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Prospects of Fish Culture in the Broad Bed and Furrow System in Andaman

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Abstract

The BBF system of cultivation is a technique of land manipulation to grow vegetables and fodder right in the midst of rice field. The technology involves making of broad beds and furrows alternatively in rice fields. In the BBF, the raised broad bed areas are used for cultivating seasonal vegetable or fodder crops during monsoon season months. To study the economic feasibilities of fish culture in broad bed and furrow system a study was undertaken in south Andaman. Indian major carps and air breathing fishes were cultured in the furrows along with rice (Taichung –sen-Yu) separately. No supplementary feeding and other management techniques were adopted for fishes. From 6000 m² area of furrow fish production of 25 and 45 kg of magur and singhi and 78 and 73 kg of Indian major carps were obtained. Best return was obtained in rice + ratoon + ground nut + fishes (singhi and magur) combination and B : C ratio was 0.94 where fishes alone contributed for 12.5 B : C ratio.

Key words : Broad bed, Furrow, Magur, Singhi, Carps.

Agriculture is one of the most important economic activities of the people of the Andaman and Nicobar Island. The area under agricultural cultivation is shrinking at a faster rate. The cultivated land available before Tsunami 2004 was 50,000 ha which came down to 43,339 ha. The area under paddy has drastically come down from 12,000 ha to less than 8,000 ha due to submergence of low lying areas or seawater intrusion (1). In the available arable lands, no other crop can be grown during monsoon due to significantly higher rainfall. Rice cultivation is becoming highly uneconomical but vegetables and fodder fetch high price due to short supply during monsoon period (2). Vegetable and fodder production in the bay islands are also hampered because of shortage of space and excess rain water accumulation during rainy season (June—December), damage caused by giant African snail *(Achatina fluviatalis)* and bacterial wilt disease (2, 3). Hence, an integration of rice and horticultural crop is a promising field for Andaman.

Integrated rice and fish culture is an age old practice in India. In the tribal communities of North Eastern India have paddy-cum fish farming along with shifting cultivation called *Jhum* (4). Indian major carps (catla, rohu and mrigal) and also common carps are cultured along with paddy in many parts of North Eastern states. It has been proved that rice-fish integration enhances the production of rice substantially (5). In Andaman rainy season (>3,000 mm) starts from May-June and last till October—December. Hence, pond culture activities continue from June to February or till sufficient water is retained in the pond. During rainy season, it has been seen that, many low lying areas are inundated with runoff water and farmers are unable to cultivate horticulture crops in those areas. Such land mass where the runoff water stagnates, some times even up to 15 days (1) is suitable for broad bed and furrow (BBF) system of cultivation. The BBF system of cultivation is a technique of land manipulation to grow vegetables and fodder right in the midst of rice field. The technology involves making of broad beds and furrows alternatively in rice fields. In the BBF, the raised broad bed areas are used for cultivating seasonal vegetable or fodder crop during monsoon season. Different horticultural crops are grown in the broad bed. The bed is above the water level and water can be supplied from the furrows as and when required. Okra, amaranthus, coriander, cowpea- groundnut, chillies, crossandra, cauliflower, cabbage, brinjal, cucumber, palak (spinach) are the best performed crops on the bed and can be sequenced throughout the year. The depressed area is used for rice and fish cultivation (6). Paddy varieties viz., C14-8, Jaya, Krishna Hamsa, Bhavani or any other long duration variety are generally suitable for cultivation

