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Contrasting Farm Livelihoods in Climate Sensitive Agro-Ecosystems in Odisha

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ABSTRACT

The spree of tackling climate change issues stems from every global corner, which remains unique to specific agro-ecosystems. Rural India with a fair majority of livelihoods dependent on agriculture, are facing the severity of challenges to cope up with climate change. Therefore, livelihood analysis is an important aspect to address the climate change issues. Present study was conducted in the year 2020-21, in a climatically vulnerable state of India, Odisha, which suffers from climate induced natural disasters both in coastal and non-coastal ecosystems. Sustainable livelihood framework was followed in analyzing differential level of human, social, physical, financial and social assets holding of three dominant livelihood groups, viz., crop, livestock and crop + livestock farmers in one each coastal and non-coastal districts covering a total of 200 farm households. The analyses showed contrasting livelihood status with varied level of assets, crop + livestock farmers having above average overall livelihood level and social assets being at above average level contributing highest to overall livelihood status. Overall level of coastal livelihoods was at lower level as compared to non-coastal livelihoods. Better livelihood assets along with both technological and institutional interventions result in better insulation to rural households against ill effects of climate change events.

INTRODUCTION

The exorbitant rates of climate change and its impacts on human life is a matter of serious concern. In an extended version of United Nations Framework Convention on Climate Change (UNFCCC) of 1992, the signing of Kyoto Protocol in 1997 by all signatories pledged to reduce the greenhouse gas emissions that directly contributed to global warming was a significant leap towards addressing the climate change concerns at global level. Twenty-five years to date, India too has gradually joined the climate campaign for a sustainable future.

Majority of rural households being agrarian in nature are challenged by the climate change, witnessing resources degradation, shortage of food and social inequalities. Climate change has been influencing agriculture-livelihood equilibrium as agriculture-based livelihoods are sensitive to climate change (Sheikh & Akter, 2017). More than half of the South Asian population's livelihood capabilities are at risk due to rising temperature and erratic rainfall resulting in decline of crop yield, water-logging/ water scarcity, reduced farm income and migration (World Bank, 2018). Livelihood is the function of assets holding, activities and capabilities required to earn a living. Sustainable livelihood underlines the importance of coping with and recovering from shocks and stress (Chambers & Conway, 1992). Climate variability is one such shock to recover from. Sustainable livelihood approach advocates measure of livelihood in terms of human, social, natural, physical and financial

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assets of a household (DFID, 1999). Differential possession of these resources along with institutional infrastructure influence farmer's decision making and coping strategies to combat climate change threats on their livelihoods (Alam et al., 2016; Ayanlade et al., 2017; Delaporte & Maurel, 2018). Adoption of climate resilient agricultural interventions aiming to sustainable livelihoods tends to vary across the farm livelihood groups depending on their level of asset holding and livelihood sensitivity (Das & Ansari, 2021). Therefore, livelihood analyses in climatically vulnerable ecosystems are the precursor of formulation and promotion of location specific adaptation and mitigation measures.

Over 70 per cent of rural livelihoods in India are agriculture driven and majority of share (82%) is with small and marginal farmers (https://www.fao.org/india/fao-in-india/india-at-a-glance/en/). Though agriculture in India has reached grain self-sufficiency but many aspects relating to the livelihood options arising out of that are still at cross roads. According to Global Report on Internal Displacement (2021), India is expected to see huge internal displacements to a tune of 2.3 million displacements every year due to climate induced disasters like floods, cyclones, earthquakes, storm surges, tsunamis etc., which in turn threatens the structure of rural livelihoods, rural asset holding and ultimate survival of rural people. And the worst sufferer of such impacts of displaced livelihood contributed by climate change is the farm households inhabiting in rural India. On this backdrop, present research is contemplated to mapping the farm livelihoods through measures of various livelihood capitals.

METHODOLOGY

The state of Odisha, purposively selected for the study is characterized with a unique geographic location on the east coast of India with contrasting agro-ecosystems, dominated with small and marginal farmers with about 38 per cent cultivators and 62 per cent agricultural labourers along with a vulnerable coastline and fragile ecosystem (State of India's Environment Report, 2021). Indian Council of Agricultural Research (ICAR) launched National Innovations in Climate Resilient Agriculture (NICRA) since 2011 through ICAR institutes, SAUs and Krishi Vigyan Kendras (KVKs or Farm Science Centers) in climate sensitive districts of India. For the present study, one coastal and one non-coastal NICRA district was purposively selected, namely, Kendrapara and Dhenkanal, respectively; based on the functionality of NICRA project as well as their level of vulnerability to climate change (Bahinipati, 2014). During the pilot study it was identified that each district had a classified distribution of rural livelihood options, namely, crop farming (CF), livestock farming (LF) and crop + livestock farming (CF+LF). Therefore, to represent three dominant farm livelihood groups, random sampling with proportionate allocation was followed to select 200 beneficiary farm households (100 from each district) as respondents for present study.

