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IMPACT OF AQUACULTURE IN THE SMALL MULTIPLE USE WATER BODIES

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The small multiple use water bodies or multiple use aquaculture resources (MAR) constitute the largest potential aquaculture resources available in the country but the present aquaculture use has been limited due to lack of policy attentions. The aquaculture in such water bodies generates wide range of benefits to the users and communities. To assess the status of aquaculture and benefits out of it, a study was conducted during 2009-2010 in the interior and coastal areas of Odisha representing three categories of the management system i.e. community-based, group-based and private management. It was found that the aquaculture production and productivity were low but produces wide range of social and community benefits. About 43 percent of the fish produced were consumed by the villagers and each household consumed around 2.7 kg of fish from MAR. The members and non-members of the management were equally benefited out of it. The community services like village function, temple maintenance, road repair etc., were also partially sponsored by aquaculture activities.

INTRODUCTION

Small multiple use water bodies are the largest categories of the water bodies available in the freshwater sector for present and future use of aquaculture. These aquaculture resources can be termed as multiple use aquaculture resources (MAR). These are considered as lifelines in villages as it provide variety of ecological, economic and social functions. The multiple uses like irrigation, domestic use, livestock use and fisheries etc. make these resources highly valued; therefore, necessitate effective management. The management of these resources involves diverse users and stakeholders from government to communities and households depending on it. Use of MAR for culture of fish has increased in the recent times due to higher demand and price of fish along with the popularization of the aquaculture technologies. The users, communities and groups put efforts to access and utilize these resources for aquaculture purposes. Most of these water bodies are owned by government, local self-governance (Panchayat) or communities. Therefore, governance arrangements determine the level of achievements in aquaculture.

But, limited information is available on socio-economic dynamics, institutions, practices and impact of aquaculture. The development agencies often ignore the opportunities of aquaculture development in the multiple use water bodies. But, the aquaculture in these water bodies poses a huge potential for fish production and socio-economic development of the communities and region.

The aquaculture practiced in these multiple use water bodies are with very low use of inputs and technologies and, are often termed as traditional aquaculture, low input aquaculture, rural aquaculture or low impact aquaculture. In recent times, the small scale aquaculture is the widely accepted term for such system (Bondad-Reantaso and Prein, 2009). It is quite contrast to the level of investments and inputs used in the commercial or industrial scale high input based aquaculture. Though the level of fish production and productivity in small scale aquaculture is quite low but social and economic benefits are quite significant (Ahmed, 1992; Ahmed and Lorica, 2002; Demaine, 2009; Gupta *et al*., 1999). The major benefits of such aquaculture are better management of the inputs and resources available in the farm; use of wastes like crop residue and waste water etc. (Edward *et al*., 1988); utilization of the unused water resources (Bunting, 2008); supply of quality protein to the local communities and environment management (Kumar, 1992). A wide variety of the technological options are available for low input aquaculture but it fails to reach to the farmers due to many constraints (Gupta, 1992; Little and Edwards, 1999; Kumar, 1992). Some of the options for the encouragement of the low input aquaculture are community-based aquaculture, integrated aquaculture system with rice and livestock and, waste water aquaculture (Bunting, 2006; FAO, 1997). The low input aquaculture can be managed in a variety of ways like community-, group-based or private management with involvement of diverse stakeholders (Barik and Katiha, 2003; Chopra and Dasgupta, 2002). The benefits from such system to the society and households are quite large.

In India, few studies on the practices in aquaculture were conducted (FAO, 1999; Kumar, 1992; Radheyshyam, 1997; 1998; 2001) but its impacts have not been systematically studied. There is considerable gap in the knowledge over the impact of such low input aquaculture or rural aquaculture in India. The impacts beyond the fish production are primarily felt at the levels of households, communities and regions (Gupta and Dey, 1999). Study of these impacts will provide valuable information and feedback to the policy makers for developing low input aquaculture in MAR.

