Adoption of cage farming has enhanced livelihood security of the reservoir fishers: Evidence from Jharkhand state of India

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Abstract The reservoirs of India, due to high biogenic production potential, form a very important fishery resource. In addition to contributing to fish production, they also play a significant role in livelihood and nutritional security to a large section of an economically underprivileged population in India. Livelihood security implies the sustainable assurance of the means of livelihood for the people. Development of livelihood security index could be one of the most important social indicators for assessing the quality of life, coupled with meeting the basic needs of human beings. The present study was conducted in the state of Jharkhand which is one of the early adopters of cage culture in India. Primary data were collected through personally interviewing 100 fishermen families in 2018. Data were collected on the different livelihood capitals viz., natural, physical, financial, human, and social capital. The study found that overall, the livelihood security of the fishers was low to moderate. The Livelihood Security Index is better in the case of cage fishers. Cage farming has contributed to both social capital formation and financial empowerment. They have also accumulated some durable assets due to improvements in household income. These findings show the importance of cage culture in enhancing the livelihood of the fishers. However, the study found much scope for further improvement of the indices. The fishers should be motivated to rear animals to supplement their income to enhance natural capital. Support needs to be provided for the purchase of farm poultry birds, small ruminants, etc. To enhance the social capital, there is a need to provide proper counseling for fishers for the formation of SHGs, youth clubs, and Farmer's Interest Groups. The co-operatives of the fishers should also be active and dynamic.

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Introduction

The reservoirs of India, due to their high biogenic production potentials, form very important fisheries resources of the country and are highly conducive for fishery activities (Ekka *et al.*, 2012). The sheer magnitude of the reservoirs (3.51 m ha) provides ample opportunity to enhance fish production substantially. In addition to fish production, they also play a significant role in livelihood and nutritional security to a large section of the economically underprivileged population in India and play a great role in the socio-economic development of the country (FAO 1997; Thilsted *et al.*, 1997). Understanding the livelihood systems of the poor is crucial to effective poverty reduction. However, there is very scant literature on consistent, regular, and reliable socio-economic information of the reservoir dependent fishers.

Livelihood security implies the sustainable assurance of the means of livelihood for the people. Frankenberger *et al.* (2000) proposed Household Livelihood Security (HLS) as adequate and sustainable access to income and resources to meet basic needs. This HLS includes adequate access to housing, food, health facilities, potable water, educational opportunities, time for community participation, and social integration.

Livelihood of a household is secured when it can acquire, protect, develop, utilize, exchange, and benefit from assets (i.e. natural, physical, financial, human, and social) and resources (Ghanim, 2000). Composite indicators (CIs), which compare the performance of social and economic parameters recognized as a useful tool in policy analysis. Human Development Index (HDI), developed by the United Nations Development Program (UNDP) (1989) is the best known composite index of social and economic wellbeing. Development of livelihood security index could be one of the most important social indicators for assessing the quality of life, coupled with meeting the basic needs of human beings. The literature on livelihood security index is very rare, although some researchers have worked on livelihood vulnerability index (Eriksen and Kelly, 2006; Hahn *et al*., 2009; Vincent and Cull, 2010; Madhuri *et al*., 2014; Pal *et al*., 2015). In the present study, a scale to measure the livelihood security of the fishers was developed. The study will provide a framework of socio-economic and livelihood security status to the planners and policymakers for formulating suitable programmes for the upliftment of these impoverished communities.

Material and methods

The study found that around 14,000 cages were installed in different inland waters of India. Among the different states, Jharkhand is one of the early adopters of cage farming. Hence, the study was conducted in the state of Jharkhand. The state became the success story in the cage culture in reservoirs. Cage fish farming was started on an NMPS scheme in the state in the year 2007. The ICAR-CIFRI has estimated that at present there were all together around 5500 cages under operation in 23 reservoirs of the state. Among all the cages, majority (89%) were of GI made frame cages. The goal of the cage culture in the state was two-fold: to fulfil the protein requirements of the people at a low cost and to create livelihood opportunities for the displaced farmers.

For the present study, the data were collected through field surveys in Tenughat, Patratu, Tilaiya, and Chandil reservoirs of the state. The State Fisheries Dept. of the state was also contacted for the said purpose. Among the four, the Chandil is a large reservoir of about 22,000 ha at FRL constructed in the river Subarnarekha. In this reservoir around 100 displaced families undertook cage culture in the reservoir since 2011-12. The reservoir is surrounded by several villages with a lot of tribal population depending on fishing in the water body. Tenughat is a medium reservoir in River Damodar having a water spread area of about 12,000 ha at FRL. Tilaiya is also a medium reservoir in River Barakar that has a water spread area of around 5,900 ha. The Patratu is the smallest reservoir among these four. The FRL area is around 990 ha and has been constructed over the River Nalkari. Cage culture in the last three reservoirs has been going on since 2012-13. In all the reservoirs Jharkhand Fisheries Department is the implementing agency of the cage culture scheme.

