

Impact of fisheries development programmes on livelihoods: A perception-based analysis of fish farmers in Chhattisgarh, India

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Abstract

A study was conducted to analyse the impact of fisheries development programmes on the livelihoods of fish farmers in Chhattisgarh State of India, based on their perceptions. A total of 120 beneficiaries were selected from 4 blocks of Raipur District viz., Tilda, Abhanpur, Dharsiwa and Arang. Data were collected using an interview schedule and the impact was assessed across five livelihood capitals using before-and-after scores. Appropriate statistical tests were performed to test the differences between the scores. Study revealed that fish farmers have benefited from these fisheries' development programmes, reporting improvements across all five livelihood capitals. The Wilcoxon Signed Rank Test revealed a significant difference between before-and-after scores for all livelihood capitals at 5% level of significance. The highest change was observed in physical capital (39.69%), followed by natural capital (37.20%), financial capital (29.64%), human capital (25.83%) and social capital (24.58%). These findings suggest that fisheries development programmes have positively impacted all livelihood capitals of fish farmers.

Introduction

Fisheries and aquaculture sectors are among the fastest growing sectors globally, contributing immensely to food supply, job creation, improved nutrition and foreign exchange earnings. In India, the leading states in aquaculture are Andhra Pradesh, West Bengal, Uttar Pradesh, Bihar and Odisha. The newly formed state of Chhattisgarh is also emerging as a notable contributor in this sector. Chhattisgarh is the 6th largest producer of both fish seed and inland fish in the country. As per the official website of Department of Fisheries (DoF), Chhattisgarh, the state recorded a fish production of 5,91,284 t in 2021-22. During the same period, total fish seed stocking stood at 14690.49 lakhs standard fry, while total fish seed production reached 30, 257 lakhs standard fry. Existing 82 circular hatcheries, 59 fish farms and 1126 individual rearing units in Chhattisgarh, collectively cover a rearing area of 646.73 ha across both Government and private sectors. Present demand for fish seed is estimated at

142 crores standard fry, while production reached 302 crores. As of 2021-22, the state has 1,23,261 rural ponds covering 1.173 lakh ha and 1,770 irrigation reservoirs spanning 0.826 lakh ha, amounting to a total of 1.999 lakh ha of water area are available for fisheries development. Currently 2.21 lakh fish farmers in the state are engaged in fisheries activities providing 352 lakh mandays of employment annually.

Fisheries sector contributed ₹3422 crore to the GDP of the state in 2015-16, which is 13.10% in the agriculture sector in Chhattisgarh. Overall GDP contribution of the state in the fisheries sector is 1.57% (DoF, 2016). Freshwater (inland) fish farming plays an important role in the rural livelihoods of Chhattisgarh. Apart from direct self-employment opportunities from fish farming, pond fish farming offers diverse livelihood opportunities. Fisheries in the region are predominantly culture based with the majority of cultivable species comprising Indian major carps (IMC), exotic carps, minor carps and catfishes.



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Keywords:

Chhattisgarh, Fisheries schemes, Fish farmers, Impact assessment, Livelihood

Received : 17.07.2022

Accepted : 25.06.2025

IMC includes catla (*Labeo catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*). Exotic carps commonly cultured include common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*) and black carp (*Mylopharyngodon piceus*). Among catfishes *Pangasius (Pangasianodon hypophthalmus)* is the widely cultured species. The State Fisheries Department has implemented various fisheries development programmes benefiting 26,164 fish farmers as reported in 2016-17 (DoF, 2016-17). These programmes are expected to have a significant impact on the livelihoods of the beneficiaries. Livelihood comprises five key capitals viz., human, social, physical, natural and financial (Chambers and Conway (1991). Accordingly, a study was undertaken to analyse the impact of fisheries development programmes on the livelihood of fish farmers.

