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Research Article

Will non-conventional alternative livelihood scheme work in the framework of mangrove dominated Indian Sundarbans?

Abstract

The Indian Sundarbans at the apex of Bay of Bengal in the lower Gangetic delta is extremely vulnerable to climate change induced Sea Level Rise (SLR). The SLR is more than 3.00 mm yr^{-1} due to which the intrusion of saline water in the island takes place. The situation has posed a negative impact on the existing livelihood of the region. On this background the concept of alternative livelihood has emerged in this deltaic complex. The alternative livelihoods like oyster culture, seaweed culture, cultivation of mangrove associate species, salt tolerant rice have been discussed with the respondents and an evaluation has been carried out to identify the success of the process. It is observed that a better understanding of the ecological condition coupled with awareness generation may strengthen the concept of alternative livelihood in this mangrove dominated deltaic complex with institutional support.

Introduction

The concept of livelihood diversification emerged in the World Heritage Site of Indian Sundarbans as a critical management intervention avenue. Indian Sundarbans is enriched with 34 species of true mangroves and several mangrove associates. The island dwellers of this deltaic complex depend on timber collection, honey collection, fishing and paddy cultivation to sustain their livelihoods. There are lot of dangers associated with these occupations as the forests of Sundarbans are the dwelling places of Royal Bengal tigers (*Panthera tigris tigris*) and the estuarine waters sustain several species of sharks and crocodiles. Due to saline soil, paddy cultivation is also affected and the production volume is very low. All these factors pose a negative impact on the traditional/conventional livelihoods of the Sundarban people. On this background, focus on alternative livelihoods has been emphasized to upgrade the economic profile of the poor island dwellers. The unique floral reservoir of the mangrove dominated deltaic lobe has the potential to trigger non- conventional alternative livelihood for the island dwellers and local inhabitants. However, the communities need more awareness and initiatives to enter in the domain of non-conventional alternative livelihood like seaweed culture, oyster culture, fish feed preparation from seaweed and salt marsh grass, food item preparation from mangrove floral resources *etc*. Supporting alternative community projects can help resolve the social-ecological crisis facing environmental conservation [1,2]. Sustainable livelihood options hold greater promise for local communities in the long term [3]. The social and capital elements need to be considered in such an approach [4]. Our results support previous studies which showed the need to strengthen the institutions and livelihood diversification programmes in sustainable conservation and management efforts [5]. The present research is an approach to evaluate the viability of non-conventional mangrove-centric alternative livelihood in the deltaic complex of Indian Sundarbans.

Methodology

Primary and secondary data were collected since more than last three decades from relevant literature [6-10], and stakeholders' views were considered and analysed during 2019 (January to July) for implementing these innovative alternative livelihood schemes in the islands of the mangrove dominated deltaic complex of Indian Sundarbans.

The methodology of acquiring stakeholders' views consist of three stages i) identification of respondents (forester, researcher, fisherman, agriculturist and local inhabitant) ii) identification of alternative livelihoods (8 in numbers) and iii) evaluation of the respondent's response to construct the Alternative Livelihood Scale (ALS) through ranking and voting.

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Although alternative livelihoods can be of various types, the present list captures the major livelihoods in two sectors of Indian Sundarbans (western and central) and is ranked in terms of their importance by building an Alternative Livelihood Assessment Matrix (ALAM). However, as there is high probability of variation of this ranking with the category of respondents, therefore the views of the respondents were also considered (by inclusion of the % of voting along with their respective ranking factor) and finally Composite Alternative Livelihood Scale (CALS) in context to Indian Sundarban mangrove ecosystem was constructed as per the expression:

$$CALS = ALS1 + ALS2 + ALS3 + ALS4 + ALS5$$

Where, ALS = Alternative Livelihood Rank (ALR) × % of Vote

It is to be noted in this context that the sample size of respondents are variable *e.g.*, for forester it is 14, but for other five groups of respondents n = 25.

In the final stage SWOT analysis was conducted on each of the selected alternative livelihood. SWOT is an acronym for Strengths, Weaknesses, Opportunities and Threats. By definition, Strengths (S) and Weaknesses (W) are considered to be internal factors over which there is substantial control. However, Opportunities (O) and Threats (T) are considered to be external factors over which there is very limited or essentially no control. In this work SWOT analysis is an effective tool for audit and analysis of the overall strategic position of the business and its environment. Its key purpose is to identify the strategies that will create a firm specific business model, which will best align resources and capabilities to the requirements of the environment in which the non-conventional resource based firm operates.

