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Differential Perception and Logit Analysis of Climate Change Adaptation Strategies among Dairy Farmers in Arid and Semi-Arid Regions of Haryana

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ABSTRACT

Background: The present research study was undertaken to study the dairy farmer's perception and adaptation practices against impending climate change in the arid and semi-arid climate regions of Haryana.

Methods: The study area Hisar and Karnal Districts had been purposively selected based on rainfall pattern and milk production potential in the state. In this study, interview schedule had been constructed to reveal the dairy farmers perception and adaptation practices against climate change were studied through Environmental, biological and socio-economic indicators.

Result: It was found that, last 10 years majority of the farmers perceived significant increase in environmental changes, biological indicators and socio-economic indicators in their dairy farming practices respectively. Due to these perceived changes, the logit analysis had been applied to assess their adaptation practices in the breeding, feeding, healthcare, management and crop production aspects of the various significant levels.

Key words: Adaptation, Climate change, Dairy farmers, Perception.

INTRODUCTION

Climate Change is one of the most potentially serious environmental problems ever confronting the global community. The Inter-governmental Panel on Climate Change (IPCC) in its fourth assessment report (2007) indicated that many of the developing countries to be especially vulnerable to extreme climatic events as they largely depend on climate sensitive fields like agriculture, livestock and allied sectors. Agriculture is extremely vulnerable to climate change. Changes in atmospheric temperature and precipitation pattern increase the likelihood of short-run crop failures and long-run production declines. Several climate impact studies indicate a probability of 10-40% loss in crop production with the increase of temperature by 2080-2100.

The phenomenon of global climate change occurring due to Green House Gas (GHG) emissions has also been directly affecting the livestock production system world over. In spite of highest livestock population in India, which contributes about 17% of India's GHG emission in CO_2 equivalent. Milk yield of cows (Cross-bred, Hariana, Sahiwal) and buffaloes were found to be negatively correlated with temperature humidity index (Kaur and Arora 1982, Lal *et al*., 1987, Shinde *et al*., 1990, Kulkarni *et al*., 1998, Mandal *et al*., 2002, Tailor and Nagda 2005). The direct heat stress on lactating cows and buffaloes causes a production loss of more than 1.8 million tonnes of milk. The increase in thermal stress days due to temperature rise has been estimated to cause an additional loss in milk production of 1.6 million tonnes in 2020 accounting about '2,365.8 crores INR at current price rate (Upadhyay *et al*., 2009). Earlier researchers revealed that an estimated annual loss of milk production due to direct climate stress on livestock is about 1.8 million tones and that was nearly 2% of the total milk production in the country (Value Rs.2661.62 crores). Subsequently the annual loss in milk production due to adverse climate effect in 2020 is likely to increase about 3.4 million tonnes milk costing more than 5000 crores at current prices. Adaptation to climate change and variability is now considered as an important response option worthy of research and assessment, not simply to guide the selection of the best mitigation policies, but rather to reduce the vulnerability of groups of people to the impacts of climate change and hence minimize the costs associated with the inevitable (Kane and Shogren 2000). Most of the farmers

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were following adaptation strategies like keeping, promoting and interested in local breeds (60.83%), about 42.50% of livestock rearers made changes in micro-climate in cattle shed/stall and 47.50% of respondents were providing extra concentrate, minerals supplementation and feed additives to their livestock, *etc.* (Naik 2016). Mostly, livestock rearers modify micro climate in changing climatic scenario for sustainable productivity of their livestock. Therefore, farmers led adaptation strategies are required to be documented to cope up with climate change. Keeping in view of all these, a comprehensive study was conceptualized on the adaptation strategies followed by the livestock rearers of coastal Odisha and West Bengal for skillful implementation that helps to reduce vulnerability to prosper their socio-economic status and overall quality of life (Rana *et al*., 2019).

MATERIALS AND METHODS

The present research was undertaken at Division of Dairy Extension, NDRI, Karnal under Institute Project on 2015 where to study the existing awareness and perception level on climatic change vis-à-vis adaptation practices of the dairy farmers. Subsequently to analyse their indigenous knowledge to combat climate change, preparedness against impending climate adverse effect and adequate adaptive measures in the respective study areas. For this study Hisar and Karnal district of Haryana (irrigated region) was purposively selected and subsequently Shapur and Churni villages have been randomly selected from Nissing and Indri Blocks, respectively. A total of 120 respondents were randomly interviewed through structured interview schedule and the result has been analysed through mean, Standard Deviation (S.D), table analysis and Logit model.