Materials and methods

The study was conducted in Raipur District of Chhattisgarh, with fish farmers selected from four blocks (Tilda, Abhanpur, Dharsiwa and Arang). From each block, 30 fish farmers were selected following a random sampling method. Data were collected through a structured interview schedule. Responses of fish farmers were recorded and analysed before and after the implementation of fisheries development programmes with reference to each livelihood capital. The same respondents were asked to rate their perceptions on a 5-point scale (0 to 4) regarding conditions both before and after the introduction of these fisheries development programmes. The Recall method was used for recording responses. Physical capital was assessed using 8 parameters, with a maximum possible score of 32; natural capital included 5 parameters, with a maximum score of 20, financial capital had 7 parameters with a maximum score of 28; human capital was measured with 9 parameters, with maximum score of 36 and social capital comprised 10 parameters with a maximum score of 40.

Average scores for each livelihood capital were calculated. To enable comparison of components measured in different units, normalisation was performed using the following formula:

$$\text{Dimension value} = \frac{\text{Actual value} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}}$$

The Wilcoxon signed rank test was performed to test the hypothesis if there was any significant difference in the livelihood scores before and after the fisheries development programmes. The hypothesis tested was as follows:

H_0 = There is no significant difference between before and after scores for each livelihood capital

H_1 = There is a significant difference between before and after scores for each livelihood capital

Wilcoxon signed-rank test was done as follows:

$$Z = \frac{T^+ - \mu_{T^+}}{\sigma_{T^+}}$$

where,

$$\mu_{T^+} = \frac{T^+ - (N + N)}{4}$$

$$\sigma_{T^+} = \sqrt{\frac{N(N+1)(2N+1)}{24}}$$

T^+ = Sum of ranks for smaller sample size (of signed rank)

N = Sample size

Wilcoxon signed-rank test for tied rank and large samples:

$$\sigma^2 T^+ = \frac{N(N+1)(2N+1)}{24} - \frac{1}{2} \sum_{j=1}^g T_j(T_j-1)(T_j-1)$$

where, g = Number of groupings of different tied ranks

T_j = Number of tied ranks in grouping j

Results and discussion

A brief profile of beneficiaries of fisheries development programmes/schemes revealed that majority of the beneficiary farmers (86.7%) belonged to middle age group (30-60 years), followed by old age group (>60 years). Only 3.3% of the beneficiary farmers were from the younger age group (<30 years). Among the fish farmers surveyed, 29.2% had a secondary level of education, followed by 25.8% with primary education, 16.7% had higher secondary education, 13.3% were illiterate, while 11.7 and 3.3% had graduate and post-graduate level educational qualifications, respectively. Out of the 120 respondents, majority (95.8%) belonged to other backward class (OBC) and majority (99.2%) were Hindus. All fish farmers were married. The majority (75.8%) of fish farmers lived in joint families, while 24.2% were part of nuclear family setup. In terms of family size, 68.3% had 6-10 members, 20.2% had smaller families of 1-5 members and only 11.7% had large families with more than 10 members.

The majority (41.7%) of fish farmers lived in kutchha houses, followed by 38.3% with semi-pucca houses and 20% in pucca houses. It was found that 99.2% of the respondents had their own house while only 0.8% of the respondents stayed in rented house. Regarding access to drinking water, 70% had drinking water facility at home and 30% relied on village hand pumps. Hospital facilities were present within the village for 84.2% of the respondents while 15.8% did not have hospital facilities within the village.

Among the respondents, 65% had only fisheries as their occupation, while 27% were involved in fisheries along with agriculture, other small businesses. A total of 39.2% of fish farmers had 11-20 years of experience in fisheries followed by 30.8% having <10 years experience and 18.3% with 21-31 years of experience. Jhajarhia *et al.* (2013); Thakur (2015) and Bhandarkar *et al.* (2017), have also reported similar findings from Chhattisgarh. Various fisheries development programmes/schemes implemented by the Department of Fisheries, Chhattisgarh in 2015 are described below.

Fish seed production scheme: This is the state plan scheme introduced in 2003-04 with the objective of promoting aquaculture by providing healthy fish seed. Implemented under both the General plan and Tribal sub-plan, the main task of this scheme is to produce quality fish seed through scientific methods and to fulfill the requirement of fish farmers especially residing in remote

areas. Demand for fish seeds for departmental reservoirs and river ranching programmes is also met out under the scheme. The scheme covers various components such as farm maintenance, electricity charges, hatchery operations, seed production and rearing, feeding and the development of new infrastructure. For fish seed production, the existing 69 circular hatcheries, 60 fish farms and 721 individual rearing units spanning a total available water area of 415.01 ha are involved across both Government and private sectors.

