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Study of Present Status and Future Prospects Aquaculture

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ABSTRACT

The present paper is an attempt to assess Indian inland aquaculture with respect to its resource base, output trends, systems and activities, yield gaps, adoption and impact on aquaculturists, economics, returns to inputs, investment needs, and future prospects.

1. Introduction

During the past two decades, the inland fisheries in India, which include both capture and culture fisheries, have registered tremendous growth and change. Until the mid-1980s, capture fisheries were major source of inland fish production. But since then, fish production from natural waterways, such as rivers and lakes, has trended downwards, primarily due to a proliferation of water control structures, indiscriminate fishing, and habitat degradation (Katiha, 1999). Diminishing resources, the energy crisis and the resultant high cost of fishing have led to an increased realization of the potential for and versatility of aquaculture as a viable and cost effective alternative to capture fisheries (Ayyappan & Jena, 2001; Ayyappan, 2004; Jana & Jena, 2004; Pillai & Katiha, 2004).

With the importance of inland aquaculture in India in mind, the present paper provides an insight into aspects of the country's inland aquacultural resources, production practices and trends, and future prospects. The sector includes both fresh and brackish waters. Based on the observations, recommendations are made about how to further develop inland aquaculture sector in India.

Data Sources and Methodology

The present study is based on literature searches and analysis of secondary and primary data gathered under ICAR-World Fish demand supply project. The data on the resources, production levels, activities and systems, potential, investment needs, future prospects, and requirements of aquaculture came either from the literature or from other secondary sources. The observations on yield gaps (IRRI, 1979), economics, and returns to inputs were based on analysis of primary information and on the responses of researchers and aquaculturists gathered during the project. The level of adoption of technology is low (<33%), medium (33% to 66%), and high (>66%) as per methodology of Bhaumik et al. (1992). The returns to various inputs=factors of production have been computed on the basis of their shares in costs=investment.

2. Results and discussion

By virtue of its geographical situation in the monsoon belt, India is endowed with good rainfall. As a consequence, it has extensive potential aquacultural area in the form of ponds and tanks. These water bodies are distributed throughout almost all the states of India (Table 1).

TABLE 1 Inland Aquacultural Water Bodies in India

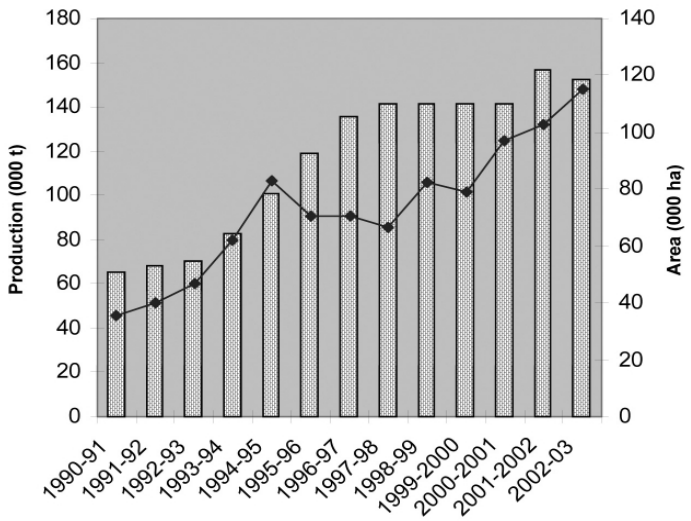
State	Total area of aquacultural water bodies ('000 000 ha)	Area as % of all aquacultural water bodies in India	Area covered by FFDA ('000 ha)	% of state aquacultural water bodies covered by FFDA	Production on FFDA adopted farms (t)	Yield on FFDA adopted farms (kg/ha/year)
Andhra Pradesh	0.517	(21.65)	13.72	2.65	26,074	1,900
Arunachal Pradesh	0.001	(0.04)	0.16	16.40	180	1,098
Assam	0.023	(0.96)	3.44	14.97	6,368	1,850
Bihar	0.095	(3.98)	22.31	23.49	47,527	2,130
Goa	0.003	(0.13)	N.A.	N.A.	N.A.	N.A.
Gujarat	0.071	(2.97)	30.93	43.57	34,027	1,100
Haryana	0.010	(0.42)	18.57	185.70	65,005	3,501
Himachal Pradesh	0.001	(0.04)	0.26	26.30	658	2,502
Jammu & Kashmir	0.017	(0.71)	1.56	9.15	2,022	1,300
Karnataka	0.414	(17.34)	21.70	5.24	31,898	1,470
Kerala	0.030	(1.26)	4.00	13.34	7,202	1,800
Madhya Pradesh	0.119	(4.98)	54.96	46.19	86,292	1,570
Maharastra	0.050	(2.09)	11.31	22.63	6,109	540
Manipur	0.005	(0.21)	1.79	35.82	2,507	1,400
Meghalaya	0.002	(0.08)	0.03	1.25	18	720
Mizoram	0.002	(0.08)	0.15	7.30	219	1,500
Nagaland	0.050	(2.09)	1.16	2.33	1,163	1,000
Orissa	0.114	(4.77)	39.84	34.95	75,698	1,900
Punjab	0.007	(0.29)	12.15	173.57	49,628	4,085
Rajasthan	0.180	(7.54)	4.17	2.32	7,211	1,730
Sikkim	N.A.	N.A.	0.06	N.A.	196	3,500
Tamil Nadu	0.224	(9.38)	12.15	1.76	16,521	1,360
Tripura	0.012	(0.50)	3.33	27.78	6,666	2,000
Uttar Pradesh	0.162	(6.78)	69.21	42.72	138,410	2,000
West Bengal	0.276	(11.56)	98.78	35.79	296,349	3,000
Pondicherry	N.A.	N.A.	0.07	N.A.	75	1,119
Other	0.003	(0.13)	N.A.	N.A.	N.A.	N.A.
Total	2.388	(100.00)	425.82	14.93	908,023	2,135

