (0.16 ha) was stocked at the rate of 6,000/ha in the species ratio of Cyprinus carpio 5 : Cirrhinus mrigala 3 : Labeo rohita 2. After two months of rearing the overall recovery was found to be 34%. In monoculture of Cyprinus carpio, when stocked @ 7,250/ha in paddy field sown with C.R. 1014 variety of paddy, produced 76.2 kg/ha of fish in 119 days. An average yield of paddy was 2,719 kg/ha (Dutta, et al., 1979).

An environment for fish culture, the paddy field is decidedly poorer than the pond. The extreme shallow depth of water and frequent and wide fluctuations in water level are features that characterise the habitat. The major source of natural fish food - plankton is poor in paddy field (321/ltr) as compared to perennial unmanured pond (2,996/ltr). Production of natural fish food organisms remains low in the paddy fields as because growing paddy just like emergent weeds in fish ponds utilises most of the nutrients from the eco-system. Phosphorus is considered most important limiting nutrient in fish production and has been found to be low (0.03-0.08 ppm) in water of paddy fields as compared to that of pond (0.08-0.24 ppm). Regular manuring and supplementary feeding would, however, increase the yield from the paddy fields appreciably (Saha et al., 1962).

EXPERIMENTAL PADDY-CUM-FISH CULTURE IN A RENOVATED PADDY PLOT OF CIFRI, RAHARA

The new technique of paddy-cum-fish culture involves sides of the paddy plot being converted into a trench which borders the plot. An experiment was conducted in a renovated paddy plot (1.02 ha) at Rahara having the perimeter trench (0.27 ha) excavated within the plot. The trench thus excavated was trapezoidal in shape with a top width 6 m, base width 3.6 m and a full canal water depth of 1.2 m. During 'Kharif' season a deep water variety of paddy 'Jaladhi-2', capable of growing rapidly in deep waters was sown directly in June in the paddy plot (0.75 ha). Fingerlings of Indian major carps, rohu, catla and mrigal were stocked @ 6,000/ha in the ratio 3 : 4 : 3 in the field after a month of paddy sowing. The fishes were fed 2-5% of body weight with rice bran and mustard oil cake in the ratio 1 : 1.

After harvesting of deep water paddy in early December the paddy plot was gradually allowed to dry up and the fishes move instinctively to the perimeter canal as the process of drying starts. During Rabi season a high yielding variety of paddy such as 'Ratna', 'Jaya', is cultivated in the same plot following the usual agricultural practices using the trench water for irrigation. During 'Rabi' season, pesticides viz., Demicron and BHC were applied to control paddy pests, mainly rice hispa and paddy stem borer. Before application of pesticides care was taken to prevent drainage of pesticide washings into the perimeter trench harbouring fish by erecting a low dyke along the periphery of the paddy plot. The kharif harvest produced 1,200 kg/ha of paddy while 'Rabi' crop produced 4,300 kg/ha, making a total for the two crops as 5,500 kg/ha/yr. During ten months rearing of the fish (6 months along with the kharif paddy and 4 months in the perimeter canal during Rabi) a production of 700 kg/ha could be achieved. The main advantages of this integrated bicommodity paddy-cum-fish system are : (i) Areas where irrigation facilities are not available and 'Rabi' paddy is not normally possible, one can adopt the system for a second crop of paddy as well as a sizable crop of fish. (ii) The operational economics show a much higher return than pure paddy cultivation. At investment of Rs. 4,700.00/ha the total output value is estimated at Rs. 9,040.00/ha made of Rs. 4,840.00/ha from paddy and Rs. 4,200.00/ha from fish showing a net profit of Rs. 4,326.00/ha. Had the same plot been used for two crops of paddy alone, the additional output of paddy from the canal area would have been worth Rs. 1,306.80/ha as against fish output at Rs.4,200.00/ha (Ghosh, 1979).