Development of reservoirs and rivers scheme: This is another component of the state plan scheme for development of reservoirs and rivers of the state. This scheme mainly aims to maintain the biodiversity in natural resources like reservoirs and rivers by fish seed ranching. As per state policy on reservoirs, average water area up to 200 ha has been transferred to Panchayat Raj bodies for leasing out to the local fishermen co-operatives. According to the policy, three-tier Panchayats under their jurisdiction have a provision of leasing for a fixed period of 10 years for up to 200 ha of reservoir area to local fishermen, though amendments have been made recently. Water bodies of 200-1000 ha and above 5000 ha are leased out to fishermen co-operative societies by the Department. Water bodies above 1000-5000 ha are allotted to Chhattisgarh Matsya Mahasangh on a royalty basis. Chhattisgarh is mostly covered by Mahanadi and Godavari river systems, with some areas of the state also falling within the Ganga and Narmada river systems.

Fish seed stocking in rivers and anicuts: As per instructions and recommendations of the Prakkalan Committee of the Chhattisgarh Legislative Assembly, a new programme for fish seed stocking in rivers and anicuts of the State was initiated in 2015-16.

Departmental training: This programme primarily aims to enhance the knowledge and skills of fish farmers and improve their livelihood conditions by providing training under the state plan schemes. Under these schemes, fishers from tribal and scheduled caste communities are trained on modern scientific methods of fish culture and capture, as well as net making and boat rowing. The training is conducted for a duration of 10 days. Each participant receives a total benefit of ₹1,250/- which includes a daily stipend of ₹75/-, nylon twine worth ₹400/- and ₹100/- in cash, along with travel fare and other incidental expenses.

Out-of-state study tour: This state fisheries scheme was introduced in 2003-04. Apart from the local training, the progressive fish farmers from various sectors across the state are sent to other states to learn advanced techniques of fish culture. Under this scheme, the Government provides ₹2500/- per trainee for a 10 days out-of-state tour. This amount includes a training allowance of ₹750/-, travel ticket fare of ₹1500/- and ₹250/- for miscellaneous expenditures.

Polyculture, prawn culture and ornamental fish culture: This state fisheries scheme was introduced in 2007-08 mainly for providing financial assistance to fish farmers for the development of fisheries. It includes grants for prawn culture and ornamental fish culture for fishers belonging to general as well as scheduled caste/tribe communities. Under the scheme, there is provision of ₹15,000/- for purchase of prawn seeds and ₹12,000/- for fish seeds. Additionally, support is extended for fertilisers and related inputs over a period

of three years; ₹7,500 in the first year, ₹4,965 in the second year and ₹2,535 in the third year.

Assistance for the net and boat: This scheme was introduced in 2007-08, with the objective of providing fishery equipment to beneficiaries in the state. Under this, financial assistance is provided to tribals and other fish farmers towards support for the procurement of boats and nets. There is a budget provision of ₹30,000/- for this purpose.

Assistance for fish seed rearing unit: The scheme, fully (100%) funded by the state Government, was implemented in the year 2007-08 to promote spawn culture in village areas. It supports stocking of spawns in seasonal ponds of 0.50 ha area. For stocking of spawn, 100% grant is provided by the DoF.

Assistance for fingerling stocking: This scheme is 100% funded by the state Government and is applicable to fish farmers from scheduled caste (SC), scheduled tribe (ST) and general categories. It provides 50% subsidy for fingerling stocking in ponds, with a provision of ₹2,000 for the purchase of fingerlings, available for a period of five years.

Assistance for retail sales: This scheme was introduced in 2010-11 to support fish farmers from SC, ST and general category, to improve their retail fish marketing practices. Assistance is provided for the purchase of essential equipment such as ice boxes, weighing machines and fish quality testing devices. Each beneficiary receives financial support of ₹6,000 for procuring the necessary equipment.

Grant to registered fishermen co-operative societies: This state fisheries scheme was introduced in 2003-04 to strengthen registered fishermen cooperative societies. Under the scheme, financial assistance of up to ₹3 lakh is provided over a period of three years for the purchase of equipment and other necessary items. As per the Government policy, water bodies above 1 ha are to be leased out to co-operatives. In addition to grants, financial assistance is also extended to fishermen cooperatives in the form of loans and subsidies under this scheme. Each fishermen cooperative society is eligible for a subsidy up to a ₹25,000/- per year for three years.