Logit model specification

$$Y = b_0 + b_1X_1 + b_2X_1 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11}$$

Where,

Y = Dependent variable
X_1 = Age
X_2 = Education
X_3 = Farm size
X_4 = Social participation
X_5 = Land holding
X_6 = Herd size
X_7 = Milk production
X_8 = Farm income
X_9 = Farming experience
X_{10} = Social capital
X_{11} = Mass media exposure

b_0 is the intercept and b_1, b_2,……., b_{11} are the coefficients of the independent variables X_1 to X_{11}.

RESULTS AND DISCUSSION

The climate related statements were revealed under three parameters like Environmental, Biological and Socio-economic changes in the last 10 years and before 10 years accordingly. And again under each parameter, the several important indicators were derived to extract the perceived changes in crop-livestock farming systems in the study area.

Table 1 depicts that in last 10 years category, majority (65.00 per cent) of the respondents perceived that increased changes in temperature, 93.33 per cent respondents perceived that decreased trend in rainfall pattern, 36.67 per cent of the respondents perceived that increased changes in humidity, 40.00 per cent of the respondents perceived that increased changes in wind pattern, 96.67 per cent of the respondents perceived that decreasing trend in ground water level, 96.67 per cent of the respondents perceived that, not much changes in flood and drainage, 45.00 per cent of the respondents perceived that increased changes in summer storm and equal percentage of respondents perceived that decreased trend and no effect, respectively. So it is correct to derive that the dairy farmers are facing hardship with adverse climate effect in the semi-arid region of study area.

Subsequently the above table depicts that, before 10 years categories majority (76.67 per cent) of the respondents perceived no changes in temperature, 41.67 per cent respondents perceived that decreased trend in rainfall pattern, 66.67 per cent of the respondents perceived that no changes in humidity, 71.67 per cent of the respondents perceived that previously no changes in wind pattern, 45.00 percent of the respondents perceived that decreasing trend in ground water level, 76.67 per cent of the respondents perceived that not much changes in flood and drainage, 68.33 per cent of the respondents perceived that not much changes in summer storm and 70.00 percentage of respondents perceived that decreased trend and no effect, respectively. Also, in the case of 10 years before category that the most of the farmers haven't perceived the climate parameters much except ground water utilization.

It is evident from the Table 2, last 10 years majority (43.33 per cent) of the respondents perceived that no changes in milk production pattern, 40.00 per cent respondents perceived that increased trend of new livestock diseases, 43.33 per cent of the respondents perceived that increased changes in calf rearing pattern, 46.67 per cent of the respondents perceived that increased changes in behavioural changes in livestock pattern, equal per cent (43.33) of the respondents perceived that restricted livestock mobility, 56.67 per cent of the respondents perceived that increased changes in manure disposal pattern, 45.00 per cent of the respondents perceived that increased changes in crop production pattern, 40.00 per cent of the respondents perceived that increased changes in flowering and fruiting time and 48.33 per cent of respondents perceived that increased trend in new pest and diseases in crop and fodder cultivation, respectively. In line with above, before 10 years category there was no much changes has been perceived by respondents in the crop-livestock farming systems.

Table 2 clearly indicated that respondent's milk production pattern was not much effect by climate followed

by increasing trend means the sample has taken from milk shed/potential area and it could be derived that the smalland marginal holdings were in declining stage in the study area. This is being a reason that commercial dairy farmers have possessed high level of scientific dairy farming knowledge which leads them for climate adaptation practices like manure management, animal shelter management, identification and management of new pest and disease, control of repeat breeding problems, calf rearing pattern and balanced feeding *etc.*

From the Table 3 depicts that last 10 years category, majority (41.66 per cent) of the respondents perceived that increased changes in environmental consciousness, 60.00 per cent respondents perceived that increased trend in entrepreneurial traits towards dairying, 41.67 per cent of the respondents perceived that decreased change in volume of dairy business, 36.67 per cent of the respondents perceived that increased changes in material possession, 45.00 per cent of the respondents perceived that decreased changes in annual income through their dairy enterprise. And the last 10 years dairy farmers had taken keen interest in high level of environmental consciousness and entrepreneurial traits towards scientific dairy farming in the study area. The decline of volume of dairy business and

Table 1: Perceived changes in environmental indicators against climate change (n=120).

