

Impact of Adoption of Pen Culture Technology on Well-being of Fishers of Haribhanga Wetland in Assam

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ABSTRACT

Assam is endowed with copious aquatic wealth in the form of beels, swamps, ponds and rivers. The floodplain wetlands (beels), extending over one lakh hectare, constitute the most important fishery resource and is most suitable for culture based fishery development. Haribhanga Beel is located in Nagaon district having water area of 125 ha. Earning of sixty four fisher families depends on fishing in this beel. The data was collected using structured questionnaire and focused group discussion with the fisher. An impact pathway was developed for studying the impact of technology intervention on the production and productivity of floodplain wetland and the consequent improvement on the well-being of the fishers. After the adoption of pen culture technology, annual fish production of the wetland was increased significantly from 37000 kg in 2002-03 to 131250kg in 2006-07. The productivity was also increased from 296 kg ha⁻¹ yr⁻¹ in 2002-03 to 1050 kg ha⁻¹ yr⁻¹. Apart from the increase in the income of lessee, there was substantial increase in the income of other fishers. The benefit cost ratio of fisheries in Haribhanga beel was 3.23. The direct impact of adoption of CIFRI technology has been seen in increase in the fish production and productivity of the floodplain wetlands of Assam, which directly helped in raising the income of the fisher household and livelihood security. The indirect impact of adoption of this technology can be seen in the increase of total fish productivity from the wetlands and increase in the per capita fish availability in the state. This impact study also provided the information on the technology profitability and its effect on household income.

Key Words: Floodplain wetland; Pen Culture; Impact; Wellbeing; Livelihood;

The fish production is determined by the nature and extent of fisheries resources. These resources are rivers, reservoirs, wetlands, other open waters, ponds and tanks. The level of fish production from these resources are dependent on the nature of the resources and production technology followed. India has extensive floodplain wetlands, defined as low lying areas bordering large rivers, which are seasonally inundated by the spillover from the main river channel. Floodplain wetlands are important fishery resources and contribute significantly to the Indian Inland fisheries.

The state of Assam is endowed with copious aquatic wealth in the form of beels, swamps, ponds and rivers. With the total area of nearly 3.74 lakh ha, the total fisheries resources of Assam is highest in the country. The floodplain wetlands (locally known as beel), the prime fishery resources in Assam, are highly productive ecosystems providing livelihood support to

a large section of the population next only to agriculture. These beels are distributed over the valleys of Brahmaputra (about 92000 ha) in the northern and central Assam and Barak valley (about 8000 ha) in southern Assam. The beels are considered to be one of the most productive ecosystems owing to their characteristic interactions between land and water system. The average productivity of floodplain wetlands of Assam was only 172 kg ha⁻¹ yr⁻¹, though the research of CIFRI indicates that the productivity potential of these beels are in the range of 1000 to 1500 kg ha⁻¹ yr⁻¹. This gap of productivity requires culture based fisheries in beels of Assam.

Culture based fisheries are recognized as an important means of increasing the fish food supplies, particularly in rural areas in developing countries in Asia and South America. Culture based fisheries also have the added advantage over traditional form of aquaculture

in that it is less resource intensive and is therefore more attractive to government of developing countries and support (DeSilva; 2003, Springer *et.al.*; 2003 and Felsing *et.al.*;2003). The beels in Assam are best suitable for culture based fishery development. They are productive in nature, rich in nutrients like organic carbon, available nitrogen and phosphorus besides having favourable thermal and oxygen level. Raising desirable stocking material through pen culture in beels offers a lucrative option to meet the growing demand for quality fish seed. The fingerlings raised in pens have shown higher rate of survivability, better growth and are also found to be fairly resistant to diseases, being raised within the same ecological condition and having been already acclimatized. The pen culture technology developed by CIFRI has been found to be an effective tool for getting quality seed of right size critical for fish yield enhancement in open waters. The technology included weed clearance in the pen area, pen construction and erection, preparation of pens for stocking of spawn and fry, feeding, monitoring and harvesting of fingerlings.