Source: Anon (1996a, 1996b); Sinha and Katiha (2002).

These bodies cover an area of over 2.388 million hectare(s), with the largest areas being in the state of Andhra Pradesh (0.52mhectare(s)), followed by Karnataka (0.41mhectare(s)) and West Bengal (0.276mhectare(s)). These three states account for about 50.5% of India's aquacultural waters.

Despite immense efforts to increase the size of the industry, only 0.8 million hectare(s) have been brought under scientific fish culture. In the early 1970s, Fish Farmers Development Agency (FFDA) was set up with World Bank assistance to promote the adoption of modern aquacultural techniques and thereby increase fish production. The agency has adopted over half of the 0.8 million hectare(s) dedicated to scientific fish culture. The greatest penetration of FFDA into the sector has been in the states of Punjab and Haryana. In those states cropping density is more than one, as is evidenced by the fact that, in those states, the cropped area is greater than the actual area.

The potential area of Indian coast brackishwater farming has been estimated at 1.19 million hectare(s), of which only 13.14% (0.157m hectare(s)) is so used. However, there has been phenomenal growth of the sector, especially in shrimp farming, during last one decade, with area coverage increased from 65,000 hectare(s) in 1990–91 to 152,000 hectare(s) in 2002–03. The area covered in different maritime states for shrimp farming during the period is presented in Figure 1.



3. Returns to Inputs for Different Freshwater Aquacultural Systems

The returns to factors of production are computed as per their share in cost. The net returns and the proportions of the gross return attributed to the various inputs for different aquacultural. Inputs were broadly divided into two groups—capital (including fixed and variable) and labour. The systems examined were carp polyculture (three levels), integrated fish farming, air-breathing fish culture, prawn and carp, prawn culture, and pen culture systems. The per hectare(s) net returns for carp polyculture varied from INR 33,075 (low input) to INR 68,625 (high input). In comparison, sewage fed carp culture with additional feed delivered a net return of INR 59,163. For systems of integrated fish farming, per hectare(s) net returns ranged from INR 16,463 (for paddy-cum-fish culture) to INR 48,168 for (duck-cum-fish culture). Of all the systems, prawn culture delivered the highest per hectare(s) net returns (INR 138,750), followed by carp and prawn culture (INR 71,750). Net returns were generally higher for systems with higher investments.

The study revealed that the return to labor as a proportion of gross return was very low. Most of the labor was associated with harvesting.

4. Freshwater Aquacultural Systems

The microlevel investment needs for various systems of aquaculture, as represented by the total annual costs per hectare(s), were provided it can be seen that costs were highest for high-input carp polyculture (INR 0.3 million), followed by air-breathing fish culture (INR 0.17 million) and prawn culture (INR 0.16 million). The investment needs were lowest for low input carp polyculture (INR 0.04 million), followed by paddycum-fish culture (INR 0.043 million).