All 120 fish farmers selected for the study, had benefitted from more than one scheme; however, not all farmers were beneficiaries of each individual development programme. Table 1 presents the number of beneficiaries for each programme/scheme among the selected farmers.

Impact of fisheries development programmes on different livelihood capitals

Physical capital: Physical capital comprises infrastructure and producer goods (DFID,1999). In the present study, the parameters used to assess physical capital included, type of house, electricity facility at home, drinking water facility at home, sanitation facility at home, health treatment facility at the village, fish market facilities, transportation facility and road facility. Fish farmers reported that the fisheries development programmes had a positive impact on physical capital. The increase in income has resulted in better facilities for drinking water, electricity and sanitation facilities at home. It was also reported that fish market facilities improved

Table 1. Beneficiaries of fisheries development programmes

S. No.	Programmes	Sample size (N)	Frequency (No.)		Percentage (%)	
			No	Yes	No	Yes
1	Fish seed production scheme	120	29	91	24.2	75.8
2	Development of reservoirs and rivers scheme	120	81	39	67.5	32.5
3	Fish seed stocking in rivers and anicuts	120	68	52	56.7	43.3
4	Departmental training	120	37	83	30.8	69.2
5	Out-of-state study tour	120	94	26	78.3	21.7
6	Polyculture, prawn culture and ornamental fish culture	120	95	25	79.2	20.8
7	Assistance for net and boat	120	27	93	22.5	77.5
8	Assistance for fish seed rearing in seasonal ponds	120	40	80	33.3	66.7
9	Assistance for fingerling stocking	120	52	68	43.3	56.7
10	Assistance to for retail sales	120	27	93	22.5	77.5
11	Grant to registered fishermen co-operative societies	120	48	72	40.0	60.0

near the villages. Table 2 presents the before-and-after scores of fish farmers for physical capital. From table 2, it is clear that for all the parameters of physical capital there has been positive change due to fisheries development programmes. Improvements were at household as well as community level.

Natural capital: Natural capital refers to environmental assets such as land, soil, water, forests and fisheries. These resources may be governed by communal management and traditional systems that determine access and usage, or they may be open access resources ('freeds') such as water bodies, forests or grazing land (DFID, 2000).

In the present study, natural capital was assessed using parameters such as pond/land area, fish production levels, water availability for fisheries activities, sources of fish seed and availability of various fish species. Similar parameters have been used in studies by Pravakar *et al.* (2013) and Khatun *et al.* (2013). Table 3 presents the natural capital scores of the fish farmers. From Table 3, it is clear that all parameters of natural capital, showed positive changes as a result of fisheries development programmes. Fish

farmers reported increase in land area under fish production, improved water availability and better availability of fish seed. While development projects often report negative impacts on natural capital, this study observed a positive effect, particularly in the context of fisheries. Similar findings were reported by Uddin and Islam (2016) in their study on integrated farming and its impact on farmers' livelihoods in Bangladesh, where improvements in cultivable land and access to open water resources were noted. Singh *et al.* (2013) also highlighted that Chhattisgarh State has enormous potential for development of fisheries with favourable climatic and meteorological conditions for fisheries sector. Additional information on distribution of agricultural land, pond area, ownership of ponds, nature of ponds and cultured fish species is presented below:

Agricultural land: Majority of the fish farmers (22.5%) had marginal (<1 ha.) and small (1-2 ha.) landholdings. Whereas 14.2% of the farmers belonged to semi-medium category (2-4 ha.), 11.7% to the medium category (4-10 ha) and 8.3% to the large category (above

Table 2. Impact of fisheries development programmes on physical capital

S. No.	Parameters	Before		After	
		Mean score	Normalised mean	Mean score	Normalised mean
1	House type	1.76	0.44	2.66	0.66
2	Electricity facility	1.57	0.39	2.98	0.75
3	Drinking water facility	1.08	0.27	2.71	0.68
4	Sanitation facility	1.44	0.36	3.05	0.76
5	Health facility	1.33	0.33	2.76	0.69
6	Fish market facilities	1.58	0.39	3.19	0.80
7	Transportation facility	1.35	0.34	3.16	0.79
8	Road facility	1.50	0.38	3.80	0.95

