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Exploring the Relationship Between Socioeconomic Attributes and Resilience Capacity of *Murrah* Buffalo-based Livestock Production System in Changing Climatic Scenario

Ruchi Singh[1], Sanjit Maiti[2], Sanchita Garai[2], S.K. Jha[2], Mukesh Bhakat[3], A.K. Dixit[4], Anjali Aggarwal[5]

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ABSTRACT

Background: The present study was conducted to study the resilience capacity towards changing climate of a farming community who reared specifically *Murrah* buffaloes in their livestock production system for their livelihood. As the study area was breeding tract of *Murrah* buffalo, hence in-depth study of resilience was performed in frequent changing climate.

Methods: In order to assess the resilience capacity and their relation with socioeconomic characteristic, total 320 *Murrah* buffalo farmers across four districts in India's Trans-Gangetic Plain, data were gathered using focused group discussions, PRA tools and in person interviews. Statistical tools such as principal component analysis for index development, cumulative square root methods for categorization of respondents and regression analysis were performed for exploring relationship.

Result: Result depicted that majority of the farmers has medium level of climate resilience index score *i.e.* 0.456. Further, it was found that farmer's involvement in social institute such as, gram panchayat, agriculture and dairy co-operative society, self-help group, farmers' association and others affected their resilience capacity in changing climatic scenario. The need for better technology inclusion and access to more formal systems of finance is necessary to increase the overall resilience capacity of households.

Key words: Climate change, Climate resilient index, Livestock, *Murrah*, Resilience, Socioeconomic profile.

INTRODUCTION

Recent report of 'Intergovernmental Panel on Climate Change' shows that the frequency and intensity of climate change-induced shocks are growing all over the world (IPCC, 2014). Intensified extremes climatic events with higher frequency would add further stress on human health, food security (through agriculture and livestock production), water resources *etc*, where the rural poor are extremely prone and adversely impacted (IPCC, 2014; IPCC, 2001). Different researcher defines resilience as "the individuals, social groups or social-ecological systems capacity to absorb disturbances (climate change impacts) without alteration of the basic structure and ways of functioning and capable to learn, adopt the change and organized themselves" (Berkes *et al.* 2003; Folke 2006). Resilience has recently emerged as a key concept in describing a household's ability to act on weather shocks and adversity. Enhancing resilience while reducing exposure and vulnerability of farming community towards climate change impacts was utmost important to withstands with this scenario. Investigating the farmers' resilience to the aforementioned climate effects in the Murrah buffalo-based livestock production system may offer insights in to the mechanisms that facilitate or restrict the system's capacity for adaptation and trade-offs among services (Turner *et al*., 2014).

MATERIALS AND METHODS

The study was conducted in purposively selected Haryana state, India, as we need to analyze relationship of socioeconomic variable with resilience capacity of *Murrah* buffalo- based livestock production system in their breeding tract in the year 2019-2021. A total of 32 villages and n=320

[1]Veterinary and Animal Husbandry Extension Education, College of Veterinary Science and Animal Husbandry, Nanaji Deshmukh Veterinary Science University, Jabalpur-482 001, Madhya Pradesh, India.
[2]Dairy Extension Division, ICAR-National Dairy Research Institute, Karnal-132 001, Haryana, India.
[3]Livestock Production Management, ICAR-National Dairy Research Institute, Karnal-132 001, Haryana, India.
[4]Division of Dairy Economics, ICAR-National Dairy Research Institute, Karnal-132 001, Haryana, India.
[5]Division of Animal Physiology, ICAR-National Dairy Research Institute, Karnal-132 001, Haryana, India.

Corresponding Author: Ruchi Singh, Veterinary and Animal Husbandry Extension Education, College of Veterinary Science and Animal Husbandry, Nanaji Deshmukh Veterinary Science University, Jabalpur-482 001, Madhya Pradesh, India.
Email: drruchivet@gmail.com

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farmer who is rearing *Murrah* buffaloes since last 10 years and has a minimum herd size of 4 were selected as respondents. Personal interview method, observation method and suitable tool (s) of Participatory Rural Appraisal (PRA) like focused group discussion, *etc*. was followed with the help of pre-tested structured interview-schedule to collect the primary data. All socioeconomic variables were categorized in to 05 major capitals *i.e*., human, social, physical, natural and financial capital (Fig 1). The respondents were contacted at their door-steps at home or farm. The collected primary data from the farming community were tabulated and statistically (mean, standard deviation,