in the furrows along with fishes (7).Fish culture in the furrows along with rice is the concept developed for improving cropping intensity and efficient utilization of the land mass. In traditional rice- fish culture system extreme environmental factors like high temperature, low dissolved oxygen, high turbidity, low water level and high human intervention is prevailing (8) and it is the same for BBF system of farming. The fish species suitable for freshwater paddy fields are magur *(Clarias batrachus)*, singhi *(Heteropneustes fossilis)*, catla *(Catla catla)*, rohu *(Labeo rohita)*, mrigal *(Cirhinus mrigala)* bata *(Labeo bata)*, Java puthi *(Puntius javanicus)*, silver carp, giant fresh water prawn and common carp *(Cyprinus carpio)* (9) can also hold good for BBF. Air breathing fishes like magur and singhi are also always preferred because they can tolerate wide fluctuation of the environmental parameters (7) and can survive longer duration out side the water. The can also fetch high price (Rs 200/ kg) in the local market. The main abjective of BBF system is to efficiently utilize the inundated land areas not vary suitable for agricultural activities. To study the efficacy, potentiality and sustainability of fish culture in broad bed and furrow system a study was undertaken in south Andaman.

Methods

General Design of BBF

Broad bed furrows are made in the shape of inverted trapezium by digging soil from either side to make furrow and filling the soil for making bed. Rectangular size plot are generally preferred for the construction of BBF. Beds and furrows are made in alternate (Fig. 1) in the ratio of 4 : 6. In one ha area, 10 furrows of 6 m width and 100 m length (6,000 m²) and 10 beds of 4 m width and 100 m length (4,000 m²) can be made. For the present experiment four furrows were constructed eah having a length of 60 m and width 6 m and bed is having 4 m wide. The furrows are 1 m deep. On lower end slop of each furrow, fish shelter/trenches are made by further digging the soil up to 1.5-2 m (Table 1) for culturing fishes. The excavated earth during construction of furrow is used for making the beds. Two PVC pipes of 50—60 mm diameter are provided for draining out excess water from furrow. The cost of making (machine excavation) one ha of a BBF area is Rs 1.0 lakh (6).

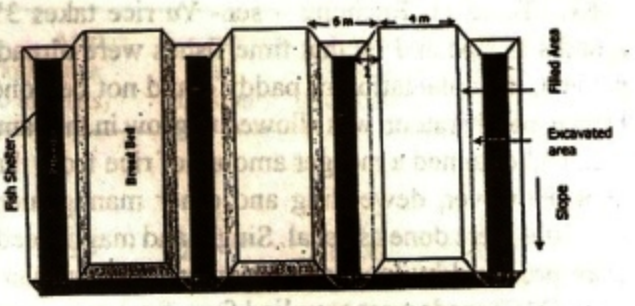

Figure 1. Schematic layout of broad bed and furrow system.

Fish Culture

In the furrow air breathing fishes and Indian major carps were cultured along with rice. The rice + azolla + fish combination in furrows was used in the present experiment and the rice variety used were

Table 1. Details of the fish stocked in broad bed and furrow system of farming. L = Length, B = Breadth, D = Depth.

Furrow	Total furrow area (m²)	Fish shelter (L × B × D)	Fish shelter (m²)	Species stocked	Stocking density	Stocking density/ ha	Size at stocking (cm)
Shelter 1	360	6 × 6 × 2 m³	36	Singhi, magur	140 (1 : 1)	3,900	7, 8
Shelter 2	360	5 × 6 × 2 m³	30	Singhi, magur	140 (1 : 1)	3,900	7, 8
Shelter 3	360	4 × 6 × 2 m³	24	Catla, rohu, mrigal	165 (0.15:1:0.5)	4,580	5, 7, 3
Shelter 4	360	3 × 6 × 2 m³	18	Catla, rohu, mrigal	165 (0.15:1:0.5)	4,580	5, 7, 3

Taichung –sen-Yu in system of rice intensification (SRI) (Table 1). Taichung – sen- Yu rice takes 3½ months to ripe and by that time fishes were already present, new plantation of paddy could not be done. Hence, paddy ratoon was allowed to grow in the same area and obtained a meager amount of rice from that area. However, deweeding and other management activities were done as usual. Singhi and magur seeds were procured by local collection and Indian major carp (IMC) seeds were supplied from fresh water fish hatcheries of Central Agricultural Research Institute hatchery. Seeds of IMC and air breathing fishes were cultured separately along with rice and azolla in each furrow for a period of 6 months. No supplementary feeding was provided during the culture period. Regular water quality monitoring was done with pH (6.3—6.5) and dissolved oxygen (4.9—5.3) are within the acceptable limit of fish culture. Both organic and inorganic fertilizers can be used for the paddy cultivation under rice cum fish culture. For organic fertilizer, Gliricidia grown in the fences of BBF area was incorporated at 5t/ha before transplanting of the rice. Azolla was introduced in furrow along with rice. Inorganic fertilizer, NPK was applied at 60 : 40 : 40 kg/ha for rice. During the culture period no insecticide was applied.