The present paper makes an attempt to convince the policy makers to place greater attention towards these aspects by assessing the benefits of aquaculture in the multiple use water bodies. It is based on the study conducted in one Indian state, Odisha during 2009-2010. Specifically, the paper has the objectives of assessing (i) nature of

aquaculture in the multiple use water bodies, (ii) production and productivity of aquaculture and (iii) social and household impacts of aquaculture.

MATERIALS AND METHODS

The study of multiple use water resources need to be characterized at physical and socio-economic level. Physically, the MAR are of diverse kinds and termed as ponds, tanks, water harvesting structures, micro-irrigation structures etc. In coastal Odisha, the ponds are created by digging out soil, whereas in interior Odisha, tanks are created by placing a bund across the drainage channel to trap and store rainwater. In sampled areas in the present study, the size of the water bodies in the interior areas (2.12 ha) were found to be relatively larger compared to coastal regions (1.06 ha). Most of the ponds in coastal regions were made for sanitation purpose like bathing etc., whereas in interior areas it was for the purposes like sanitation, irrigation, water storage and fisheries etc.

The social and institutional factors governing these resources are critical for the sustainable aquaculture management of these resources. These resources are primarily owned by the Government, as most of the water bodies during post-independence period brought under the Government control. Subsequently, these resources were transferred to the Panchayats, Irrigation Department and Revenue Department etc. In the recent policy of Government (Anonymous, 2004), all the water bodies those are less than 40 ha were transferred to the Panchayats or local self-government. The Panchayats are empowered to control, manage or lease out these water bodies. In actual practice, the Panchayats lease out these water bodies to the individual or self-help group for a period of 1-5 years. Even though there is lack of clear policies, the role of communities in the access and management of these resources are quite evident. The communities exert indirect pressure for the aquaculture use of these water bodies. In large number of cases communities directly manage the aquaculture. Hence, the aquaculture management in these water bodies are either community-based, group-based or private management.

The present study is an attempt to report and analyze the first hand information on benefits of aquaculture by conducting empirical study through sampling in four districts of Odisha i.e., Puri and Khordha in coastal areas and, Nuapada and Bargarh in interior areas. The study is based on the samples of 84 (51 from coastal and 32 from interior) water bodies. The village level information and about five to six users associated with the MAR were also sampled. A total of 324 households and 61 villages were studied. The field study was undertaken during the year 2009-10. The samples were drawn from the water bodies put to aquaculture uses, which constitute only a small part of the water bodies as a large part of such bodies are not used for aquaculture purposes.

For the present study, the impact of aquaculture in the multiple use water bodies were assessed through observing direct benefits in the production, productivity, profit and consumption of fish. The community benefits are assessed primarily through indicators like fish consumption, sponsoring of community services and number of persons benefited.

The net consumption of fish from the water bodies was assessed by the following formula;

C =A+B1+B2i+B2ii*0.5

Where,

C- Fish consumption per village from multiple use water bodies

A- Small fish caught for self-consumption

B1- Fish shared among the community members

B2i- Fish directly sold to villagers

B2ii- Fish sold to retailers

RESULTS AND DISCUSSION

Multiple use water bodies as aquaculture resources

The state of Odisha in general lacks reliable information system to assess the extent of the aquaculture resources and its use. The published information by Department of Fisheries, Government of Odisha considered the ponds and tanks as aquaculture resources. Among the sampled ponds and tanks, the multiple use water resources recorded as Gram panchayat and revenue tanks constitute 71% of the water areas. Therefore, at least 71% of total water bodies are in the form of the multiple use aquaculture resources (MAR) in Odisha (Table 1). However, a wide variety of water bodies like small irrigation and water harvesting structures, farm ponds, check dams, mini-barrages etc. can also be used for aquaculture purposes. These resources are used for various purposes like irrigation, religious and domestic uses etc. and can also be used for aquaculture with application of various levels of technologies and inputs. In recent times, the aquaculture use has been on the rise due to high demand and price of fish.