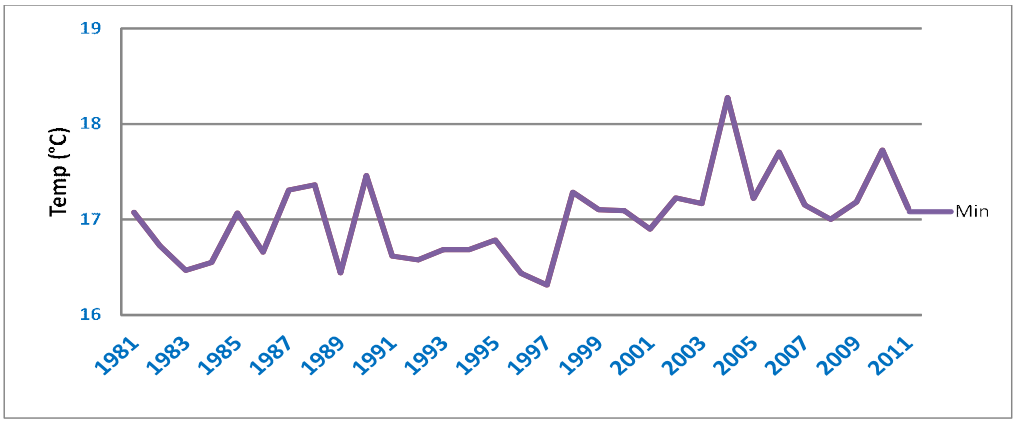
A	Perceived environmental indicators	Last 10 yrs			10 yrs before		
		Increased	Decreased	No effect	Increased	Decreased	No effect
1	Perceived change in temperature	39 (65.00)	17 (28.33)	4 (6.67)	2 (3.33)	12 (20.00)	46 (76.67)
2	Perceived change in rainfall pattern	0 (0.00)	56 (93.33)	4 (6.67)	19 (31.66)	25 (41.67)	16 (26.67)
3	Perceived change in humidity	22 (36.67)	21 (35.00)	17 (28.33)	0 (0.00)	20 (33.33)	40 (66.67)
4	Perceived change in wind pattern	24 (40.00)	16 (26.67)	20 (33.33)	0 (0.00)	17 (28.33)	43 (71.67)
5	Change in ground water level	0 (0.00)	58 (96.67)	2 (3.33)	16 (26.66)	27 (45.00)	17 (28.33)
6	Irregular flooding	0 (0.00)	2 (3.33)	58 (96.67)	0 (0.00)	14 (23.33)	46 (76.67)
7	Perceived change in summer storm	27 (45.00)	11 (18.33)	22 (36.67)	0 (0.00)	19 (31.67)	41 (68.33)
8	Perception and frequency of drought occurrence	12 (20.00)	24 (40.00)	24 (40.00)	1 (1.67)	17 (28.33)	42 (70.00)

Table 2: Perceived changes in biological indicators against climate change (n=120).

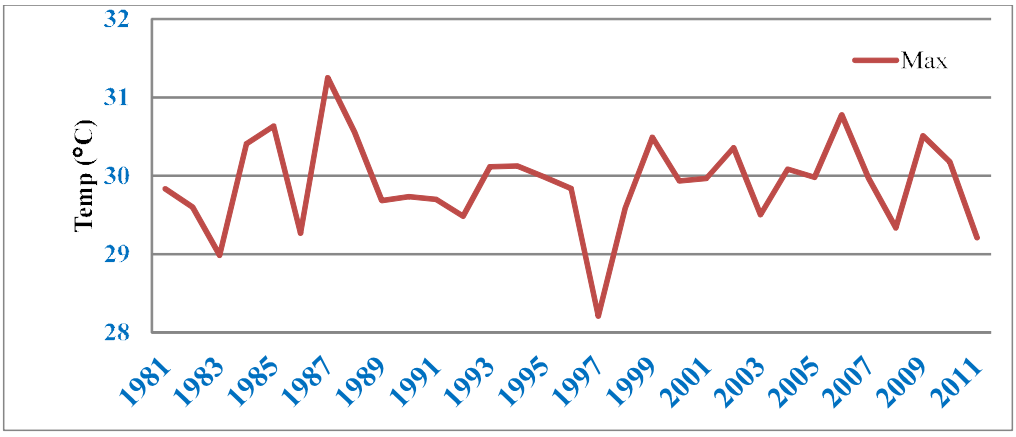
B	Perceived biological indicators	Last 10 yrs			10 yrs before		
		Increased	Decreased	No effect	Increased	Decreased	No effect
1	Change in milk production pattern	25 (41.67)	9 (15.00)	26 (43.33)	0 (0.00)	22 (36.67)	38 (63.33)
2	Incidence of new livestock diseases	24 (40.00)	20 (33.33)	16 (26.67)	0 (0.00)	19 (31.67)	41 (68.33)
3	Change in calf rearing pattern	26 (43.33)	23 (38.33)	11 (18.33)	0 (0.00)	1 (1.67)	59 (98.33)
4	Behavioral change in livestock	28 (46.67)	13 (21.67)	19 (31.67)	1 (1.67)	5 (8.33)	54 (90.00)
5	Restricted livestock mobility	26 (43.33)	8 (13.33)	26 (43.33)	1 (1.67)	0 (0.00)	59 (98.33)
6	Change in manure disposal pattern	22 (36.67)	4 (6.67)	34 (56.67)	0 (0.00)	1 (1.67)	59 (98.33)
7	Change in cropping pattern	27 (45.00)	23 (38.33)	10 (16.67)	0 (5.00)	3 (5.00)	57 (95.00)
8	Change in flowering and fruiting time	24 (40.00)	13 (21.67)	23 (38.33)	2 (3.33)	2 (3.33)	56 (93.33)
9	New pest and diseases in Agriculture andfodder crops	29 (48.33)	19 (31.67)	12 (20.00)	0 (0.00)	4 (6.67)	56 (93.33)