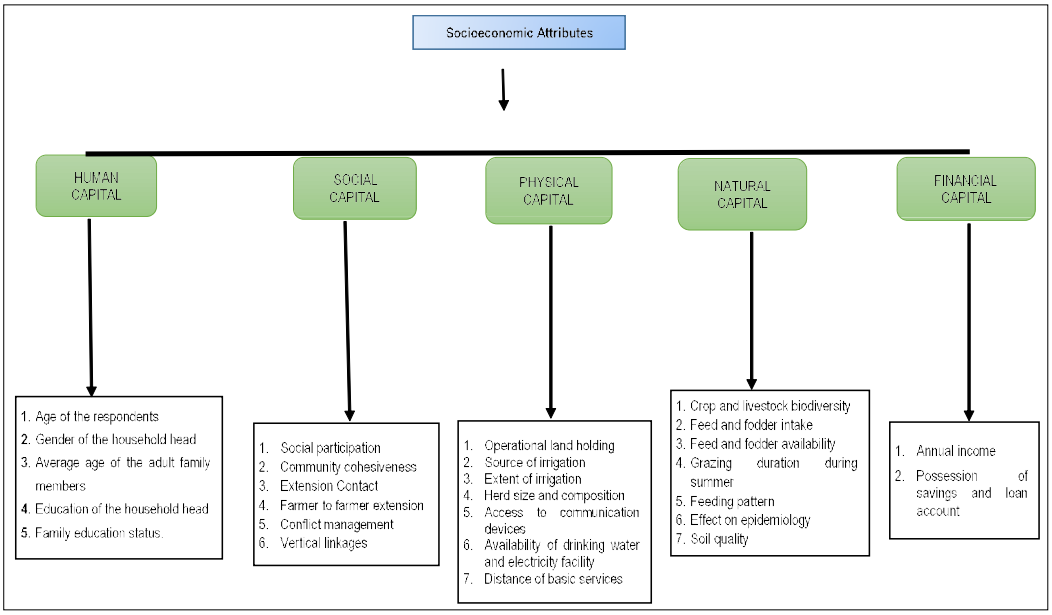

Fig 1: Socio economic attributes of respondents.

Table 1: Human capital possessed by the respondents. (n=320)

Variables	Respondents	Categories	Frequency	Percentage
Age of the household head (years)	Young	Up to 35 yrs	63	19.69
	Middle	35-55 yrs	153	47.81
	Elder	above 55 yrs	104	32.50
Mean±SD				48.10±13.71
Gender	Male	309	96.56	
	Female	11	03.44	
Average age of adult family members	Young	Up to 35 years	173	54.06
	Middle	35-55 years	138	43.13
	Old	>55 years	9	02.81
Mean±SD				34.88±07.82
Education status of respondents	Illiterate	0	48	15.00
	Primary	1	16	05.00
	Secondary	2	136	42.50
	Higher secondary	3	59	18.44
	Graduate and above	4	61	19.06
Mean±SD				2.89±1.62
Family education status	Low	04.00-08.83	76	23.75
	Medium	08.84-11.18	150	46.88
	High	11.19-15.00	94	29.37
Mean±SD				10.15±01.94
Dependency ratio	Low	1.00-2.79	102	31.87
	Medium	2.79-4.16	154	48.13
	High	4.17-7.00	64	20.00
Mean±SD				3.45±1.15

cumulative square root frequency methods, regression) analyzed in the dairy extension division, NDRI, Karnal. Whereas, climate resilience index was developed with the dimensions maintained in Annexure I. Finally, weighted index calculation method was used to calculate resilience index of MBLPS farmers.