Primary data were collected through personally interviewing 100 fishermen families in 2018. Among the respondents, 32 were ordinary reservoir fishers and 68 were fishers involved in cage fish farming. Data were collected on the different livelihood capitals viz., natural, physical, financial, human, and social capital. The indices were developed following Binkadakatti (2013). However, the methodology was substantially modified to suit the capture fishers particularly in cage culture in reservoirs. The livelihood security index was worked out by taking an arithmetic mean of the 5 livelihood capital indices.

Results and discussion

Basic socio-economic characteristics of the fishers' households

Basic socio-economic characteristics of fishers' households, presented in Table 1, revealed that the average family size of the fishers was around 5.5. The literacy

Table 1. Socio-economic characteristics of the fishers households

Particulars	Cage fishers	Ordinary fishers
Average age of the respondent (yrs)	37	33
Years of education of the respondent	9.15	6.22
Average family size (headcount)	5.49	5.74
Literacy rate of the household (%)	83.99	74.07
Occupation migration (in % of households)	8.82	11.11
Number of economic activities	3.66	3.63
Monthly Income (Rs.)	17548	11093

Table 2. Sub-components and scores under natural capital

Sr. No.	Sub-components	Maximum score
1	Size of reservoirs	3
2	Owned agricultural land	3
3	Possession of livestock	14
	Total score under natural capital	20

rate of the respondents was also good. In general, the socio-economic characteristics of the cage fishers are better than those of ordinary fishers. The monthly income was also significantly higher in the former group of fishers. On an average the number of economic activities was almost equal in both categories of fishers, however, the occupation migration was lower in cage farmers households.

Development of livelihood security index

Based on the review of the past studies (Binkadakatti, 2013) five components, namely, natural, physical, financial, human, and social capitals that are most relevant to measure Livelihood Security of the fishers were enlisted. Subcomponents of each component were identified through review of literature. The numbers of sub-components of each component were three for natural, four for physical, four for financial, four for human, and three for social capital. Weightages/scores for different types of sub-components were assigned based on their significance in livelihood.

Natural Capital

Reservoir area, owned agricultural land and possession of livestock were taken into consideration for natural capital (Table 2). The reservoir area influences the livelihood of the fishers. Small reservoirs very often dried up and fishers lost their important source of livelihood. Hence small, medium and large reservoirs carry 1, 2 and 3 weights, respectively.

Similarly, the livestock composition includes possession of buffaloes/cows, bullocks, goat/sheep, and poultry by the fishers. Scores were assigned based on different types and the number of livestock and the maximum possible score for livestock composition is 14. After totaling these three sub-components, the maximum possible score of natural capital was 20. Finally, the natural capital index was computed as the ratio of scores related to reservoir area, owned land, and livestock composition to the maximum possible score of natural capital. The formula is as follows.

Natural Capital Index % (NCI) = 100 (Score related reservoir resource + owned land + livestock composition)/20

Physical capital

Physical capital connotes the basic infrastructure facilities like the type of house, source of energy for cooking, household asset, fishery crafts and gears possessed by the fishers. Each sub-component of physical capital and maximum scores as given in Table 3.

Type of house refers to the house type where the fishers were living. Two types of houses, viz., kachha and pucca with weightages were considered for quantification of house type. To quantify the source of energy for cooking, firewood and LPG were considered.

Table 3 Sub-components and scores under physical, financial, human and social capital

Physical capital	Maximum score	**Human capital**	Maximum score
Sub-components		Sub-components	
Type of house	4	Frequency of visit to a hospital by the Head of HH	3
Source of energy for cooking	3	Medical treatment available	6
Household asset possession	15	Access to the health facility	3
Fishery crafts and gears	12	Education of the family head	3
Total score	34	**Total score**	15
Financial capital		**Social capital**	
Annual income	3	Organisation participation	2
Off-fishery/nonfishery	4	General information access	9
Unpaid loans	3	Fishery information access	6
Savings	3	**Total score**	17
Total score	13		

Table 4 component-wise Livelihood Security Indices (LSI)

Index	Cage fishers	Ordinary fishers
Natural capital index	31.03	30.19
Physical capital index	35.55	33.66
Financial capital index	74.77	62.68
Human capital index	42.74	36.11
Social Capital index	42.39	30.72
Livelihood Security Index	42.06	36.63

Weightage of 1 and 2 was given for firewood and LPG respectively. Household asset possession refers to the different household materials possessed. Five types of house hold materials, viz. radio/FM, television, mobile phones, own source of drinking water, own toilet, bike, and four-wheelers were taken into account as they are directly related to the livelihood of the fishers. The maximum possible score for household material possession is 15. Fishermen possessed different types of nets and boats to catch fishes from the reservoirs. Four types of crafts and gears (nets < 10 kg, nets > 10 kg, small boat (*dinghy*) and wooden boat) with weightages were considered. The maximum possible score for crafts and gears is 12 since a fishermen household may possess multiple crafts and gears. Physical Capital Index was calculated as discussed in the Natural Capital Index.