Table 3. Impact of fisheries development programmes on natural capital

S. No.	Parameters	Before		After	
		Mean score	Normalised mean	Mean score	Normalised mean
1	Area of pond/land	1.37	0.34	2.32	0.58
2	Fish production (per ha.)	1.48	0.37	2.64	0.66
3	Water availability for fisheries activities	1.46	0.36	2.91	0.73
4	Source of fish seeds	1.50	0.38	3.38	0.85
5	Availability of various fish species	1.63	0.41	3.63	0.91

10 ha). Notably, 20.8% of the fish farmers did not own any agriculture land. Table 4 presents the distribution of agricultural land among the fish farmers.

Pond area: Majority of the fish farmers (44.2%) had medium sized ponds, whereas 21.7% had semi-medium ponds (2-4 ha) followed by 20.8% who owned large ponds.

Ownership of pond: The majority of fish farmers (74.2%) had leased ponds, while 21.7% owned their ponds. Only 4.2% of the farmers had access to both leased and own ponds. The lease amount ranged from ₹4000-110000 per year, depending on the size of the pond.

Nature of pond: Majority of fish farmers (47.5%) had perennial fish ponds, while 45.8% had both perennial and seasonal ponds. Only 6.7% of the farmers relied solely on seasonal ponds.

Fish species: All fish farmers practiced composite and single species fish culture in their ponds, primarily using Indian major carps (IMC); exotic carps (EC) and catfishes. IMC includes catla (*Labeo catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*). Exotic carps cultured were common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*) and black carp (*Mylopharyngodon piceus*). Among catfishes *Pangasianodon hypophthalmus*, was the major species cultured.

Financial capital: Financial capital includes the financial resources that people use to achieve their livelihood objectives. It includes two main sources of financial capital, which are available stocks and regular flow of money (DFID, 1999). In the present study, financial capital parameters comprised annual income of the fish farmer, total annual family income, annual income from fisheries, saving, family expenditure (on fish farming, food and other expenses), general assets and fisheries assets. Table 5 presents the financial capital scores.

From Table 5, it is evident that there was positive changes for all the parameters of financial capital due to fisheries development

Table 4. Agricultural land

Land area	Frequency	%
No land	25	20.8
Marginal (less than 1 ha)	27	22.5
Small (1.0-2.0 ha)	27	22.5
Semi-medium (2.0-4.0 ha)	17	14.2
Medium (4.0-10.0 ha)	14	11.7
Large (above 10 ha)	10	8.3
Total	120	100.0

Table 5. Impact of fisheries development programmes on financial capital

Parameters	Before		After	
	Mean score	Normalised mean	Mean score	Normalised mean
Annual respondent income	1.59	0.40	2.93	0.73
Annual family income	1.88	0.47	3.08	0.77
Annual income from fisheries	1.65	0.41	2.93	0.73
Annual savings	0.53	0.13	1.89	0.47
Annual family expenditure (For fish farming, food and for any other items)	1.90	0.48	2.98	0.74
General assets	1.67	0.42	2.73	0.68
Fisheries assets	1.38	0.34	2.36	0.59

programmes. The increase in profit depicted in financial capital resulted from an increase in fish production due to various fisheries development schemes. It can thus be inferred that the development programmes contributed to the flow of financial capital which has the capacity to be converted to other forms of capital, like assets, food, health, production equipment, education and housing. In addition, information about annual family income, annual savings of the farmers and annual family expenditure are presented below:

Family income: Majority of the fish farmers (49.2%) had an annual family income in the range of ₹1,00,000-2,00,000, followed by 25% with an income in the range of ₹2,00,001-3,00,000; 14.2% had income above ₹3,00,000 and only 11.7% had income less than or equal to ₹1,00,000. The average annual family income was found to be ₹2,24,908.30.

Savings: It was found that majority of the respondents (37.5%) had annual savings of ₹10,001-25,000; 24.2% had savings less than or equal to ₹10,000 and 11.7% had annual savings less than ₹25,000. The remaining 26.7% of families reported no savings. Average annual savings was found to be ₹22,348.33.