RESULTS AND DISCUSSION

An overview of socio-economic profile of the *Murrah* buffaloes rearers

Human capital

Numbers of variables under human capital were depicted

Table 2: Social capital possessed by the respondents. (n=320)

Variables	Respondents	Categories	Frequency	Percentage
Social Participation	Households having	1 (Yes)	273	85.32
		0 (No)	47	14.68
	Low	2.00-03.12	73	26.74
	Medium	3.13-04.25	148	54.21
	High	04.26-6.00	52	19.05
Mean±SD				3.46±1.28
Community cohesiveness	Low	1.00-4.05	119	37.19
	Medium	4.06-5.10	145	45.31
	High	5.10-6.00	56	17.50
Mean±SD				4.87±0.98
Respondents having extension contact	Yes	1	320	100
	No	0	0	0
Average frequency of contact	Never	0	0	0
	Occasionally	1	67	20.93
	Once in a month's	2	178	55.63
	Weekly	3	75	23.44
Extension contacts for climate change	Yes	1	68	21.25
	No	0	252	78.75
Level of extension contacts	Lower	03.00-08.93	57	17.81
	Medium	08.93-11.31	181	56.56
	High	11.32-15.00	82	25.63
Mean±SD				10.26±02.19
Sources of extension contact for climate change	Veterinary and Livestock Development Assistant, Veterinary Officer, Agricultural Officer, Cooperative official and KVK Personnel			
Types of information seeking for climate change	New crop varieties, techniques of land shaping, sustainable cropping mechanisms *etc*. vaccination, health care and management *etc.*			
Sources of extension contact for agriculture and livestock farming	Veterinary doctors, Agronomy scientist, e-Mausam Krishi Sewa, Agromet Advisory Service (AAS)			
Types of information seeking for agriculture and livestock farming	Sowing time, feeding management, animal house management and adverse climate resistant variety of crops and animal breeds			
Farmer-to-farmer extension	Low	3.00-07.32	86	26.88
	Medium	7.33-09.95	121	37.81
	High	9.96-12.00	113	35.31
Having farmer-to-farmer extension	Yes	1	320	100
	No	0	0	0
Mean± SD				8.27±1.98
Types of suggestion received	Different practices like zero tillage, high yield variety, vermicomposting, use of happy seeder, shed management, repeat estrous management in summer *etc.*			
Conflicts management	Low	0.00-0.13	209	65.31
	Medium	0.14-1.14	50	15.63
	High	1.15-2.00	61	19.06
Mean±SD	0.54±0.79			
Vertical linkages	Low	1.00-2.43	87	27.18
	Medium	2.43-3.92	133	41.57
	High	3.93-6.00	100	31.25
Mean±SD				3.02±0.89

in Table 1. Moreover, the data clearly described that the *Murrah* buffalo rearers were quite mature with regard to farm experience, well-educated and average years of schooling for the family of *Murrah* buffalo rearers were 10.15 which comes under medium level of literacy level and occupied by 46.87 per cent of the *Murrah* buffalo farmers.

Literacy rate in Haryana is 75.55 per cent (http://censusindia.gov.in/2011census/dchb/ dchb haryana.html) and the people of Haryana gradually giving much importance to formal education. This was the reason for medium to higher family education status of the respondents.

Social capital

An attempt was made to measure the involvement of the respondents in formal and informal social organizations (Gram Panchayat, Co-operative Society, Rural Youth Club, Self Help Group, Aanganwadi *etc*) as members or as office bearers through their social participation. Table 2 clearly states that majority (85.32%) of the respondents were either member or office bearer in any formal or informal social organization with average community cohesiveness among the farmer was 4.87, whereas, all respondents were having farmer to farmer extension and extension contact for

Table 3: Physical capital possessed by the respondents.