Table 1. Category wise ponds and tanks in Odisha

Category	Number (in 1000)	Area (in 1000 ha)	Av. size of pond in ha	Percentage of total
Gram panchayat tank	63.29	50.31	0.79	41.79
Revenue tank	13.36	35.93	2.69	29.84
Private tank	155.57	34.16	0.22	28.37
Total	233.22	120.4	0.52	100.00

(Source: Department of Fisheries, Government of Odisha)

Constraints to the aquaculture production

There are numerous constraints in practicing aquaculture in these water bodies (De and Saha, 2006). Most important among them is the lack of access to the resources, technologies and information. Radheyshyam *et al.* (2011) studied the constraints in details and the major constraints are short term lease, lack of technical support, conflicts and financial strength. Overall, the lack of access, restrictions to use inputs and conflicts are important for the lack of aquaculture development. Among the selected samples, the users reported limited restrictions on the management of aquaculture or input use and hence, there exist great potentials for the aquaculture development in these areas (Table 2).

Table 2. Restrictions in aquaculture management in multiple use ponds (percent of cases reported)

Types of restrictions imposed	Region		Management type			Total
	Coastal	Interior	Community	Group	Private	
Aquaculture management	11.8	3.1	10.0	11.1	4.0	8.4
Input use	5.9	6.3	7.5	0.0	8.0	6.0

Aquaculture technology

The aquaculture productivity in the MAR was very low due to lower level of technology applications. The percent of water bodies using various components of aquaculture is presented in Table 3. Use of inputs like fertilizer and manuring were reported in about 50 percent of the water bodies and higher percentage were reported for liming and stocking of these ponds. The adoption of technologies was very low in the interior areas compared to coastal areas. The level of selected input use was found to be about 231 kg of lime and 125 kg feed, which is normally considered as low (Table 4). The use of seeds for stocking was at a variable degree. The seeds used were based on the availability and convenience without following appropriate technological recommendations. The users reported using spawns at various stages, which was often unreliable to estimate the stocking size especially in the context of mortality and predation.

Table 3. Adoption of technology components of aquaculture (Percent reported)

	Region		Management types			All
	Coastal	Interior	Community	Group	Private	
Liming	84.0	16.7	84.2	50.0	50.0	71.0
Fertilization	48.0	25.0	50.0	33.3	33.3	43.5
Manuring	54.0	75.0	50.0	75.0	66.7	58.1
Feeding	48.0	75.0	44.7	75.0	58.3	53.2
Stocking	86.0	91.7	89.5	83.3	83.3	87.1
Medicine	2.0	0.0	0.0	0.0	8.3	1.6

Table 4. Selected input use in aquaculture in kg per ha

Inputs	Region		Management type			All
	Coastal	Interior	community	Group	Private	
Lime	293.75	187.5	262.5	231.25	206.25	231.25
Feed	293.75	12.5	350	18.75	18.75	125

Fish production, income and profit

The fish productivity was found to be 581 kg/ha/yr among the sampled water bodies. This indicated a general low level of technology and investment in aquaculture practiced in these water bodies. Among the various management systems, the productivity was higher in community (695 kg/ha) and group (500 kg/ha) managed water bodies compared to private (390 kg/ha) managed one. Similar productivity was reported in the multiple use water bodies in Bangladesh (Ahmed, 1992; Gupta *et al.*, 1999). This form of the aquaculture was even lower than the standard extensive system of aquaculture which has the productivity level of around 1 t/ha (Edwards *et al.*, 1988). This low extensive system of aquaculture depended primarily on the natural fertilization and fish food organisms available in the water bodies with very limited supplementary inputs from outside. But, under this system of management the profitability in the aquaculture was very high. On an average 218% of profit was found over the net investment. The average cost of production was Rs. 22/kg of fish compared to the selling price of Rs. 70/kg. The income per ha of the water bodies was found to be around Rs. 41,000 with a profit of about Rs. 28,000, which was comparatively higher than other productive activities. This high level of profit is an encouragement for the users to put the resources under aquaculture use (Table 5).