annual income implicates that the small and marginal livestock holding is decreasing trend due to the higher cost of feeding, low remunerative price of milk and other employment options by the rural youth.

The scientific data of last 30 years of temperature and rainfall trend in Karnal district have been obtained from Agro Meteorology Department, Central Soil Salinity Research Institute (CSSRI), Karnal which clearly depicts the changing trend of maximum and minimum temperature and rainfall pattern in the study area. Since, the year 2000 on wards the average maximum temperature and rainfall pattern is increasing and decreasing trend, respectively. Perhaps, this trend shows the environmental parameter which eventually determines the farming situations in the study area. So it may be concluded that the temperature and rainfall pattern of Karnal District, which slowly changing over a period of time and simultaneously making adverse effect on crop-livestock farming systems.



Graph 1: Changes in minimum temperature (1981-2011)-Karnal (Western Region of Haryana, India).



Graph 2: Changes in maximum temperature (1981-2011) Karnal (Western Region of Haryana, India).

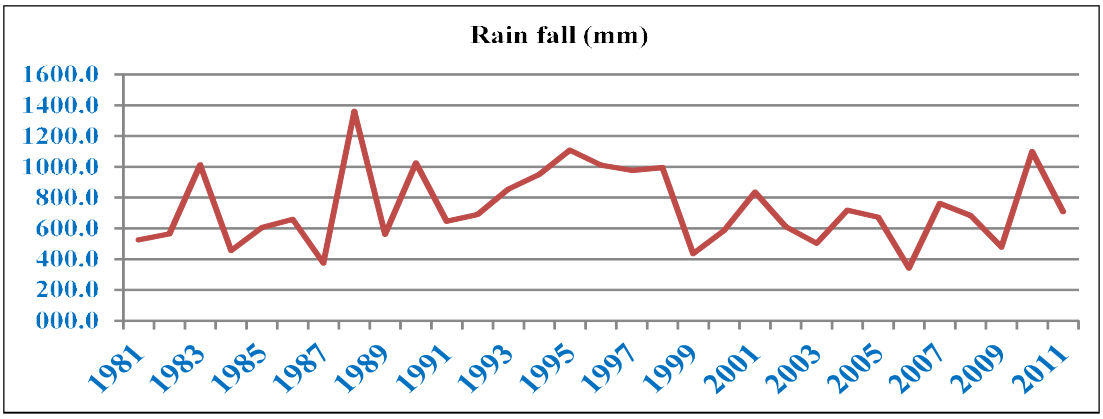
Table 3: Perceived changes in socio-economic indicators against climate change (n=120).