(n=320)				
Operational land holdings	Marginal	Up to 1 ha	64	20.00
	Small	1-2 ha	92	28.75
	Semi Medium	2-4 ha	104	32.50
	Medium	4-10 ha	56	17.50
	Large	>10 ha	4	01.25
Mean±SD				2.40±1.96
Extent of irrigation to total holding	Average percentage of irrigation	80.96		
	Maximum percentage of irrigation	99. 00		
	Minimum percentage of irrigation	49.50		
Herd size (standard animal unit)	Small	02.95-04.33	47	14.69
	Medium	04.34-14.18	248	77.50
	Large	14.19-59.26	25	07.81
Mean± SD				8.33±6.10
Access to communication devices	Low	1.00-2.13	108	33.75
	Medium	2.14-3.76	118	36.88
	High	3.77-5.00	94	29.37
Mean±SD				2.96± 0.92
Climate resilient livestock technology followed by a farmers	Average number of climate resilient livestock technology (Mean score)			1.76
	Minimum no. of climate resilient technology			1
	Maximum no. of climate resilient technology			4
	SD			0.78
Practices: All weather shade for livestock, Microenvironment alteration by foggers, sprinkler *etc*., follow of vaccination and deworming schedule, alteration in feeding material and time of feeding as per season.				
Climate resilient agriculture technology followed by a farmers	Average number of climate resilient agriculture technology (Mean score)			1.45
	Minimum no. of climate resilient technology			1
	Maximum no. of climate resilient technology			4
	SD			0.62
Practices: Zero tillage, diversification, micro-irrigation, ICT based agro-advisories, climate resistant crop variety and DSR				
Availability of drinking water and electricity facility		Drinking water facility	1 (Yes)	312 97.50
			0 (No)	08 02.50
	Sources of drinking water	Tap point, Hand pump, tube well		
		Mean±SD		**Max distance**
Average distance to nearest all weather road, primary health Centre and veterinary hospital (km)	Distance to nearest primary health center (km)		2.85±2.40	7.5
	Distance to nearest veterinary hospital (km)		2.01±1.26	6.2
	Distance to nearest all weather road (km)		2.28±1.62	2.6

agriculture and livestock farming and out of which only 21.25 percent of the farmers were having extension contact for getting information related to climate change. Generally, rural farmers having a tendency to sit in chaupal and discuss the various issue of agriculture and livestock farming.

It is observed that speedy and effective transfer of technology and dissemination of information is possible through regular extension contact with agriculture officer, VLDA, Veterinary doctor *etc.*

Physical capital

Respondents were categorized as marginal (0-1 ha), Small (1 to 2 ha), Semi medium (2 to 4 ha), Medium (4 to 10 ha) and Large (10 ha and above) (Haryana and Agriculture and Farmers welfare report). From Table 3, it can be clearly understood that the average operational land holding of the respondents were 2.4 ha *i.e*., majority of the farmers (28.75 and 32.5%) were falls under the small to semi medium holdings of land with average percentage of extent of

Table 4: Natural capital possessed by the respondents. (n=320)

Variables	Reference range	Frequency	Percentage
Availability of climatic information Having climatic information	1 (Yes)	229	71.56
	0 (No)	91	28.44
Sources of climatic information- KVK (SMS service), radio, television, newspaper, block (or) panchayat administration, fellow farmers and mobile app			
Type of climatic information- Weather forecast on temperature, rainfall *etc*.			
Extreme climatic events experienced	Yes	236	64.37
	No	114	35.63
Types of extreme climatic events-Heat wave, cold wave, flood, Drought and Hailstorm			
Number of extreme climatic events experienced during last years	Only one events	15	06.36
	Two events	23	09.74
	Three events	120	50.85
	Four or more events	78	33.05
Number of diseases observed by respondents in livestock in last 10 years (Mastitis, Pneumonia, Ketosis, Hemorrhagic Septicemia, reproductive disorders *etc*.)	Maximum no. of animal affected by any diseases in a herd		9
	Minimum no. of animal affected by any diseases in a herd		1
	Average no. of animal affected by any diseases in a herd		3
Number of diseases observed by respondents in human in last 10 years (Malaria, Dengue, Diabetes, Blood pressure, Kidney stone, common cold and cough, cancer and eyes disorder.)	Maximum no. of human affected by any diseases in a family		6
	Minimum no. of human affected by any diseases in a family		1
	Average no. of human affected by any diseases in a family		2.52
Crop biodiversity (Crops - Rice, Wheat, Jowar, Bajra, Barley, Maize, Gram, Sugarcane, Cotton and pulses)	Average number of crops		3.06
	SD		1.13
	Maximum number of crops grown by the farmers		6
	Minimum number of crops grown by the farmers		2
Livestock biodiversity (Livestock species-Cattle (*Hariana, Sahiwal, Tharparkar, Holstein Friesian*), Buffalo (*Murrah*, Graded *Murrah, Nili Ravi*), Sheep, Goat and poultry)	Average number of livestock species		1.75
	SD		0.75
	Maximum number of livestock species		4
	Minimum number of livestock species		1

Table 5: District wise soil quality indices in Haryana.