Livelihood was considered as a function of asset holding of farmers like physical, social, financial, natural and human assets following the DFID (1999) framework to have a holistic and sustainable way of conceptualization of livelihood opportunities (Chambers & Conway, 1992). The better holding and better access a household is having to assets, the lower will be negative impact of climate change. Five types of assets as they are described in the literature, have been identified as measures of livelihood. This considers the comparative position of physical, social, financial, human and natural assets of the farm households. All the variables under five types of assets were measured on the basis of the responses of farmers on appropriate scales of measurements with the help of semi-structured personal interview schedule. Thereafter, the measured data was normalized.

Overall Livelihood Status (L_i) was calculated as given below:

$L_i = \Sigma(P_i+S_i+F_i+H_i+N_i)$, where, i indicates number of farmers-respondents

$P_i = \Sigma PA_{ij}/\Sigma j$, j (=1,2, …) indicates variables measuring physical assets

$S_i = \Sigma SA_{ik}/\Sigma k$, k (=1,2, …) indicates variables measuring social assets

$F_i = \Sigma FA_{il}/\Sigma l$, l (=1,2, …) indicates variables measuring financial assets

$H_i = \Sigma HA_{im}/\Sigma m$, m (=1,2, …) indicates variables measuring human assets

$N_i = \Sigma NA_{in}/\Sigma n$, n (=1,2, …) indicates variables measuring natural assets

RESULTS AND DISCUSSION

The livelihood groups varied in number in climatically vulnerable ecosystems of Kendrapara and Dhenkanal districts of Odisha. In Kendrapara district, more than half (55%) of the selected respondents belonged to crop farmers category while 25 per cent and 20 per cent farmers were from livestock and crop + livestock categories, respectively. For the Dhenkanal district, 60 per cent of the selected beneficiaries were from crop farmer category and 20 per cent each belonged to livestock farmers and crop + livestock farmer category. Similar results were reported by Pal et al., (2017). Overall, crop farmers were dominant farm livelihood group followed by livestock, and crop + livestock farmers (Figure 1).

The physical assets holding of farm households in both climatically vulnerable districts are given in Table 1. It is evident that respondents of both the districts had certain similar distribution of holdings and certain dissimilar distribution of holdings. Majority of the farm households had concrete type house for human inhabitation while semi-concrete type house for livestock inhabitation. The share (in per cent) of households with

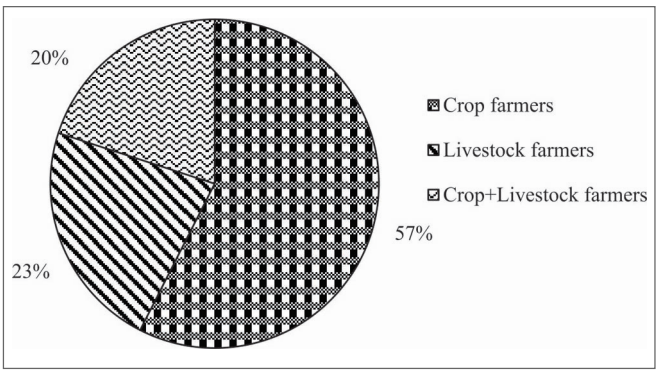

Figure 1. Overall livelihood groups in selected climate sensitive region

Table 1. Physical assets holding of the farmers in coastal & non-coastal districts