Human capital: Human capital includes the skill, knowledge and ability/availability of labour and good health that enable people to pursue different livelihood strategies and achieve their livelihood objectives (DFID, 1999). In the present study, human capital parameters included fisheries skill, fisheries related information, fisheries knowledge, awareness about government fisheries schemes, desire to learn new tasks related to fisheries, participation in the fisheries training programmes, attitude towards fisheries department, attitude towards fisheries schemes and availability of labour for fisheries activity. Table 6 presents the scores of human capitals.

From Table 6, it is clear that most of the human capital parameters improved following the fisheries development programmes. The enhanced knowledge and education through various programmes enabled farmers to pursue fish farming more efficiently. However, respondents reported a decline in labour availability. Additional data on fisheries skills, training participation, stipend received and women's participation in training are presented below:

Fisheries skills: Fish farmers had skills in fish identification, breeding, disease identification, water and soil quality analysis, netting, net making and boat rowing. Most fish farmers (79.2%) attended training programmes organised by the Department of Fisheries (DoF), lasting 3 and 10 days under the guidance of fisheries officers. But 20.8% of fish farmers did not attend any fisheries related training. Through these training programmes, most of the farmers enhanced their skills in species identification,

Table 6. Impact of fisheries development programmes on human capital

Parameters	Before		After	
	Mean score	Normalised mean	Mean score	Normalised mean
Fisheries skill	1.64	0.41	3.01	0.75
Fisheries information	1.28	0.32	2.72	0.68
Fisheries knowledge	1.20	0.30	2.65	0.66
Awareness about Govt. fisheries schemes	1.11	0.28	2.58	0.65
Desire to learn new tasks related to fisheries	2.91	0.73	3.31	0.83
Participation in the fisheries training programme	1.26	0.31	2.48	0.62
Attitude towards fisheries department	1.06	0.26	2.36	0.59
Attitude towards fisheries schemes	1.04	0.26	2.40	0.60
Availability of labour for fisheries activity	3.38	0.85	2.67	0.67

fish breeding, disease detection, water/soil testing, netting and net braiding. Women's participation in the training was low, with only 23.3% attending training programmes, despite 60.8% of women actively involved in fisheries activities such as stocking, feeding, harvesting, marketing and net braiding. Kumari *et al.* (2014) have reported that women have benefitted from formation of SHGs in Chhattisgarh. Sharma *et al.* (2015) also reported about the need for women empowerment in the fisheries sector.

Social capital: Social capital includes networks and connectedness, membership in formal groups and relationships of trust (DFID, 1999). In the present study, social capital parameters included, leadership capabilities, desire to be a leader, participation in social meetings, participation in social work, social relationships with family, neighbours and other fish farmers, women's participation in fisheries work, contact with government organisations (GOs) and contribution of women in decision making. Table 7 presents the social capital scores.

From Table 7, it is evident that, all social capital parameters among fish farmers had a positive impact due to the fisheries development programmes. Farmers reported stronger relationship with peers, increased participation in meetings and enhanced contact with the DoF. The provision of grants to fishery cooperatives significantly boosted participation of members in fish farming. Capacity-building programmes such as trainings and meetings further strengthened social networks. According to DFID (2007), connectedness and social relations facilitate cooperation and reduce transaction costs. Kebe *et al.* (2009) too found that social capital of fishers' results in better leadership, cooperativeness and community participation

in fisheries activities. Social capital in the form of networks, connectedness, cultural norms and others social attributes have significantly helped in exchanging experiences, sharing of knowledge and cooperation among rural households as reported by Fine (1999) and Stirrat (2004). Mondal *et al.* (2013) similarly reported that neighbours, relatives and friends who had received training served as main sources of technical assistance, thereby strengthening social capital.

The above discussion clearly demonstrates that fisheries development programmes have positively impacted all five livelihood capitals as perceived by the fishers. The most pronounced outcomes were in physical capital followed by natural and financial capitals. Improvements were also observed in human and social capitals.