In this context, an impact study was undertaken at Haribhanga wetland in Nagaon district of Assam with following objectives:

1. To assess the benefit cost analysis of pen culture technology adoption in beel,
2. To assess the impact of pen culture on the productivity of the beel,
3. To assess the economics of beel fisheries management; and
4. To assess the impact on the well-being of the fisher community of Haribhanga beel.

METHODOLOGY

Nagaon district is situated in the Central Assam on the southern bank of river Brahmaputra. The total number of floodplain wetlands located in Nagaon district is 172 and formed by the Kollong, Sonai, Diju, Na and Kapili river basins. Haribhanga Beel is located in Nagaon district at 26:31:15° latitude and 92:48:33° longitude with an average effective water area of 125 ha. The maximum, minimum and average depth of water in the beel is 4.24m, 3.03m and 3.64 m, respectively. This beel can be classified as closed, medium and shallow beel based on riverine connection, size and

depth respectively. The ownership of the Haribhanga wetland was with Assam Fisheries Development Corporation (AFDC). The fishing right of the beels were leased out to the lessee for seven years on the rent of 5.75 lakh per year from 2002-2003 to 2008-2009 by the government. Fisheries from Haribhanga beel supports livelihood of the lessee family as well as of other sixty four fisher families. Research carried out by CIFRI in Assam beels revealed a productivity potential of 1060 kg/ha/year in Central Assam. The present study was conducted during the year 2006-07. The detailed field visit was made and data was collected using structured questionnaire and focused discussion with the lessee. The data were analyzed using various parameters given in the following impact pathways.

There is an increasing perception that additional investment in the natural resource sector could result into corresponding gains in improved well being, and invariably improvement in the state of natural resources in the country. A new impact pathway was developed for studying the impact of technology intervention i.e. stock enhancement through pen culture on the production and productivity of the natural resources like floodplain wetland and the consequent change on the wellbeing of the fisher family through increase in income. Springer-Heinz, et. al. has defined Impact pathway as a general approach for conceptualizing impact processes which provide a frame work for research planning and data studies.

Table 1. Impact pathway for analysis of impact

S. No	Impact Flow Diagram	Determinants
1.	Stock enhancement through Pen enclosure	Species ratio, Stocking, Growth and Economics of pen culture
	↓	
2.	Floodplain Wetland Productivity	Fish production, Productivity of beel, Annual trend of production
	↓	
3.	Floodplain Wetland Economics	Net Return, Wealth generation, Price
	↓	
4.	Improvement in wellbeing of fishers	Efficiency, Sharing Arrangement, Benefit to community

RESULTS AND DISCUSSION

The collaboration of fishers of Haribhanga with CIFRI was started in the year 2002 when this beel was selected as one of the eleven beels for demonstration of Pen culture technology for stock enhancements under the National Agricultural technology Project (NATP Jai Vigyan mission mode Project on Household Food and Nutritional security in Hilly, Backward and tribal areas) to solve the quality seed problems and popularize culture based fisheries among the beel fishers of Assam. Pen enclosure was erected in an area of 2500 m². The three Indian major carp species viz. Rohu, Catla and Mrigal were taken as candidate species in this demonstration. The benefit cost ratio of this demonstration was 1.89 and 2.01 in 2002 and 2003 respectively.

Fisheries in Haribhanga wetland: After the discontinuation of the project in 2004, the lessee has continued the pen culture operation from the year 2005-06 on a larger area of 5000 m² through using the species of three Indian major carps as well as three exotic carps namely common carp, grass carp and silver carp as candidate species. One crop of pen culture operation was completed in three months. The fingerlings were harvested and released in the beel. The result shows that the length and weight of exotic carp especially common carp was better than the other species. This is because the growths of exotic carps are faster than the three IMC and with a very nominal price difference.

Table 2. Fish species stocked and harvested in pen culture in Haribhanga beel

FS	NS	SL	SW	NH	HL	HW	P
Rohu	10000	8	5	9000	17	50	450
Catla	2000	8	5	1800	18	100	180
Mrigal	2000	8	5	1800	17	50	90
G carp	2000	12	7	1800	28	200	360
S carp	10000	12	7	9000	25	100	900
C carp	10000	12	7	9000	28	300	2700

FS=Fish Species
 SL=Stocking Length (cm)
 NH=Number harvested
 HW=Harvested Weight (gm)
 P=Production (Kg) (used in stocking of beel)

NS=Number stocked
 SW=Stocking weight (gm)
 HL=Harvested Length (cm)

The pen culture information is given in Table 2. The result indicates that the growth of exotic carps was faster than the three major carps. More over the survival

rate of the fingerlings was ninety percent in beel condition. Around four seed crops were grown in two year life span of pen enclosure. The harvest of two cycle of pen culture operation was used in further stocking of beels.