S.No.	Physical assets	Coastal district (Kendrapara)	Non-coastal district (Dhenkanal)
		Respondent farmers (%)	Respondent farmers (%)
1.	House Type (Human)		
	Concrete	74	59
	Semi-Concrete	24	41
	Mud house (hut)	2	-
	House Type (Livestock)		
	Concrete	34	21
	Semi-Concrete	36	40
	Mud house (hut)	13	13
2.	Communication Devices		
	Radio	1	-
	TV	94	97
	Mobile phone (Non-smart phone)	62	74
	Mobile phone (Smart phone)	63	53
	Internet connectivity	55	53
3.	Electricity		
	Domestic connections	100	100
	Farm connections	84	98
4.	Conveyance / Transportation		
	Bi-cycle	85	82
	Two-wheeler	81	77
	Four-wheeler	7	6
5.	Farm machinery/implement		
	Tractor	8	8
	Power Tiller	10	26
	Farm implements	91	86
	Mean no. of machinery/implement (SD)	2 (1)	2 (2)
6.	Water source for domestic purpose		
	Pipe/Supply water	68	96
	Tube well	69	59
	Dug well	32	57
	Community (tube well/dug well)	50	9
7.	Water source for farm irrigation purpose		
	Lift irrigation- own well	65	50
	Borrowed or shared from neighbors' well	13	30
	Canal	32	73
	River	69	2
	Community or village pond	3	35
8.	Road connectivity and condition		
	Coal tar road	34	73
	Mean perceived condition:5-point scale (SD)	3.43 (0.92)	3.79 (0.64)
	Concrete road	66	27
	Mean perceived condition:5-point scale (SD)	3.23 (0.63)	3.81 (0.56)
9.	Sanitation facility		
	Inside	80	62
	Outside	21	54
10.	Cooking facility: Means of cooking		
	Gas	90	100
	Kerosene stove	17	43
	Wood	54	66

smartphones was greater for Kendrapara (coastal district) but internet connectivity of both the districts were at par. Average farm machinery or implement ownership remained same for both districts. But clear difference in the source of water for both drinking and irrigation purpose differed among the coastal and non-coastal districts. The road condition for both the districts remained average but for coastal district majority households responded to have concrete roads connecting their houses while for non-coastal district majority responded to have coal tar made roads.

Table 2 represents social assets distribution of both the districts. For coastal district, the social recognition was marginally lower than non-coastal district; the coastal district had better social participation and cohesiveness than non-coastal district. Overall community initiatives and accessibility to common facilities were similar; it remained at moderate level for coastal district and higher level for non-coastal district.

The average annual family income of non-coastal district was better than the coastal district (Table 3). However, the number of income sources was more in coastal district than the non-coastal

Table 2. Social assets holding of the farmers in coastal & non-coastal districts

S.No.	Social assets	Coastal district (Kendrapara)	Non-coastal district (Dhenkanal)
		Respondent farmers (%)	Respondent farmers (%)
1.	Social Recognition: Household status in society		
	Low	19	11
	Medium	66	53
	High	15	36
	Mean score (SD)	1.96 (0.58)	2.25 (0.64)
2.	Social participation: Involvement in different social organizations		
	Very low	-	-
	Low	50	54
	Medium	40	41
	High	10	5
	Very high	-	-
	Mean score (SD)	2.60 (2.21)	2.46 (2.03)
3.	Social cohesiveness		
	Very low	-	-
	Low	1	1
	Medium	13	22
	High	48	62
	Very high	38	15
	Mean score (SD)	4.23 (0.71)	3.91 (0.64)
4.	Participation in different types of community initiatives (Numbers)		
	Never	26	23
	One type	64	41
	Two types	8	31
	≥Three types	2	5
	Mean number (SD)	1 (0.68)	1.08 (0.85)
5.	Accessibility & use of common facility		
	Very low	-	-
	Low	2	-
	Medium	71	3
	High	27	68
	Very high	-	29
	Mean score (SD)	3.25 (0.48)	4.26 (0.50)

Table 3. Financial assets holding of the farmers in coastal & non-coastal districts

S.No.	Financial assets	Coastal district (Kendrapara)		Non-coastal district (Dhenkanal)	
		Respondent farmers (%)	Mean (SD)	Respondent farmers (%)	Mean (SD)
1.	Economic status		-		-
	BPL	17		10	
	APL	83		90	
2.	Annual family income (Rs.)		75750 (36758)		118530 (70650)
	Low	15		9	
	Medium	70		70	
	High	15		21	
3.	Number of income sources		1.40 (0.60)		1.20 (0.40)
	One source	65		80	
	Two sources	31		20	
	≥Three sources	4		-	
4.	Annual family expenditure (Rs.)		44710 (22529)		56555 (31811)
	Low	15		7	
	Medium	68		65	
	High	17		28	
5.	Savings (Rs.)				
	No saving	10	-	7	-
	Low	63	4658 (4555)	70	10588 (9003)
	Medium	20	20714 (4617)	18	46389(4791)
	High	7	47143 (4880)	5	92000 (10955)

Table 3 contd...