The present paper is a qualitative approach and a first-order analysis and hence the cost of changing livelihoods or the BCR (Benefit Cost Ratio) for each type of livelihood has not been carried out.

Result

Oysters, seaweeds and fruits of *Sonneratia apetala* based livelihood options were primarily accepted by the island dwellers as means of additional income although polyculture and monosex tilapia culture were given priority. However, people of central sector of Indian Sundarbans showed their inclination towards these untapped resources compared to the people of western sector of Indian Sundarbans.

Table 1 reflects the results of respondent analysis in the western sector of Indian Sundarbans, which is almost semi-urbanized with fish landing stations/harbours, tourism units and pilgrims. The mangroves in this sector have been mostly sacrificed for shrimp farms, which is one of the major existing livelihoods in this area.

It is seen from the table highlighting the opinion of the stakeholders of western Indian Sundarbans that there is a strong inclination towards pisciculture related livelihoods (Table 1). The stakeholders exhibited least interest on oyster and

Table 1: Mangrove based alternative livelihoods with scaling in western Indian Sundarbans.

Alternative livelihood category	Forester (Respondent Type 1)		
	ALR	% of Vote	ALS1
Pisciculture with mangrove floral based feed	7	24.4	170.8
Seaweed culture	3	10	30
Food products development from mangrove associates	3	6.1	18.3
Oyster culture	3	22.6	67.8
Mangrove fruit based food products	6	12.5	75
Salicornia and *Suaeda* cultivation	2	8.1	16.2
Monosex tilapia culture	4	11.8	47.2
Salt tolerant rice cultivation	1	04.5	4.5
Alternative livelihood category	**Researcher (Respondent Type 2)**		
	ALR	% of Vote	ALS2
Pisciculture with mangrove floral based feed	7	27.9	195.3
Seaweed culture	3	8	24
Food products development from mangrove associates	5	13.7	68.5
Oyster culture	5	5	25
Mangrove fruit based food products	6	20.6	123.6
Salicornia and *Suaeda* cultivation	2	4.9	9.8
Monosex tilapia culture	5	16.5	82.5
Salt tolerant rice cultivation	1	03.4	3.4
Alternative livelihood category	**Fisherman (Respondent Type 3)**		
	ALR	% of Vote	ALS3
Pisciculture with mangrove floral based feed	7	27.2	190.4
Seaweed culture	4	10.2	40.8
Food products development from mangrove associates	4	15	60
Oyster culture	7	2.3	16.1
Mangrove fruit based food products	6	19.8	118.8
Salicornia and *Suaeda* cultivation	2	4.3	8.6
Monosex tilapia culture	5	19	95
Salt tolerant rice cultivation	1	2.2	2.2
Alternative livelihood category	**Agriculturist (Respondent Type 4)**		
	ALR -1	% of Vote	ALS4
Pisciculture with mangrove floral based feed	7	19.7	137.9
Seaweed culture	4	11	44
Food products development from mangrove associates	7	7.3	51.1
Oyster culture	5	16.3	81.5
Mangrove fruit based food products	5	18.1	90.5
Salicornia and *Suaeda* cultivation	2	9	18
Monosex tilapia culture	4	14.1	56.4
Salt tolerant rice cultivation	1	4.5	4.5
Alternative livelihood category	**Local inhabitant (Respondent Type 5)**		
	ALR	% of Vote	ALS5
Pisciculture with mangrove floral based feed	7	22.4	156.8
Seaweed culture	3	11.1	33.3
Food products development from mangrove associates	4	11.7	46.8
Oyster culture	5	16	80
Mangrove fruit based food products	6	19	114
Salicornia and *Suaeda* cultivation	2	9.9	19.8
Monosex tilapia culture	7	7.4	51.8
Salt tolerant rice cultivation	1	2.5	2.5

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seaweed culture. This may be due to the geographical location of the western Indian Sundarbans adjacent to Haldia port-cum-industrial complex. Apart from industries and tourism units, people in the western sector earn their livelihood from fish landing related activities and agriculture, and hence has little interest towards non-conventional alternative livelihood. The chain of factories and industries, fish landing stations (like Kakdwip, Namkhana *etc.*), tourism units (at Bakkhali, Sagar Island *etc.*), Brick kilns (at Kakdwip), pilgrims (like Kapil Muni Ashram at Sagar South) offer employment at different levels. This is one of the possible reasons of less interest of the people towards alternative livelihood like oyster culture, seaweed culture, mangrove fruit based food manufacturing etc. in this sector of Indian Sundarbans.