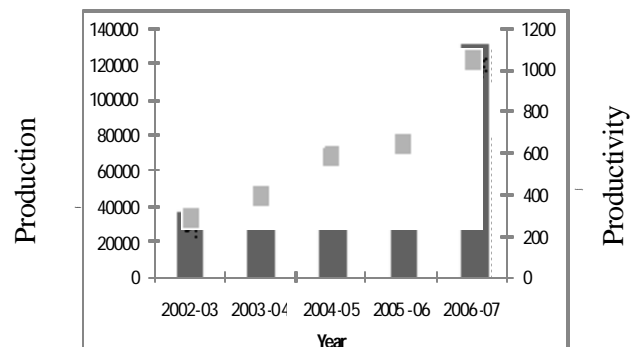
Economics of pen culture: The total cost of pen culture operation was Rs. 41380. But the unrealized return (since all the fish were restocked in beel) from pen culture was Rs. 89,100 giving benefit cost ratio of 2.15 (Table 3).

Table 3. Economics of pen culture in Haribhanga beel

Items	(Rs)
Total cost of pen construction	41520
Cost of pen/crop	10380 (25.08)
Weed clearance	1500 (3.62)
Lime	1000 (2.42)
Seed	18000 (43.50)
Feed	3000 (7.25)
Labour	6000 (14.50)
Harvesting	1500 (3.62)
Total recurring	31000 (74.92)
Total cost of pen culture	41380 (100)
Return	89100
Profit	47720
B:C ratio	2.15

(Figure in parentheses shows percentage)

Production and productivity of the beel : The total production from the year 2006-07 achieved was 131250 kg of fish with a productivity of about 1050 kg/ha. Apart from the production of stocked fishes other fish species caught were Bighead, *L. calbasu*, *L. Gonius*, *L. bata*, *C. reba*, *N. chitala*, *C. punctatus*, *C. gachua*, *Chanda sp.*, *C. batrachus*, *H. fossilis*, *Colisa spp*, *C. striatus*, *C. marulius*, *A. mola*, *D. aequipinnatus*, *G. giuris*, *M. armatus*, *M. puncaulus*, *A. testudineous*, *N. notopterus*, *Puntius Spp.*, *Xenetodon cancella*, *M.*



tengra, *Wallago attu*, etc. The production of Indian major carps, exotic carps and other fishes was 80500, 40750 and 10000 kg respectively.

Annual trend of Production and Productivity: Annual trend of production and productivity indicates a paradigm shift in the fish catch in Haribhanga wetland. The fish production of this beel was increased significantly from 37000 kg in 2002-03 to 131250kg in 2006-07. The productivity was also increased from 296 kg ha⁻¹ yr⁻¹ in 2002-03 to 1050 kg ha⁻¹ yr⁻¹ (figure 1).

Cost benefit analysis of beel fisheries management: The total capital expenditure incurred by the fisher and the income received after selling of their catch comes under the economics of beel fisheries management. The fixed cost include the lease amount paid to the government whereas the variable cost includes the expenditure incurred in fishing operation, cost of weed clearance, seed cost and other practices.

Table 4. Cost benefit analysis of fishery activity of Haribhanga Beel

Items	Investment (Rs)
Lease amount	575000 (23.96)
weed clearance	280000 (11.67)
Fishing operation including Katal	700000 (29.17)
Seed	400000 (16.67)
Other	425000 (17.71)
Transportation	20000 (0.83)
Total recurring	1825000 (76.04)
Total cost of Beel Fishery Management	2400000 (100)
Fish production	131250
Return	7750000
Profit	5350000
B:C ratio	3.23

(Figure in parentheses shows percentage)