Table 5. Production, income and profit of aquaculture in multiple use water bodies

	Region		Management type			Total
	Coastal	Interior	Community	Group	Private	
Total cost per ha (Rs.)	16598.5	5091.0	14223.7	14516.7	8345.4	12877.2
Production per ha (kg)	742.7	244.3	694.7	499.8	389.9	581.5
Income per ha (Rs.)	52375.1	17332.5	49105.2	35665.7	27130.1	41057.3
Income per water bodies (Rs.)	55668.5	36687.1	56259.1	48172.5	42503.8	52012.9
Av size of water bodies (ha)	1.06	2.12	1.15	1.35	1.57	1.27
Profit per ha (Rs.)	35776.6	12241.5	34881.5	21149.0	18784.7	28180.1
Profit per water bodies (Rs.)	38026.2	25911.1	39963.2	28565.3	29429.3	35699.7
Profitability (%) (Profit/cost*100)	215.5	240.5	245.2	145.7	225.1	218.8

Disposal pattern of fish

The aquaculture in the multiple use water follows unique pattern of disposal of fish. The net production of the fish could be divided into three parts *viz.*, small fish caught for self-consumption among the villagers (A), fish shared among the community members who were part of the management system (B1) and fish sold to others. The fish sold were either in form of direct sale in the village, to retailers, to wholesalers or others.

A part of the small fishes were caught by the villagers in smaller quantities with smaller nets which were accessed freely by the communities. These fishes were caught from the connecting channels and marginal areas etc., generally for self-consumption. However, the cultured fishes caught from these water bodies were either consumed by the villagers or being sold to the market. It was found that in each water bodies about 6.3 quintals of the fishes were available for disposal. Out of which about 14 percent in the coastal area and 11 percent in the interior areas were distributed among the users or villagers. In the community-managed resources, the distribution to the community was about 19 percent. The share was 8.3 percent among members in the group-managed system. About 14 percent of the fishes from the community ponds were sold directly to the villagers, whereas it was 8 and 3 percent for the group and private ponds, respectively. In the coastal areas and community ponds most of the remaining fishes were sold to wholesalers. But in the interior areas almost all the fishes were given to the retailer to sale directly to the consumers in the nearby areas. The groups were giving equally to the wholesaler and retailers whereas private mangers were depending on the retailer for fish disposal. This is indicative that a large portion of the fishes were available to the villagers and nearby areas for consumption (Table 6).

Table 6. Disposal pattern of fish (%)

	Region		Management type			All
	Coastal	Interior	Community	Group	Private	
Among the users	13.9	10.7	18.5	8.3	1.2	12.9
Sold in village	10.9	4	13.6	7.7	3.2	9.5
Sold to wholesalers	63.8	2.2	63	38.4	7.7	53
Sold to retailers	8.6	81.1	3.4	44.3	84.9	22.3
Others	2.8	2	1.5	1.3	3	2.4

The species-wise disposal patterns were also important to understand the dynamics of the fish disposal in the multiple use ponds. The share of the villager or community through direct distribution and purchase was less for Indian major carps as most of them were sold outside the village either through wholesalers or retailers.

Whereas, the access of other fishes likes catfishes, small fishes and other fishes were very high. The access of the villagers to these fishes was as high as 40 to 60 percent. In other words, it can be said that except major fishes at least half of the fishes produced from the village MAR were consumed in the village itself (Table 7).