S.No.	Financial assets	Coastal district (Kendrapara)		Non-coastal district (Dhenkanal)	
		Respondent farmers (%)	Mean (SD)	Respondent farmers (%)	Mean (SD)
6.	Credit behavior				
	Loan Amount (Rs.)		12290 (6923)		8063 (4494)
	No credit	80		84	
	Low	12		14	
	Medium	6		2	
	High	2		0	
	Ease in accessibility of credit		2.47 (0.61)		2.25 (0.58)
	Difficult	2		1	
	Moderately difficult	8		10	
	Easy	10		5	
7.	Insurances		-		-
	Type of insurances				
	Life insurance	55		63	
	Crop insurance	11		66	
	Health insurance	10		16	
	KCC	14		84	
	PMJDY	86		65	
	No. of insurance		2 (0.90)		3 (1.14)
	Nil	7		1	
	One	31		8	
	Two	44		27	
	≥Three	18		64	

Note: Low (≤Mean-SD), Medium (>Mean-SD to Mean + SD), High (>Mean + SD)

district. The savings behavior was towards lower side in both the districts. In terms of credit behavior, coastal district rural households used to take on an average higher loan than the non-coastal rural households. The type of insurance initiatives taken up by both the districts was dissimilar in terms of availing them and the non-coastal households were better on an average in availing these insurances than the coastal households.

The human assets of rural households of the two districts are given in Table 4. The education level remained alike in both the districts. However, the communication sources and pattern of use of these sources were different. The coastal district respondents had more reliance on mass media sources while the non-coastal district had communication interactions with personal cosmopolite sources. Overall, the communication scenario was better among the non-coastal respondents. Majority of the respondents of both the districts were similar in seeking information about various facilities and had have rated them moderately. The coastal rural households had a better exposure to trainings and they participated better in most extension services than the non-coastal respondents. The coastal belt respondents experienced relatively less suffering than the non-coastal respondents. And the average family health statuses of both the districts were similar.

Table 5 depicts the natural asset holdings of the respondents in both the districts. It is evident that non-coastal households had a better average farm land holding than the coastal households. Majority rural households in both the districts were belonging to the category of marginal and small farmers and additionally many landless farmers in coastal district. There were two growing seasons in coastal belt while three (an additional summer season) in non-coastal belt and a similar pattern was found in case of irrigated landholdings throughout a year. The non-coastal respondents had a better gross cropped and gross irrigated area than the coastal respondents. The coastal respondents had better dairy animals rearing while the non-coastal respondents had better small ruminants and poultry birds rearing. A good number of coastal respondents had ownership of fish ponds while it was sparse for non-coastal respondents.

The Figure 2 depicts differential level of five assets as well as overall livelihood status of the three dominant farmers' groups in coastal district (Kendrapara) and non-coastal district (Dhenkanal). It indicated irrespective of type of climatic events; lower level of natural & financial assets has a significant bearing on the livelihood status of the respondent farmers of both the districts. It further intensifies the fact that natural assets take longer time than any other assets to be re-created post climatic hazards, so it is lowest in contributing to the overall livelihood status of the farmers in these districts. And during any climatic malady the poorest of the poor are hit hardest, the same is concluded from lower level of the financial assets holding of the farmers in these districts. The livelihood analyses of dominant farmers' groups in climatically vulnerable coastal and non-costal eco-systems unravel differential levels of assets holdings. Better level of social assets in comparison to other assets shows the strong social positions of households that are often referred as one of the important facets of rural development. And social asset holding for both the districts were having the highest contribution to their overall livelihood status that maybe attributed to the different agencies intervening into the social structure of the climatically vulnerable areas. Thus, we can conclude that a farm household with better social assets is better insulated from the detrimental effects of climatic maladies.

The higher level of physical assets and human assets also strengthen the household level resilience. According to past studies,