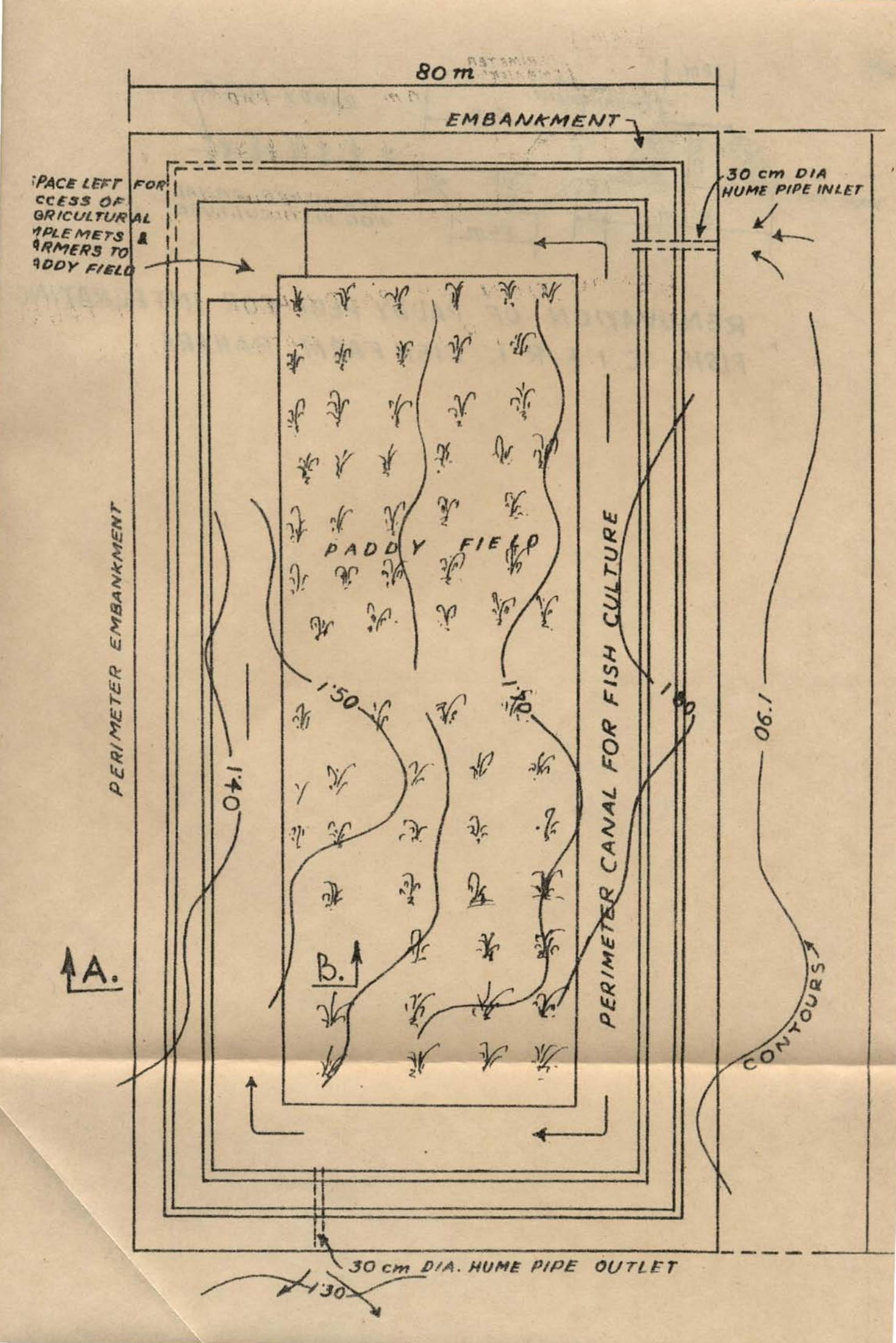
Paddy-cum-fish culture akin to above has also been in practice in some of the North-Eastern hill States. In experimental studies in Rabi season in Tripura, Pusa 2-21 seedlings were used while fish component was made of Cyprinus carpio and mrigal fingerlings. The rate of return was Rs.6,600.00 as against capital investment of Rs. 2,930.00 (Sinha, 1979).