Table 7. General patterns of disposal of various categories of fishes

	Indian major carps	Catfishes	Small fishes	Others
Among the users	5.0	12.2	27.8	51.3
Sale in village	4.6	41.3	15.9	12.8
Sale to wholesalers	28.5	21.2	29.3	35.9
Sale to retailers	60.9	-	-	-
Others	0.9	12.9	15.9	-

Access to fish among the community members

The fish sold were either through direct sale to villagers (B2i), retailers (B2ii) and wholesalers (B2iii). Out of which the components A, B1, B2i and B2ii were directly available to the communities in the villages. Total fish consumption in the village was total of all the above i.e. fish consumption per village (C) =A+B1+B2i+B2ii*0.5 with the assumption that half of the fish given to retailers are sold in the village. Most of the fishes were available to the villagers or nearby villages. Therefore, the consumption benefits to the local areas were quite high which increased the access of the communities to the fish (Fig 1). About 43% of the fish produced from the water bodies are available to the villagers. On an average, MAR supplied about 0.4 kg fish per capita and each family consumed around 2.7 kg of fish. The total access to the fishes among the villagers was through direct catch, share of fish or purchase. The estimation based on these calculations is presented in the Table 8.

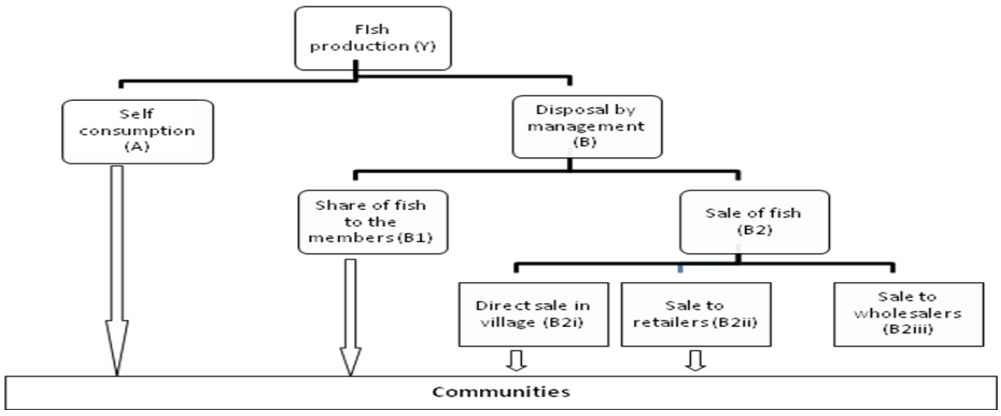

Fig 1. Process of access to fish by the communities from multiple use water bodies

Table 8. Access to fish to the village communities

	Region		Management type			All
	Coastal	Interior	Community	Group	Private	
Fish production/WB (kg/ha) (Y)	789.4	517.1	795.9	675	610.8	736.7
fish disposed (kg/yr) (B)	688.2	479.2	685.7	585.3	567.8	630
Self-consumption (kg/yr/WB) (A)	101.2	37.9	110.2	89.7	43	106.7
Share of fish (kg/yr/WB) (B1)	95.7	51.3	126.9	48.6	6.8	81.3
Direct sale to villagers (kg/yr/WB) (B2i)	75.0	19.2	93.3	45.1	18.2	59.5
Sale to retailers (Assume 50% in village) (B2ii) (kg/yr/WB)	29.6	194.3	11.7	129.6	241.0	70.1
Total fish available to villages (kg/yr/WB)(C)	301.5	302.7	342.0	313.0	309.0	317.6
Share of fish to village (%)	38.2	58.5	43.0	46.4	50.6	43.1
Population in the village (nos)	834	771	848	765	797	822
Family size (nos)	7.4	5.2	7.8	5.4	5.9	7.0
Per capita fish consumption from WBs (kg)	0.36	0.39	0.40	0.41	0.39	0.39
Per family availability (kg)	2.68	2.03	3.15	2.21	2.29	2.70

Number of persons benefited

On an average 30 members were engaged in the management of the aquaculture. In the community-based management 37 people were involved, whereas in group-based system 21 people were involved. The members were eligible to receive the share of fish and other benefits from aquaculture. The other members were also having access to the water bodies for fishing purposes. The open access fishing was limited to the small fishes in the channels or in the marginal areas or after major fishing from the water bodies. Generally after the last harvest of fish, the village communities together were involved in fishing. In each water bodies around 54 people were involved in such practices. The share of the member and other fisheries users were 2.7 and 2.0 kg of fish per person per year. The other community members like fish harvesters were benefited by catching fish while the villagers were benefited from consuming fish (Table 9).