The central Indian Sundarbans is noted for erosion and hypersaline ambient environment (due to blockage of fresh water on account of massive siltation). Tourism is one of the major livelihoods of the local inhabitants. The respondents' views towards the alternative livelihood in this sector are presented in Table 2. It is observed that the stakeholders associated with livelihood issue in central Indian Sundarbans have greater inclination towards oyster and seaweed culture, which may be due to availability of these natural resources in this region. Oyster cannot stand salinity below 10 psu and hence the hypersaline central sector of Indian Sundarbans is suitable for the culture of the species.

Table 2: Mangrove based alternative livelihoods with scaling in central Indian Sundarbans.

Alternative livelihood category	Forester (Respondent Type 1)		
	ALR	% of Vote	ALS1
Pisciculture with mangrove floral based feed	1	5.6	5.6
Seaweed culture	5	24.1	120.5
Food products development from mangrove associates	3	10	30
Oyster culture	6	20	120
Mangrove fruit based food products	5	16.2	81
Salicornia and *Suaeda* cultivation	2	7.9	15.8
Monosex tilapia culture	4	14	56
Salt tolerant rice cultivation	1	2.2	2.2
Alternative livelihood category	**Researcher (Respondent Type 2)**		
	ALR	% of Vote	ALS2
Pisciculture with mangrove floral based feed	1	5.4	5.4
Seaweed culture	7	24.1	168.7
Food products development from mangrove associates	3	8.9	26.7
Oyster culture	7	21.4	149.8
Mangrove fruit based food products	5	17.2	86
Salicornia and *Suaeda* cultivation	2	6.2	12.4
Monosex tilapia culture	4	12.3	49.2
Salt tolerant rice cultivation	1	4.5	4.5
Alternative livelihood category	**Fisherman (Respondent Type 3)**		
	ALR	% of Vote	ALS3
Pisciculture with mangrove floral based feed	1	6.7	6.7
Seaweed culture	7	22	154
Food products development from mangrove associates	3	10.1	30.3
Oyster culture	6	20	120
Mangrove fruit based food products	5	18.2	91
Salicornia and *Suaeda* cultivation	2	7.4	14.8
Monosex tilapia culture	4	12.1	48.4
Salt tolerant rice cultivation	1	3.5	3.5
Alternative livelihood category	**Agriculturist (Respondent Type 4)**		
	ALR	% of Vote	ALS4
Pisciculture with mangrove floral based feed	1	3.5	3.5
Seaweed culture	6	25.2	151.2
Food products development from mangrove associates	3	8	24
Oyster culture	6	23	138
Mangrove fruit based food products	5	18.2	91
Salicornia and *Suaeda* cultivation	2	4.3	8.6
Monosex tilapia culture	4	15.3	61.2
Salt tolerant rice cultivation	1	2.5	2.5
Ecosystem Service	**Local inhabitant (Respondent Type 5)**		
	ALR	% of Vote	ALS5
Pisciculture with mangrove floral based feed	1	3	3.0
Seaweed culture	6	28.4	170.4
Food products development from mangrove associates	3	10	30
Oyster culture	4	12.1	48.4
Mangrove fruit based food products	5	17.2	86
Salicornia and *Suaeda* cultivation	2	3.8	7.6
Monosex tilapia culture	6	23	138
Salt tolerant rice cultivation	1	2.5	2.5

The study showed that alternative livelihoods like oyster culture, seaweed culture, pisciculture with mangrove floral based feed, food products development from mangrove associates etc. are preferred more in the central Indian Sundarbans compared to the western Indian Sundarbans (Table 3).

Table 3: Composite Alternative Livelihood Scale (CALS) for each of the alternative livelihoods in the western and Central Indian Sundarban.

Alternative livelihood	Western Indian Sundarbans	Central Indian Sundarbans
Pisciculture with mangrove floral based feed	851.2	24.2
Seaweed culture	172.1	764.8
Food products development from mangrove associates	244.7	141.0
Oyster culture	270.4	576.2
Mangrove fruit based food products	521.9	435.0
Salicornia and *Suaeda* cultivation	72.4	59.2
Monosex tilapia culture	332.9	352.8
Salt tolerant rice cultivation	17.1	15.2

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Discussion

Our results show a great opportunity for positive change in the domain of mangrove-centric alternative livelihood if programme and policies are developed and implemented along with local institutional arrangements to ensure effective decision- making. Encouraging community participatory initiatives is considered key in shaping future conservation planning and management efforts. However, the SWOT analysis reveals that factors like alteration of salinity, turbidity, high dilution due to run of pollution *etc*. are the major barriers for initiating non- conventional alternative livelihood in Indian Sundarbans.