District	pH	Electrival conductivity (Mili siemens)	Organic carban (%)	Phosphate P_2O_5 (kg/acre)	Potassium (kg/acre)
Bhiwani	7.65	0.53	0.27	6.56	120.72
Hisar	7.59	0.44	0.28	6.79	168.17
Jind	7.94	0.78	0.20	15.94	171.54
Rohtak	7.87	0.51	0.23	5.89	169.79

Table 6: Financial capital possessed by the respondents. (n=320)

Variables	Category	Reference range	Frequency	Percentage
Annual income (in lakhs)	Low	03.00-06.48	130	40.63
	Medium	06.49-10.86	150	46.87
	High	10.87-26.00	40	12.50
Mean±SD				8.49±3.54
Average income and ratio of different farm output to total income of the sample households	Annual income of the households (In lakh)		Mean	08.49
			SD	03.54
	% of average income of the households from agriculture		Mean	36.13
			SD	18.47
	% of average income of the households from livestock		Mean	45.49
			SD	12.98
	% of average income of the households from others		Mean	18.71
			SD	01.36
Average cropping intensity	Mean			173.56
	SD			10.32
	Maximum cropping intensity			200
	Minimum cropping intensity			140
Savings and loan accounts holding	Low	1.00-2.17	197	61.56
	Medium	2.18-3.23	84	26.25
	High	3.24-6.00	39	12.19
Mean±SD				2.33±0.94

Table 7: Categorization of household based on their resilience index score. (n=320)

Respondents' categories	Reference range	Frequency	Percentage
Low resilient	≤0.401	73	22.81
Medium resilient	0.402-0.507	138	43.13
High Resilient HH	≥0.508	109	34.06
Mean		0.454	
SD		0.053	

Table 8: Multiple linear regression analysis of *Murrah* buffalo-based livestock production system with determinants of resilience index.

Explanatory variables	Coefficient±SE	VIF
Social Participation	.023±.001**	1.196
Extension Contact	.033±.002*	1.205
Farmer to Farmer Extension	.026±.001*	1.191
Community Cohesiveness	.038±.002***	1.273
Annual Income from different sources	.025±.003**	3.741
Years of Schooling	.013±.001*	1.517
Family average education status	.015±.002*	1.346
Operational land holding	.019±.006*	6.005
Herd Size	.017±.004*	2.955
Savings and loan accounts	.010±.002*	1.213
Age of Respondents	-.009±.002*	1.818
Family Average Age	.013±.002	1.513
Access to basic services	.089±.003**	4.082
Conflict Management	.036±.001*	1.124
Vertical Linkages	-.038±.002	1.232
N	320	
R-squared	0.894	
Adjusted R-squared	0.883	

irrigation was 80.96 per cent and the major source of irrigation was extensive system of canals, tube wells and pump. Herd profile refers to the average herd size and herd composition of the respondents, who owned animals. The herd was composed of *Murrah* and graded *Murrah* buffalo, indigenous cattle, cross bred cattle and goat.

Technology or practices which was used in *Murrah* buffalo-based livestock production system to cope up with changing climatic scenario are known as climate resilience livestock practices. From the Table 3, it can be seen that farmers of the study area followed the practices such as all-weather shade for livestock, microenvironment alteration by foggers, sprinkler *etc*., follow of vaccination and deworming schedule, alteration in feeding material and time of feeding as per season and pond availability. These practices supposed to be enhanced resilience capacities of farmers by maintaining animal productivity in heat or cold stress.

Since, water is very crucial for sustaining life of all (Livestock, human being, plants *etc*) Therefore, availability of water for household triggers towards resiliency of a systems. Majorly 97.50 percent of the farmers were having availability of drinking water at their home premises either via tap point or hand pump. Majority of farmers were followed the wheat-rice cultivation primarily followed by diversified farming in form of vegetables crops, horticulture crop whereas due to very less irrigation facility, Siwani block farmers's grow only those crops which required very less water like bajra (*Pennisetum glaucum)*, pulses *etc*.

Natural capital

It refers to the access to information on different parameters of climate, especially information on cold waves and heat waves days, heavy rains *etc*. This information can help the

farmers in better management of risk and in creating favorable condition for timely adoption of different management practices to cope up with the climate change. The result is portrayed in Table 4 and depicted that maximum percentage of the farmers (71.56%) seeking information regarding climate change, 64.37 per cent of the farmers of Haryana region experienced extreme climatic events like flood, drought, cold and heat waves, hailstorm *etc*.