Results and Discussion

Table 1 indicates the details of fishes stocked in the BBF system. For operational convenience fish shelters were made in different sizes. However, as water level in BBF was always maintained above 20 cm, for calculation of stocking density, whole area of furrows were considered. As bigger size fish seeds were not available, stocking size of fishes was relatively smaller. After the culture period of six months, catla, rohu and mirgal attained the maximum size of 263 g, 134 g and 56 g respectively with a production 73—78 kg/ha where as singhi and magur attained the average weight of 65 g and 80 g respectively and production was 25—45 kg/ha (Table 2). If whole area would have considered then expected production would have been better (Table 2). In the present production no supplementary feeding was given through out the trial. This indicates the compatibility of these fishes with rice + azolla + fish system in the furrows. Earlier reports illustrate that fish production as low as 75 to 100 kg/ha can be achieved by stocking 1000—2000 numbers common carp (8—10 cm) per ha (10) and as high as 1044 kg/ha of common carp in the rice-fish cultivation when maintained at stocking density of 4,500 numbers/ha for 75 days (11). In Indian condition production of 240 kg/ha in nine months was achieved when stocked with Indian major carps in rice-cum-fish culture (12). As low as 67.65 kg/ha of fish production in rice-fish farming was also reported from tribal dominated areas of Apatani plateau of Arunachal Pradesh (13). Integration of rice and fish is a beneficial proposition as many pest of rice are consumed by fishes, enhanced fertilization and release minerals from the soil. Khedkar and Gyananath (5) reported that integrating rice farming with common carp enhanced rice and straw production by 7—10% and 9.26% respectively and net returned by 45.3%. They also got 113 kg/ha of fish where fishes were fed with 10% of the body weight. In the present study, maximum rice production was 1,333 kg/ha and ratoon yield was 25 kg in cropping sequence I (CS 1) (Table 3). Hence, production obtained in the present experiment is not low compared to the earlier report of rice-fish farming.

As such productivity of rice is relatively low in Andaman (14) and in the present experiment B : C ratio from rice was positive in CS I and 4. In ratoon,

Table 2. Yield and economics of fish in rice + azolla + fish cultivation in BBF system.

Furrow	Yield furrow (kg)	Yield (kg) in 6,000 m² or 10 furrows/ha BBF	Prevailing market rate (Rs/kg)	Approximate gross return (Rs/ha)	Expected yield (kg) in one ha (pond area)
Shelter 1	2.5	25	180	4,500.00	41.7
Shelter 2	4.5	45	180	8,100.00	75.2
Shelter 3	7.8	78	100	7,800.00	130.0
Shelter 4	7.3	73	100	7,300.00	121.7
	Total gross return from furrow			27,700.00	
	Average gross return per furrow			6,925.00	

Table 3. Yield, cropping intensity and B : C ratio in furrows in BBF system.