Table 4. Human assets holding of the farmers in coastal & non-coastal districts

S.No.	Human assets	Coastal district (Kendrapara)		Non-coastal district (Dhenkanal)	
		Respondent farmers (%)	Mean (SD)	Respondent farmers (%)	Mean (SD)
1.	Education (years)		11 (3.28)		10 (3.17)
	Illiterate	1		-	
	Primary (≤4 years)	3		4	
	Secondary (5-10 years)	40		49	
	Higher secondary (11-12 years)	30		29	
	Graduation (>12-15 years)	26		18	
2.	Communication sources use pattern:				
	Mass media sources use		9.69 (3.64)		11.58 (3.86)
	Low	20		16	
	Medium	68		68	
	High	12		16	
	Personal cosmopolite sources use		8.39 (3.26)		14.11 (4.56)
	Low	17		15	
	Medium	65		67	
	High	18		18	
	Personal localite sources use		6.50 (3.77)		7.06 (3.76)
	Low	1		22	
	Medium	87		54	
	High	12		24	
3.	Information availability:			-	
	Information related to weather		3.40 (0.59)		3.34 (0.62)
	Agricultural practice		2.41 (1.30)		2.37 (1.32)
	Livestock management (Vet. service)		2.04 (1.43)		1.62 (1.45)
	Agricultural inputs		2.12 (1.36)		2.07 (1.19)
	Market prices		1.31 (0.90)		1.76 (0.88)
	Health		1.41 (0.72)		1.58 (0.59)
	Government programmes and subsidies		1.43 (0.70)		1.66 (0.60)
	Credit facilities		1.36 (0.76)		1.38 (0.49)
	Overall information availability		13.31 (5.11)		13.73 (5.02)
	Low	16		21	
	Medium	73		58	
	High	11		21	
4.	Participation in training and extension services (no. of times)		11 (7)		10 (5)
	Low	12		18	
	Medium	76		64	
	High	12		12	
5.	Family health status: Extent of suffering		1.50 (0.66)		1.44 (0.62)
	No. suffering	56		38	
	Low suffering	26		38	
	Medium	14		22	
	High	4		2	

Note: Low (≤Mean-SD), Medium (>Mean-SD to Mean + SD), High (>Mean + SD)

poor households are vulnerable to climatic change due to lack of social safety nets, access to education and health care, so they are least able to adapt measures safeguarding from climate change events thus questioning their livelihood security (Singh, 2020). Low level of natural and financial assets of households hampers their farming operations in disaster years due to lower resilient capacity to extreme climatic events. The findings of present study have a similarity with the results reported by Sarkar et al., (2022). Narayanan and Sahu (2016) & Ashoka et al., (2022) have reported importance of financial and natural assets like access to credit facilities, access to irrigation, ownership and size of land holding in influencing farmers' vulnerability and adaptation capacity to various measures to become climate resilient. Brown et al., (2019) & Letha et al., (2021) have suggested that better access to wide range of resources give better livelihood opportunities. With diversified livelihood options, better income can be generated thus boosting agricultural practices & other adaptation strategies for climate change concerns (Rijal et al., 2021). The relatively better index values in case of coastal district of Kendrapara as compared to non-coastal district of Dhenkanal may be attributed to the effective & efficient implementation of different capacity building measures by Krishi Vigyan Kendra (KVK) besides the technical & institutional interventions promoted under the ICAR's NICRA project. And it is worth concluding that involvement of KVK in implementation of NICRA has resulted in a better impact in that district (Kendrapara) as compared to other district (Dhenkanal) where interventions were made by ICAR institutes/SAUs alone on pilot basis without involvement of KVK. It also reiterates that

Table 5. Natural assets holding of the farmers in coastal & non-coastal districts

S.No.	Natural assets	Coastal district (Kendrapara)		Non-coastal district (Dhenkanal)	
		Respondent farmers (%)	Mean (SD)	Respondent farmers (%)	Mean (SD)
1.	Farm size (acre)				
	Own land		1.68 (1.33)		2.27 (1.37)
	Landless	21		19	
	Marginal	62		51	
	Small	15		25	
	Semi medium	2		5	
	Leased in (acre)		1.31 (0.75)		2.19 (1)
	Landless	57		92	
	Low	35		6	
	Medium	1		2	
	High	-		-	
	Operational land (own + leased in) (acre)		2.21 (1.35)		2.49 (1.41)
	Landless	19		19	
	Low	51		47	
	Medium	28		27	
	High	2		7	
2.	Cultivated land				
	Kharif season		2.21 (1.35)		2.47 (1.39)
	Landless	19		12	
	Low	51		47	
	Medium	28		28	
	High	2		6	
	Rabi season		2.21 (1.35)		2.24 (1.44)
	Landless	19		12	
	Low	51		53	
	Medium	28		22	
	High	2		6	
	Summer season	-	-		2.17 (1.59)
	Landless			19	
	Low			46	
	Medium			22	
	High			6	
	Gross cropped area (acre)		4.43 (2.71)		6.69 (4.37)
	Landless	19		19	
	Low	21		16	
	Medium	21		14	
	High	39		51	
3.	Irrigated land				
	Kharif season		2.21 (1.35)		2.47 (1.39)
	Landless	19		12	
	Low	51		47	
	Medium	28		28	
	High	2		6	
	Rabi season		2.21 (1.35)		2.24 (1.44)
	Landless	19		12	
	Low	51		53	
	Medium	28		22	
	High	2		6	
	Summer season	-	-		2.21 (1.60)
	Landless			22	
	Low			43	
	Medium			22	
	High			6	
	Gross irrigated area (acre)		4.43 (2.71)		6.65 (4.40)
	Landless	19		19	
	Low	21		16	
	Medium	21		15	
	High	39		50	
4.	Livestock holding				
	Dairy animals	85	5 (4)	59	7(6)
	Farm animals	6	3 (1)	4	3 (1)
	Small ruminants (Goat, sheep)	30	5 (4)	37	9(8)
	Poultry birds (hen, duck)	38	36 (34)	27	102 (89)
5.	Water bodies/ fish ponds				
	Number	37	1 (0)	7	1 (0)
	Size (sq. m)	-	233.78 (75.51)	-	200 (65)