The total investment made by the lessee in the year 2006-07 was Rs. 24, 00,000. The cost was huge; hence, the lessee took a loan from Assam Grameen Vikas Bank for Rs. ten lakh (refinanced by NABARD). The average farm gate price of the different fish species were in the range of Rs. 25-30/kg for small indigenous fishes, Rs. 40-45 for Silver carp, Rs. 50-55/kg for other exotic carps, Rs. 60-70/kg for Rohu, Catla and Mrigal, and Rs. 100-200/kg for catfishes like *W. attu*, *N. Chitila*, etc. The gross profit from the sale of harvested catch was 77.5 lakhs giving a benefit cost ratio of 3.23 means every rupee investment in beel fisheries has given profit of more than three times of investment. The prices of

these fishes were almost doubled on the occasion of *Magh Bihu* festival (on 13th and 14th January every year). Almost one harvest was done on eleventh or twelfth of January every year for reaping higher profit. An investment of Rs. two lakhs and eighty thousand was made by the lessee for clearance of weed manually. Table 4 indicates the cost benefit analysis of beel fisheries management in Haribhanga.

Improvement in well-being of fisher community: Access and control over the resources are major factors in the distribution of wealth especially with regard to natural resources. Therefore it is possible to have active engagement in an activity and yet not realize the benefits depending on the structure of value distribution mechanism. The leaseholder works as manager of the beel and fishers help in this process. The distribution of income in terms of a part of fish catch or a part of the net income between the lessee and the other fishers are based on the sharing arrangement either fixed before the fishing season or during the fishing calendar. The agreement involves catching as well as transporting them to the market. The share of fishers varies between 25 to 50 percent depending on the availability of catch, ease of catch, type of harvested fish, prevailing fishing practices, provision of craft and gear, membership of the fishing group, provision of food etc. Higher efficiency of management leads to better income as well as better remuneration to both lessee as well as other fishermen. The better managed beels provides more benefit to fishers. Share of benefits between the lessee and the fishers in Haribhanga wetland revealed that more or less every fisher family earns an income of Rs. 30273. There was a sharp rise in the income of all the fishers fishing in the Haribhanga beel after the adoption of pen culture technology from the year 2002-03 onwards. The benefits to fishers family gives a glimpse of the livelihood to the fishing community at large who are totally dependent upon these wetlands for their survival. One of the major benefits of the adoption of this technology was that apart from the lease holder the other stakeholder also got benefited. More and more adoption of this technology will not only increase the income of the fishing community but also the corresponding well-being in the state. The trends of profit and share of fishers shows an increase from Rs. 11535 in 2003-04 to Rs. 30273 in 2006-07 (Table 5).

The change in income for other fishers was very significant because earlier they were below the per capita income of Assam and national poverty line but now in 2006-07 they were above the national poverty line of Rs. 21378. The official per capita income of India estimated by the NSSO 61st round is Rs. 21378 (say Rs. 22000) per annum for a household of five members in rural area also known as national poverty line. There was also a significant change in the dietary habits of fisher family after the adoption of pen culture technology in the beel.

Table 5: Benefit sharing arrangement in Haribhanga beel

Year	2003-04	2004-05	2005-06	2006-07
Total profit received	2952857	4355464	4798393	7750000
Lessee Share	2214643	3266598	1199598	5812500
Fishers Share	738214	1088866	3598795	1937500
Benefit per fisher family .in Rs	11535	17014	18744	30273

CONCLUSION

The beels in Assam offer immense potential for increasing fish production, besides generating additional employment and income for the fishers. Stock enhancement of desirable fish species remains the single

most important management tool towards this end. The transformation of Haribhanga beel from a low productive beel to high productive beel has been achieved through adoption of stock enhancement measures through pen culture and also due to the risk bearing capacity of the fisher. This study also gives us the opportunity to get information on technology profitability and its effect on household income as wellbeing.

The direct impact of adoption of CIFRI technology has been seen in increase in the fish production and productivity of the Haribhanga wetlands of Assam, which directly helped in raising the income of the fisher household and livelihood security.

The indirect impact of adoption of this technology can be seen in the increase of total fish productivity from the wetlands and increase in the per capita fish availability in the state. More over the other indirect impact was change in the dietary pattern of the fisher family and availability of educational avenues for the children.

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