Respondents of the study area observed mastitis, pneumonia, ketosis, hemorrhagic septicemia, reproductive disorders, heat stress *etc*. Consequently, in changing climatic condition occurrence of mastitis, repeat breeding was noticed.

Diversification is one of the important strategies to confer resilience at time of crises. Level of diversity of concerned system i.e., in present study number of crops and livestock species reared by the farmers indicated their capacities to transform their livelihood strategies at the time of crises. In terms of feeding pattern, farmers follow the regularity in feeding on fixed time and concentrate ration fed to livestock mostly before milking (half in the morning and the other half in the evening). Most of the selected respondents of the study areas having soil health cards of their field.

Table 5 depicted the soil quality indices of selected district. Variability in moisture, temperature and local

Annexure 1: Resilience capacities, major components and sub-components.

Resilience capacities	Major component	Indicators
Absorptive capacity	Natural Disaster and climatic variability (NDCV)	Awareness of climate change
		Climatic extreme events experience
		Availability and accessibility of climatic information
		Level of preparedness
	Stability (ST)	Knowledge regarding climate change impact
		Perception to CC impacts
	Social capital (SC)	Social Participation
		Community Cohesiveness
		Extension Contact
		Farmer to farmer Extension
Adaptive capacity	Income and food access (IF)	Productivity of (crop /hac)
		Productivity of animal (Milk yield/animal)
		Annual income and Proportion of income from different source
		Household Food Insecurity Access Scale ScoreDiversity of Food
	Health (H)	Animal Health
		Human Health
	Water (W)	Availability of Water for drinking
		Ground water level
		Extent of irrigation facility
	Socio demographic status (Human capital HC)	Family average age
		Age of household head
		Dependency ratio
		Year of schooling of HH heads
		Av. Education status of family
	Assets (A)	Farm Size (Land holding)
		Livestock ownership
		Access communication device
		Saving and loan associations
	Livelihood strategy and technology utilization (LS and TU)	Crop biodiversity
		Livestock biodiversity
		Climate resilient livestock practices
		Climate resilient agriculture practices
Transformative Capacity	Access to basic services (ABS)	Distance to nearest Health care servicesDistance to nearest veterinary hospitalDistance to nearest all weather road
		Household access to electricity
	Social capital	Conflict management,
		Vertical linkage

atmospheric chemistry within the soil impacts the microbial activity to climate change.

Financial capital

From Table 6, it can be understood that the average income of the households were more than 8.49 lakhs with that 46.87 percent of the respondents comes under medium level of income categories. The result is clearly indicating that farmers look different source of income for livelihood maintenance.

Categorization of respondents in different resilient categories

All the components measured under resilience capacity (Annexure 1) were measured and analyzed to calculate climate resilience index. Selected *Murrah* buffalo farmers were categorized into 03 categories on the basis of mean±SD methods and findings clearly depicted in Table 7.

Relationship of respondent's socioeconomic variables with their resilience capacity

It was desirable to ascertain the contribution or variation explained by all antecedent characteristics (independent variables) towards resilience capacity of farmers against climate change. The data (Table 8) revealed that all the fifteen variables entered in the regression analysis accounted for 89.9 per cent of variation towards resilience capacity against impact caused by changing climate on livestock farmers.

Farmers of Haryana region having better economic status contributing households to better adapt to climate change impacts. In agreement with this finding, Asmamaw *et al.* (2019); Frankenberger *et al.* (2013), stated that diversified livelihood sources, better communication and financial institutions were contributing to enhance resilience capacity towards adverse effects of climate change. Variables such as more diversified social, financial and natural capital or assets by households reduces their vulnerability, at the same time as enhancing their resilience capacities to cope up with changing climate.

CONCLUSION

In a social science research various phenomena such as resilience capacity, adoption of technology and their constraints etc, depends on socioeconomic status of the community. It influences the accessibility to the resources, livelihood pattern, food and nutritional security. Farmers of Haryana's region having better economic status contributing households to better adapt to climate change impacts. Variables such as diversified livelihood sources, better communication and financial institutions were contributing to enhance coping mechanism towards adverse effects of climate change. Consequently, more diversified social, financial and natural capital or assets by households reduces their vulnerability, at the same time as enhancing their resilience capacities to cope up with changing climate.

Conflict of interest

The authors declare that there is no conflict of interest.

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