Note: Low (upto 2.5 acre), Medium (>2.5-5 acre), High (>5-10 acre)

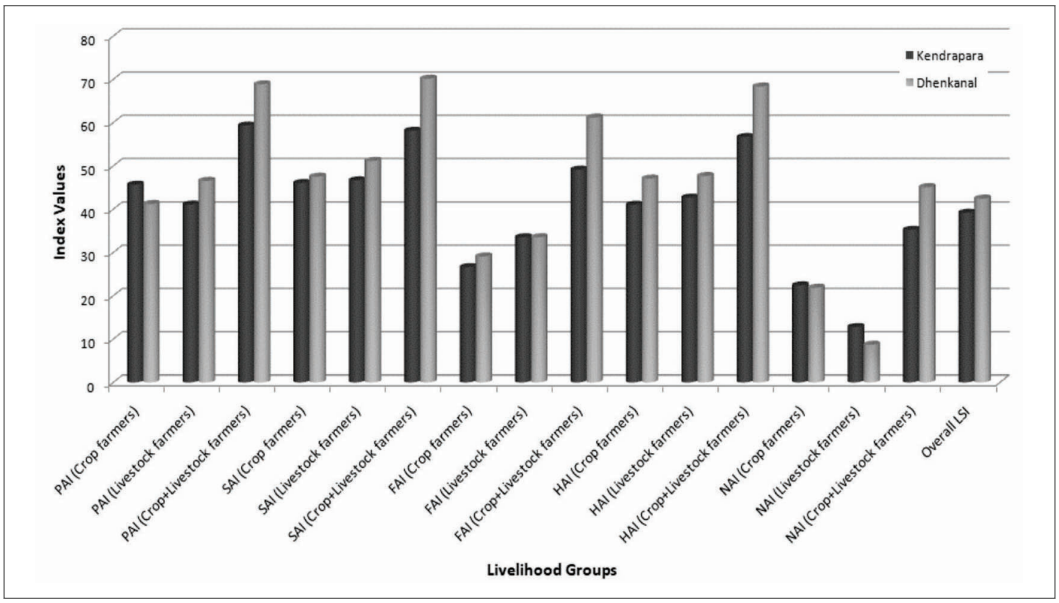

Figure 2. Comparative measures of livelihood of Kendrapara (coastal) and Dhenkanal (non-coastal) districts

institutional interventions are of pivotal importance to put climate smart technologies in practice resulting in sustainable livelihood in rural areas. Agricultural diversification like crop-livestock integration results into a better livelihood; therefore, climate smart agricultural policy may focus on livelihood diversification for better income and resilience in climatically vulnerable rural areas.

CONCLUSION

Any policy advocacy, program or subsidy pushed in the dimension of uplifting the livelihood status must consider such division & diversification of livelihood options and differential levels of assets determining overall livelihood status in any climate compromised rural area identified in three dominant livelihood groups. Irrespective of type of climatic events lower level of natural & financial assets has a significant bearing on the livelihood status of the farm households. Natural assets take longer time than any other assets to be re-created post climatic hazards, so it is lowest in contributing to the overall livelihood status of the farmers. The highest contribution of social assets to overall livelihood status may be attributed to the different agencies intervening into the social structure of the climate sensitive rural areas. Household with better social assets is better insulated from the ill effects of climatic maladies. To reduce the adverse impacts of climate change need to consider strengthening livelihood assets in convergence with climate smart agriculture interventions in contrasting ecosystems.

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