The levels of investment that would be needed to exploit the potential areas for intensive, semi-intensive and extensive carp culture in various states of India were estimated and are presented in Table 2. In total, investment of INR 113.37 billion would be required—66% of that in semiintensive carp culture, 20% in extensive carp culture, and 14% in intensive carp culture.

TABLE 2 Investment Needs of the Dominant Freshwater Aquaculture Systems (in million INR)

States	Intensive carp culture	Semi-intensive carp culture	Extensive carp culture	Total
Andhra Pradesh	612.75	1,324.40	293.48	2,230.63
Assam		144.48	12.58	157.06
Bihar		481.60	125.78	607.38
Goa			6.29	6.29
Gujarat		240.80	83.85	324.65
Haryana	153.19	48.16		201.35
Himachal Pradesh		3.61	0.84	4.45
Jammu & Kashmir		48.16	20.96	69.12
Karnataka		120.40	586.95	707.35
Kerala		24.08		24.08
Madhya Pradesh		240.80	209.63	450.43
Maharastra		120.40	83.85	204.25
Orissa		481.60	125.78	607.38
Punjab	153.19	24.08		177.27
Rajasthan		180.60	209.63	390.23
Tamil Nadu		240.80	335.40	576.20
Uttar Pradesh		1,083.60		1,083.60
West Bengal	612.75	2,408.00		3,020.75
North-east		120.40	167.70	288.10
Other		6.02		6.02
Total	1,531.88	7,341.99	2262.69	11,136.56
% of total	13.76	65.92	20.32	100.00

(Modified from Katiha & Bhatta (2002) and Katiha et al. (2003)).

5. Future prospects and requirements

Freshwater : As mentioned above, despite immense efforts to expand the inland aquaculture in India, only one third of the potential freshwater area under ponds=tanks has been brought under scientific fish culture. Tapping the production potential would require effective and intensive adoption of available technologies, the transfer of technical know-how and the provision of material inputs. Flexibility in both areas of operation and scales of investments, compatibility of freshwater aquaculture practices with other farming systems and a high potential for eco-restoration have provided a congenial environment for the establishment of freshwater aquaculture as a viable industry. Because of its potential and its impressive annual growth rate of over 6%, the government of India is encouraging aquaculture development. As part of the national freshwater aquaculture development plan, ‘‘Operation Aqua-Gold’’ is looking to increase the area dedicated to aquaculture to 1.2 million hectare(s). With an average productivity of 2762 kg= hectare(s)=year, this will result in an annual yield of 3.3mt of fish, 1.65 times the current level of freshwater aquacultural production (Gopakumar et al., 1999). Strategies to increase the area (by 45.2%) and productivity (by 50.9%) in order to reach the target output have been developed. These strategies incorporate both horizontal and vertical expansion and take into account the potential and problems of the different states. The

projected water spread area of aquaculture ponds and tanks under different production levels should reach 1.2mhectare(s) (Table 3)

TABLE 3 Projected Water Spread under Different Production Levels ('000 ha)

State	Projected water spread under different production levels							
	8 t/ha/year	6 t/ha/year	5 t/ha/year	3 t/ha/year	2 t/ha/year	1 t/ha/year	0.5 t/ha/year	Total
Andhra Pradesh	20		50.0	60.0		70.0		200.0
Assam			6.0	6.0	3.0			15.0
Bihar			10.0	30.0	30.0			70.0
Goa					1.5			1.5
Gujarat				20.0	20.0			40.0
Haryana	2.0	3.0	4.0					9.0
Himachal Pradesh				0.3	0.2			0.5
Jammu & Kashmir				4.0	5.0			9.0
Karnataka				10.0	20.0	50.0	70.0	150.0
Kerala			1.0	1.0				2.0
Madhya Pradesh				20.0	50.0			70.0
Maharastra				10.0	10.0	10.0		30.0
Orissa			10.0	30.0	30.0			70.0
Punjab	2.0	3.0	2.0					7.0
Rajasthan			5.0	10.0		20.0	30.0	65.0
Tamil Nadu				20.0	20.0	60.0		100.0
Uttar Pradesh			10.0	80.0				90.0
West Bengal	20.0		100.0	100.0				220.0
North-east				10.0	20.0	20.0		50.0
Other				0.5				0.5
Total	44.0	6.0	198.0	411.8	209.7	230.0	100.0	1,199.5
% of total	3.67	0.50	16.51	34.33	17.48	19.17	8.34	100.00