Cropping sequence	Varieties	Season	Yield (kg) in 6,000 m²	Market rate (Rs)	Gross returns (Rs/ 6,000 m²)	Cost of cultivation (Rs/6,000 m²)	Net returns (Rs)	B : C ratio
CS 1								
Rice	Taichung Sen Yu	Jun - Oct	1333	5	6,665	4800	1865	0.39
Rice ratoon	Taichung Sen Yu	Oct - Dec	25	5	125	1200	-1075	-0.9
Groundnut	TG 37 A	Jan - Apr	652	20	13,040	7800	5240	0.67
Fish (singhi, magur)	70 + 70	Oct - Mar	25	180	4,500	600	3950	6.58
Sub-total					24,330	14400	9930	0.69
CS 2								
Rice	Taichung Sen Yu	Jun - Oct	1000	5	5,000	4800	200	0.04
Rice ratoon	Taichung Sen Yu	Oct - Dec	25	5	125	1,200	-1075	-0.9
Groundnut	ICGV 91114	Jan - Apr	736	10	14,720	7800	6920	0.89
Fish (singhi, magur)	70 + 70	Oct - Mar	45	180	8,100	600	7500	12.5
Sub-total					27,945	14400	13545	0.94
CS 3								
Rice	Taichung Sen Yu	Jun - Oct	667	5	3,335	4,800	-1465	-0.31
Rice ratoon	Taichung Sen Yu	Oct - Dec	12.50	5	62.5	1200	-1137.5	-0.95
Maize	X3342	Dec - Apr	443	10	4,430	3,600	830	0.23
Blackgram	Local	Jan - Apr	29.80	10	298	1,200	-902	-0.75
Groundnut	ICGV 86015	Jan - Apr	647	20	12,940	7,800	5140	0.66
Fish (catla, rohu, mrigal)	15 + 100 + 50	Oct - Mar	78	100	7,800	1,000	6800	6.8
Sub-total					28865.5	19,600	9265.5	0.47
CS 4								
Paddy	Taichung Sen Yu	Jun - Oct	700	5	3,500	4,800	-1300	-0.27
Ratoon	Taichung Sen Yu	Oct - Dec	18	5	90	1,200	-1110	-0.93
Groundnut	ICGV 00350	Jan - Apr	306	20	6,120	7,800	-1680	-0.21
Fish (catla, rohu, mrigal)	15 + 100 + 50	Oct - Mar	73	100	7,300	1,000	6300	6.3
Sub-total					17,010	14,800	2210	0.15
Average from all four fishery section					6925	800	6137.5	7.67
Average from all four cropping sequence					24537.63	15,800	8737.63	0.55

negative B : C ratio was recorded. Minimum production of ratoon and high expenditure for deweeding and other activities caused negative B : C ratio. In the same BBF system, in the beds, different horticultural crops were also grown. Among different crops sequence, radish and chillie combination gave the best net return of Rs 189,486.00 with B : C ratio 6.94 (15). Similarly from the present study in cropping sequence 2 (CS2) gave the best return of Rs 13,545.00 (Table 3) where air breathing fishes contributed Rs 7,500. Hence, in a BBF system, integrating radish and chillie in bed and rice + ratoon + ground nut + air breathing fish in furrow, a net production of Rs 203,031.00 can be achieved. The B : C ratio is a good indicator of profitability of a project (16) and in the present study average B : C ratio from whole furrows was 0.55, and fishes alone contributed 7.66. Out of four cropping sequence, B : C ratio of CS 2 (0.94) was the best where fishes alone contributed 12.5. If we include contribution from beds also, B : C ratio will be almost 2.48. For economic viabilities of a project B : C ration more than one is good for an agricultural enterprise and 2.48 is

lucrative which indicates that for every one rupee invested there will be a return of Rs 3.48. In the present study fisheries alone contributed a sum of Rs 27,700.00 (Table 2) which is an additional income of the farmers. Fish production in the present study is relatively low, owing to the lack of any specific management practice. However, production can be further improved if stocking density is increased and/or furrows are stocked with relatively bigger size fingerlings and adopting better management practices like feeding and fertilization. The higher net return from the rice- fish integration as evidenced from this experiment can be attributed to variety of rice used, type of fish species and existing price of the fishes in Andaman.

In Andaman and Nicobar Islands, farmers mostly grow mono crop of traditional photosensitive low yielding varieties with low level of inputs and poor management. Broad bed and furrow (BBF) system may be an effective system during the monsoon season (May—December) especially for rain water inundated area. The BBF helps the farmer to include fish rearing in the furrows, which is proved to be not only for efficient utilization of the water spread area of the furrow, but also contribute substantially to the income of the farmer.

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