B	Perceived socio-economic indicators	Last 10 yrs			10 yrs before		
		Increased	Decreased	No effect	Increased	Decreased	No effect
1	Impact on environmental consciousness	25 (41.66)	22 (36.67)	13 (21.67)	1 (1.67)	4 (6.67)	55 (91.67)
2	Change in entrepreneurial traits towards dairying	36 (60.00)	18 (30.00)	6 (10.00)	0 (0.00)	1 (1.67)	59 (98.67)
3	Change in volume of dairy business	16 (26.66)	25 (41.67)	19 (31.67)	0 (0.00)	3 (5.00)	57 (95.00)
4	Change in material possession (household and farming)	22 (36.67)	21 (35.00)	17 (28.33)	0 (0.00)	6 (10.00)	54 (90.00)
5	Change in annual income through dairying	15 (25.00)	27 (45.00)	18 (30.00)	0 (0.00)	6 (10.00)	54 (90.00)

Table 4: Logit analysis of adaptation options in the aspect of breeding, feeding, health care, management and crop production.

Selected variables	Breeding		Feeding		Healthcare		Management		Crop production	
	B	Sig	B	Sig	B	Sig	B	Sig	B	Sig
Age	-.139***	090	. -1.070*	.099	-.001*	.092	-.086**	.042	.107*	.099
Education	-.579	.153	11.666**	.048	.816**	.006	.689*	.091	-2.954	.298
Family size		.809	5.033	.721	-.179	.696	.893	.155	5.817	.340
Social participation	.153	.061	-.782	.022	-.234	.569	.276	.231	2.074**	0562
Land holding	-.062	.333	4.192**	.0516	.499***	.012	.073	.603	-5.993	.783
Herd size		.012	.780*	.002	.077	.772	.665*	.127	-2.241	912
Milk production	.809	.994	-.570	.347	.044*	.084	.073*** .	008	2.847	.764
Farm income	.115**	.087	.850***	.008	.000	.680	006	.220	.312***	.000
Farming experience		.106	.680	.121	-.062	.575	.084	.216	6.830	.528
Social capital	.061	.081	.348	.954	.442	.580	-.610	.515	-7.364	.439
Mass media	-.091	.083	-1.388	.164	.119**	.041	.145	.508	.794	1.000
Exposure	.333									
	431***									
	.012									
	.000									
	.000*									
	.087									
	.121*									
	.106									
	.740*									
	.176*									
	.083	.								

***, **, * = Significant at 1%, 5% and 10% probability level respectively.



Graph 3: Changes in Rainfall pattern (1981-2011)- Karnal (Western Region of Haryana, India).

It could be inferred from the Table 4 that, the independent variables like age and herd size were significant at 1% probability level, social participation at 5% significant level and farm income, experience, social capital, mass media exposure variables show 10% significant level in the breeding aspects which gives that, the commercial and progressive dairy farmers would prefer the indigenous breeds rather than crossbreeds against climate change. Also in feeding aspects education, land holding and farm income were significant at 1%, age and herd size were significant at 5% level with adaptation options, means the respondents are using the balanced feeding strategies like providing feed additives, mineral supplements, bye-pass fat in livestock diet and fibre in diet especially summer and winter stress periods. In the healthcare aspects, land holding variable shows that significant at 1% level, education and mass media exposure at 5% significant level and age and milk production at 10% significance level with adaptation options. Especially in climate stress periods the respondents were taking precautionary measures like mite/tick control measures, epidemic and contagious disease management and vaccination of dairy animals.

In this management aspect the milk production, age, education and herd size shows 1%, 5% and 10% significant level with dependent variable, respectively. Respondents has followed the adaptation practices in animal husbandry like hygienic animal shelters and sheds, ventilation in animal shelters, environment cooling and sprinkle system through sprinklers, drippers, misters, foggers *etc*. and made environmental protection during winter season as top and side wall protection through gunny bag or wooden planks in their cattle sheds against climate adverse effect. Finally in crop production aspect, farm income, social participation and age shows 1%, 5% and 10% significance level with adaptation options, respectively. Here the respondents has taken some of adaptation practices like different varieties, different crops, crop diversification, different planting dates, shortening growing season, changing quantity of land under cultivation, shifting from crops to livestock and increased uses of irrigation/ground water/watering to combat the seasonal vagaries for higher milk production.

CONCLUSION

From the above analysis, majority of the respondents revealed that due to climate effect, the changes in environmental, biological and socio-economic impact is high especially last 10 years and same as the scientific data also depicting clearly. In line with adverse effect, the adaptation practices also followed in breeding, feeding, health care, management and crop production areas. Therefore, it is envisaged that, due to high impact on environment especially in semi-arid region like Haryana, the immanent need of timely dissemination of suitable site-specific interventions to the field level. Further the emphasis must be given to enhance the farmers' adaptive capacity with various stakeholders to combat the climate change and adopt resilience agriculture and livestock practices through appropriate adaptation and mitigation measures for their sustainable livelihood.

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