Table 9. Share of fish of members and non members of aquaculture management

	Region		Management type			All
	Coastal	Interior	Community	Group	Private	
No. of users (members)	33	20	37	21	1	30
Share of fish per capita in kg	2.9	2.6	3.4	2.3	6.8	2.7
Other fisheries users (nos)	58	49	61	43	48	54
Consumption per capita of others in kg/yr	1.7	0.8	1.8	2.1	0.9	2.0

Community benefits

Average cumulative savings from the aquaculture was found to be approximately 67 thousands rupees in sampled water bodies. In the interior, the saving was far lesser than in the coastal areas even though the sizes of the water bodies were quite large. The community-managed ponds were used to save around Rs. 36,000 where as it was Rs. 49,000 for the group-based management. The private were able to save a large sum of money (around Rs. 2,15,000). The community-managed ponds were used primarily for all the expenditure, whereas the group used for operational expenditure as well as in creating assets (Table 10).

Table 10. Community benefits from aquaculture

	Region		Management type			All
	Coastal	Interior	Community	Group	Private	
Cumulative savings from aquaculture (Rs.)	73258	47231	35931	48769	215250	66874
Money used for community purposes (% reported)	76.4	18.8	80	44.6	20	54.2

In addition to the consumption benefits, the aquaculture in the multiple use ponds contributed significantly to general welfare of village communities. A part of the savings from the aquaculture were used for various community purpose expenditures like village function, village development, panchayat development, SHG development, fishery development or development of the religious institutions. In Odisha, most villagers organized annual village functions which were linked to the annual religious festival of village goddess. Such functions were socially and culturally important for village communities. The income from the community ponds contributed significantly to the village function. In 10 percent of the cases, the income from the fisheries was used for the religious Institution like temple. In the group-managed water bodies, the development of SHG and fisheries were sponsored by income from MAR. In the private-managed ponds also the income was used for village function or development (Table 11).

Table 11. Pattern of use of the saved money (% reported)

Items	Region		Management type			All
	Coastal	Interior	Community	Group	Private	
Village function	69.2	100.0	81.3	37.4	80.0	73.4
Village development	5.1	0.0	0.0	12.6	20.0	4.4
Panchayat development	2.6	0.0	3.1	0.0	0.0	2.2
SHG development	7.7	0.0	0.0	37.4	0.0	6.6
Fishery development	5.1	0.0	3.1	12.6	0.0	4.4
Religious institutions	10.2	0.0	12.5	0.0	0.0	8.9

CONCLUSION

The small multiple use water bodies often ignored at the policy level for the impression of being conflicts laden and unmanageable. Little attention on research and development are paid on such system of aquaculture. The flow of the information and support to these water bodies are very limited. Despite these limitations, the community interests in these water bodies are quite significant. The communities have a direct and indirect engagement in these water bodies particularly in access, management and appropriation of it. The study has given strong evidence that the aquaculture benefits are equally shared among the large numbers of households in the villages. The village communities are the largest beneficiaries in terms of fish consumption and community services. At least 43 percent of the fish produced are available to the villagers; therefore, the fish consumption benefits are quite significant. These resources constitute the single largest water bodies covering 71 percent of the aquaculture resources in the state of Odisha. Therefore, the small multiple use water bodies offer a huge potential for the aquaculture development and, community and social benefits out of it would be large.

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