The survey conducted to evaluate the inclination of local population on alternative livelihood exhibited a significant spatial variation in terms of their opinion.

The western sector of Indian Sundarbans has multiple livelihood options like fishing, aquaculture (shrimp culture), tourism, fishing vessels and boat repairing, pilgrim guidance *etc*. Hence they have little interest on oyster and seaweed culture or preparing food products from mangrove fruits. However, in central Indian Sundarbans these resources are available in plenty and inclination of the local community is extremely high towards additional income. The SWOT analysis reveals the adverse impact of natural disasters, turbidity and salinity on the culture of few untapped biotic resources (Tables 4,5).

Conclusion

In conclusion it can be advocated that a better understanding of the ecological condition is of utmost importance for sustaining the mangrove centric alternative livelihood in Indian Sundarbans. Such non conventional livelihood options from untapped mangrove resources hold greater promise for local communities in the long term. It is also a positive step towards conservation of coastal resources. However, to give this effort a proper shape there is a need to strengthen the institutional set up coupled with mass awareness.

Table 4: SWOT analysis on alternative livelihood in western sector of Indian Sundarbans.

S.No.	Alternative livelihood category	Western sector			
		Strength	Weakness	Opportunity	Threat
1	Pisciculture with mangrove floral based feed	+++	+ (Disease and water quality)	+++	++ (Natural disaster)
2	Seaweed culture	+	+++ (Turbidity, water quality, lack of market)	+	+++ (Natural disaster, wave actions, tidal surges)
3	Food products development from mangrove associates	+	+++ (Lack of market, lack of knowledge of the local inhabitants)	+ (Rich in mineral salts and can be linked with pharamaseutical/health care units	++ (Soil salinity, lack of available land in the supra-littoral zone)
4	Oyster culture	+	+++ (Turbidity, water quality, lack of market, lack of knowledge of the local inhabitants)	+	++ (Natural disaster, wave actions, tidal surges, extreme rain, lowering of salinity)
5	Mangrove fruit based food products	+	+++ (Seasonal availability, lack of market, lack of knowledge of the local inhabitants)	++ (Rich in vitamin C and can be linked with pharamaceutical/health care units	++ (Sea water intrusion and increase of salinity, soil quality)
6	*Salicornia* and *Suaeda* cultivation	++	+++ (Seasonal, lack of market, lack of knowledge of the local inhabitants)	++	+++ (Supply of raw materials)
7	Monosex tilapia culture	+++	+ (Disease and water quality)	+++	++ (Natural disaster)
8	Salt tolerant rice cultivation	+	+ (Seasonal, lack of market, lack of knowledge of the local inhabitants)	+++	+++ (Lack of standardized technology, soil quality)

Table 5: SWOT analysis on alternative livelihood in central sector of Indian Sundarbans.

S.No.	Alternative livelihood category	Western sector			
		Strength	Weakness	Opportunity	Threat
1	Pisciculture with mangrove floral based feed	+++	+ (Disease and water quality)	+++	++ (Natural disaster)
2	Seaweed culture	+	+++ (Turbidity, water quality, lack of market)	+	+++ (Natural disaster, wave actions, tidal surges)
3	Food products development from mangrove associates	+	+++ (Lack of market, Lack of knowledge of the local inhabitants)	+ (Rich in mineral salts and can be linked with pharamaceutical/health care units	++ (Soil salinity, Lack of vailable land in the supra-littoral zone)

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4	Oyster culture	+	+++ (Turbidity, water quality, lack of market)	+	++ (Natural disaster, wave actions, tidal surges, extreme rain, lowering of salinity)
5	Mangrove fruit based food products	+	+++ (Seasonal, lack of market, lack of knowledge of the local inhabitants)	++ (Rich in vitamin C and can be linked with pharamaseutical/health care units	++ (Extreme rain, lowering of salinity, soil quality)
6	*Salicornia* and *Suaeda* cultivation	++	+++ (Seasonal, lack of market, lack of knowledge of the local inhabitants)	++	+++ (Supply of raw materials)
7	Monosex tilapia culture	+++	+ (Disease and water quality)	+++	++ (Natural disaster)
8	Salt tolerant rice cultivation	+	+ (Seasonal, lack of market, lack of knowledge of the local inhabitants)	+++	+++ (Lack of standardized technology, soil quality)

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