Fig. 1 presents the radar chart on the impact of fisheries development programmes on livelihood capitals. Table 8 presents the results of Wilcoxon signed rank test, assessing whether there were any significant differences in the livelihood scores before-and-after the fisheries development programmes. From Table 8, it is evident that fisheries development programmes have led to positive change across all livelihood capitals. Results of non-parametric Wilcoxon signed rank test also revealed significant differences ($p < 0.5$) between before-and-after scores for all livelihood capitals. Interpreting the empirical evidence of the study, the most pronounced impact of the fisheries development programmes was on physical capital. Fish farmers reported that higher income led to better facilities of drinking water, electricity, and sanitation at home along with improvement in market facilities leading to

Table 7. Impact of fisheries development programmes on social capital

Parameters	Before		After	
	Mean score	Normalised mean	Mean score	Normalised mean
Leadership capabilities	2.49	0.62	3.37	0.84
Desire to be a leader	0.93	0.23	2.22	0.55
Participation in social meetings	1.75	0.44	2.78	0.69
Participation in social works	1.77	0.44	2.84	0.71
Social relationships with family	3.60	0.90	3.88	0.99
Social relationships with neighbours	2.03	0.51	2.77	0.69
Social relationships with other fishers	2.03	0.51	3.17	0.79
Women's participation in fisheries work	1.01	0.25	1.93	0.48
Contact with government organisations	1.36	0.34	2.55	0.64
Contribution of women in decision making	1.34	0.34	2.63	0.66

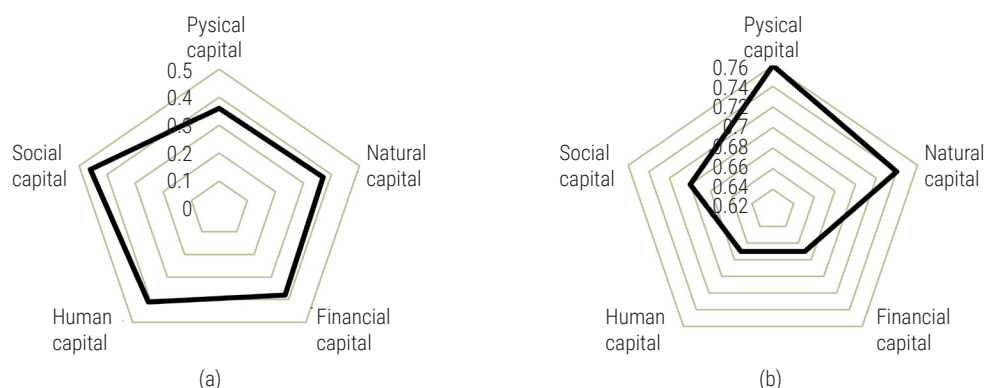


Fig. 1. Impact of fisheries development programmes on livelihood capitals. (a) Before; (b) After

Table 8. Results of Wilcoxon signed rank test

Livelihood capital	Before		After		%	Z values	Decision
	Mean score	Normalised mean score	Mean score	Normalised mean score			
Physical capital	11.61	0.36	24.31	0.76	39.69	9.475	Reject H_0
Natural capital	07.43	0.37	14.88	0.74	37.20	9.513	Reject H_0
Financial capital	10.58	0.38	18.88	0.67	29.64	9.531	Reject H_0
Human capital	14.88	0.41	24.15	0.67	25.83	9.516	Reject H_0
Social capital	18.31	0.46	28.14	0.70	24.58	9.534	Reject H_0

improvement in physical capital scores. Natural capital showed significant improvement due to the increase in land under fish production, water availability and increase in fish production. Financial capital improved as farmers realised higher profits. It was reported by fish farmers that the enhanced knowledge and education achieved through various programmes enabled them to pursue fish farming more effectively, leading to higher human capital scores. Human capital, is distinct from other assets since it is something that cannot be taken away once obtained; and represents a durable, sustainable resource that directly elevates quality of life. The provision of grants to fishery cooperatives has resulted in significant participation of members in fish farming, thus bringing an improvement in the social capital score. The positive social attributes of aquaculture make it an attractive entry point to improve the livelihood. However, despite these gains, respondents noted a decline in available labour for fisheries activities, indicating a potential constraint on future growth.

Acknowledgements

Authors gratefully acknowledge all fish farmers of Chhattisgarh for their invaluable participation and support.

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