Financial capital

Financial capital denotes the capital bases or financial resources like cash/annual income, expenditure, credit/ loans, and savings of the fishers. The sub-components and scores have been given in Table 3. For annual income scores were assigned based on the magnitude of the annual income. Off-fishery/nonfishery income refers to the presence of off-fishery and non-fishery income which supplement the income of the family. Weightages were assigned based on the number of off-fishery and non-fishery income in the household. Fishers take loans from various sources like nationalized banks, co-operative societies, private agencies, *etc.* The unpaid loans are a liability to the fishers, hence, it is an indicator of financial health. The scores were inversely assigned depending upon the percentage of the loan remained unpaid on the day of investigations. Saving in the present context refers to the balance of income after the regular expenditure of the households. Weightage was assigned for low, medium, and high savings of the fishers, respectively. Therefore, the maximum possible score for financial capital is 13.

Human capital

Good health facilities and level of education were considered for human capital. Scores for each sub-component of human capital were given as mentioned in Table 3. Health facilities refer to the various medical facilities available and their accessibility. Education of the family head refers to the number of years of formal education acquired by the fisher family head. Weightages were assigned for a different level of education viz. illiterate, primary, secondary, collegiate and the maximum score of human capital is 15. The index for Human Capital was calculated as earlier.

Social capital

Social capital incorporates the extent of organizational participation, and sources of information. Organizational participation refers to the type of participation (members or office bearer) informal organization. The weightages were assigned as per the type of participation. Information access refers to the extent of access to information by the fishers from different categories of sources. Family members, neighbours/ friends, print and electronic media, elected member of GP/TP/ZP under general and forefathers, department and University scientist/KVK under fishery were considered for quantification of information access. The maximum possible score for social capital is 17 and the Social Capital Index was also calculated in a similar way as followed in other capital indices.

Finally, the Livelihood Security Index (LSI) was calculated as follows.

Livelihood Security Index (LSI) = 100 (Score related to natural capital + physical capital + financial capital + human capital + social capital)/ Maximum possible score for Livelihood security

The empirical results

The developed indices were applied with the collected data from the four reservoirs. The component-wise livelihood security indices have been presented in Table 4.

Table 5 Distribution of the fishers based on their Livelihood Security Indices (LSI)

LSI	% of fishermen households	
	Cage fishers	Ordinary fishers
<30	11.76	7.41
30-40	35.29	62.96
40-50	26.47	29.63
50-60	20.59	-
60-70	2.94	-
>70	2.94	-
Total	100.00	100.00

The table reveals that, the Livelihood Security of the fishers was found to be 42.06 and 36.63 per cent for the cage and ordinary fishers, respectively. Among the components of Livelihood Security, financial capital performed better. Human capital and social capital performed moderately well among all the capitals. In general, the indices are better in the case of cage fishers. This is due to better indices in all the livelihood capitals. Cage culture provided them better performance in all the fronts, income, asset possession, health, education, social contacts. However, overall, in both cases, there is a scope of increasing the indices. Among the components of the Livelihood Security, the natural capital of both kinds of fishers was found to be low (30-31%). This is mainly because the land holdings and livestock possession were poor among the fishers. There were no significant differences in the natural capital and physical capitals of both kinds of fishers. However, in the other three components, there are significant differences. The Financial capital of the fishers was found to be highest (75 and 63%) among the various components of the Livelihood Security. This is because of better performance in loan/credit, annual income, and presence of off-fishery or non-fishery income. The Human capital of the cage fishers was found to be better than their non cage counterpart. The social capital of the fishers was found to the extent of 42 percent and 31 percent for cage fishers and ordinary fishers, respectively.

Most of the ordinary fishers (63%) belonged to the lower Livelihood Security category followed by medium (30%). Whereas, their counterpart of cage fishers belong to medium to high Livelihood Security categories. These findings show the importance of cage culture in enhancing the livelihood of the fishers.

Conclusions

Overall, the livelihood security of the fishers was found to be low to moderate. The Livelihood Security index is better in the case of cage fishers. These findings show the importance of cage culture in enhancing the livelihood of the fishers. The schemes of cage fish farming have solved the livelihood problems of the displaced to some extent. Cage farming has contributed to both social capital formation and financial empowerment. They have also accumulated some durable assets due to improvements in household income.

However, there is much scope for further improvement of the indices. The Government should take appropriate measures to enhance livelihood security to a satisfactory level. Hence, the fishers should be impressed upon to rear animals to supplement their income to enhance the natural capital. Support needs to be provided for the purchase of farm poultry birds, small ruminants, *etc*. To enhance the social capital, there is a need to provide proper counselling for fishers for the formation of SHGs, youth clubs and Farmer's Interest Groups as suggested by Binkadakatti (2013). The co-operatives of the fishers should also be active and dynamic.

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