Source: Modified Gopakumar et al. (1999), Katiha & Bhatta (2002).

in order to achieve the targeted fish production of 3.3mt. For this purpose the aquaculture activity needs to be cover 0.37mhectare(s) additional water area. The percentage share of area under different production levels in total projected area would be 3.67%for 8 t=hectare(s)=year, 0.50%for 6 t=hectare(s)= year, 16.51%for 5 t=hectare(s)=year, 34.33%for 3 t=hectare(s)=year, 17.48% for 2 t=hectare(s)=year, 19.17%for 1 t=hectare(s)=year, and 8.34%for 0.5 t= hectare(s)=year. It indicates that approximately 80% of the area will be under production level of 3 t=hectare(s)=year or less. It seems to be a viable option.

In addition to more land dedicated to ponds and tanks, an increase in fish production levels would require an increase in seed and feed. The requirements are detailed in Table 4.

TABLE 4 : Present and Projected Area, Fish Production and Input Requirement for Freshwater Aquaculture in India

State	Total area (m ha)	Projected water area coverage (m ha)	Present production (m t)	Projected fish production (m t)	Projected yield (t/ha/yr)	Present seed production (Million fry)	Projected seed production (Million fry)	Projected feed requirement (000 t)
Andhra Pradesh	0.517	0.2	0.18	0.66	3.3	709	3020	1170
Assam	0.023	0.015	0.03	0.054	3.6	2547.54	222	93
Bihar	0.095	0.069	0.13	0.2	2.9	332.2	860	295
Goa	0.003	0.002	0.001	0.003	1.5	0.03	15	3
Gujarat	0.071	0.04	0.04	0.1	2.5	191.17	440	130
Haryana	0.01	0.009	0.026	0.054	6	200.73	212	116
Himachal Pradesh	0.001	0.001	0.002	0.001	1	23.1	5.6	1.75
Jammu & Kashmir	0.017	0.009	0.005	0.022	2.44	12.6	98	28
Karnataka	0.414	0.15	0.07	0.155	1.03	164.34	1240	85
Kerala	0.003	0.002	0.005	0.008	4	20.26	32	14.5
Madhya Pradesh	0.119	0.07	0.07	0.16	2.29	564.34	740	190
Maharastra	0.05	0.03	0.04	0.06	2	293	320	65
Orissa	0.114	0.07	0.093	0.2	2.86	186.69	860	295
Punjab	0.007	0.007	0.026	0.044	6.29	44	172	96
Rajasthan	0.18	0.065	0.005	0.09	1.38	175	600	95
Tamil Nadu	0.224	0.1	0.08	0.16	1.6	467.43	1040	130
Uttar Pradesh	0.162	0.089	0.1	0.29	3.26	546.62	1160	460
West Bengal	0.276	0.22	0.58	0.96	4.36	8180	3800	1850
North-eastern region	0.072	0.05	0.028	0.09	1.8	334.78	520	85
Other	0.001	0.001	0.001	0.001	1	14.52	6	2.25
Total	2.358	1.199	1.512	3.312	2.76	15,007.35	15,362.6	5,204.5

(Modified Gopakumar et al. (1999)).

It should be noted that, currently, the 18,500 million fry produced each year supply both the culture and the culture-based fisheries; to reach the target production levels, almost the same amount of fry would be needed to supply just the culture fisheries alone. The projected seed requirement could be supplied by new hatcheries in seed-deficit states and=or

imported from seed-surplus states. The projected area required for brood-stock management and seed rearing is 79,950 hectare(s), about 6.7% of the projected culture area in the country. It would need to be prepared for the purpose of providing the quality seed needed to increase aquacultural productivity.

6. Conclusion

Freshwater aquaculture is largely based on organic fertilization, but to increase productivity and fully exploit the potential of aquacultural waters, intensive use of supplementary feed would be necessary. An estimated 5.2mt of fish feed would be required for this purpose. The feed formulations could be traditional mixtures of rice=wheat bran and groundnut= mustard oil cake. The enrichment of these mixtures with at least 30% of protein is necessary for high production systems (6–8 t=hectare(s)=yr). Besides, these requirements special emphasis is needed on the institutional settings in terms of multiple uses, lease policy and ownership pattern, and infrastructural support for research and development, marketing, and value addition.

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