Assessment made on survival of the fish stocked in ordinary paddy fields was always found to be poor. Due to high temperature (30-40°C) and shallowness of the paddy fields during summer the fishes are subjected to predation by snakes, birds of prey and otters. Moreover, such fields are embanked with earthen dykes not sufficiently high to prevent inflow of pesticide washings

from the adjacent paddy plots during flood season. In such paddy fields it is difficult to take up paddy-cum-fish culture. Biological control of pests may be one of the effective solution to be tried in this system. It is observed that construction of perimeter trench in paddy-plot increases survival of carps from 34% to 70% and thus the overall productivity of the ecosystem is increased. Cultivation of deep water paddy can be favourably integrated with fish culture, particularly in deep water swampy areas after reclamation.

Modern rice varieties receiving recommended amounts of fertilizer probably will benefit less from fish activities in paddy plots than traditional varieties although in either case fish may eat some of the undesirable insects including mosquitoes. Spiders which eat destructive insects are also more numerous in rice fields when no insecticides are used. It is ecologically more desirable to have biological rather than chemical control of insect pests (Grover, 1979). In brackishwater areas of West Bengal and Kerala more emphasis should be laid on paddy-cum-shrimp culture using commercially important export quality prawn seeds following scientific methods. it is encouraging that banks has come forward to finance farmers engaged in prawn culture in these areas to earn valuable foreign exchange from World market. Paddy fields presently detached from tidal influence should also be integrated with fish culture by stocking prawn seeds collected from open estuarine canals or backwaters for effective utilization of our natural aquatic and saline swamp resources. This will ultimately pave the way for establishing an effective brackishwater fish seed trade as is prevalent in case of carp spawn in the country.

In the freshwater sector, 2.3 m ha is under deep water paddy cultivation (Dutta, Banerjee, 1979). Deep water comditions ranging from 50 cm to 2 m or more can be put to use for synchronus cultivation of deep water paddy and fishes, particularly Indian major carps, by suitable renovation.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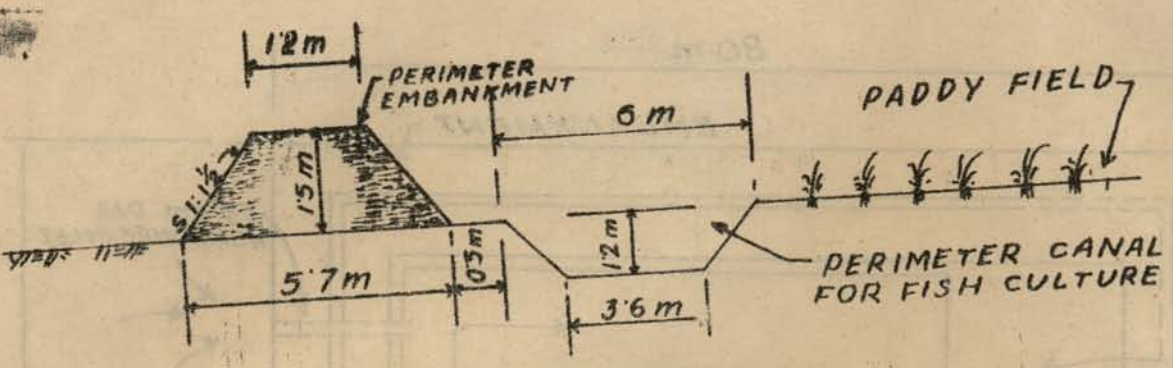

RENOVATION OF PADDY PLOT FOR INTEGRATING FISH, C.I.F.R.I. FISH FARM, RAHARA.

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