Determinants to Climate Change Adaptation among the *Brokpa* Pastoral Nomads of Western Arunachal Pradesh

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ABSTRACT

Transhumance system of livestock rearing is a source of livelihood among the Brokpa *pastoral nomads inhabiting in the climate sensitive yak tracts of Arunachal Pradesh. This primitive pastoral nomad has their own traditional coping mechanisms as adaptation strategies. The present study was designed to identify the determinants of differential adoption of adaptation strategies by the* Brokpa *pastoral nomads of western Arunachal Pradesh. A representative sample of 240* Brokpa *pastoral nomads from all the yak rearing tracts of Arunachal Pradesh was selected as respondents for the present study. Multinomial logit model was used to assess the determinants of differential level of adoption of adaptation strategies among the pastoral nomads of western Arunachal Pradesh. It is found that extension contact and ratio of the productive animal in the herd showed significant positive effect on adoption of adaptation strategies among the pastoral nomads.*

***Key words**: Adaptation; Climate change; Multinomial logit; Pastoral nomads;*

The *Monpa* is a primitive tribe inhabiting parts of West Kameng and Tawang districts of Arunachal Pradesh. They constitute more than 80 per cent of the population of the two districts. The *Monpa*s who are inhibiting in the highland of these two districts are mainly depended on livestock for their livelihood and it is also reported that 62 per cent of their livelihood requirements is provided by yak (*Poephagus grunniens* L.) (*Ramesha and Bhattacharya 2008*). The pastoral nomad of the *Monpa* tribe is popularly known as B*rokap* (tenant herdsmen) and transhumance system of livestock rearing is their main source of livelihood. The future of transhumant pastoralists depends on the way they will manage their stay and livestock in over stocking winter grazing land (*Pant, 2010*). But in recent past, the *Brokpa* pastoral community is facing newer challenges due to the dwindling population of yak, degradation of high altitude pastures, and subsequently shortage of feed and fodder. But, now-a-days, these challenges transform in to threat as a synergistic effect of impending climatic change in the one of most vulnerable and fragile ecosystem of mountain ecosystem in Arunachal Pradesh. But, this pastoral nomad also followed their own adaptation strategies to cope up with changing climatic scenario.

More recently, adaptation to climate change and variability has also come to be considered an important response option worthy of research and assessment, not simply in order 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; Smit and Pilifosova, 2001*). Adaptation refers to adjustment in ecological, social or economic systems in response to actual or expected climate stimuli and effects or impacts. It is often heard about different adaptation strategies like micro-environment modification like shelter management, ventilation in shelter, heat alleviation by water cooling or sprinkler system; strategic nutrient supplementation etc. But, we are trying to forget the ground reality that out of 529.7 million livestock, 440 million livestock reared by 100 million household with/ without any housing system and by crop residue. But, pastoral nomads have their traditional mechanism to cope up with changing climatic scenario for sustainable

productivity of their livestock. There are several factors lying behind skilful implementation of these traditional mechanisms as adaptation strategies to reduce vulnerability to prosper their 'socio-economic status' and overall 'quality of life'. Therefore, a comprehensive study on the determinants of differential adoption of adaptation strategies by the pastoral nomads of western Arunachal Pradesh was conceptualized.

METHODOLOGY

Yak is the predominant livestock reared by the *Brokpa* pastoral nomads and yaks are found only in the highlands of Tawang and West Kameng District of Arunachal Pradesh. Therefore, the present study was confined mainly in the different yak tracts of Arunachal Pradesh. Nyukmadung, Lubrang, Senge, Mandla-Phudung, Dirnang Basti and Chhander village were selected purposively from West Kameng District; and Jangda, Shyro, Rho, Mirba, Mukto and Sherjong villages were selected from Tawang district. Both the yak owner and tenant herdsmen (*Brokpa*) were considered as respondents for this study. From each selected villages, 20 respondents including owner and tenant herdsmen were selected randomly. Thus, total 240 yak owners and *Brokpas* were interviewed during 2011 -12 with the help of local leader like *Gaon Burah* (village pradhan).

Differential level of adoption among the sampled households: Adaptation refers to adjustment in ecological, social or economic systems in response to actual or expected climate stimuli and effects or impacts. Adaptation strategies was operationalized as the measures adopted and/or followed by the *Brokpa* pastoral nomads to cope up with the adverse impact of climate change on livestock rearing and/or their livelihood for sustainable livestock productivity and/or sustainable livelihood security.

The *Brokpa* pastoral nomads were directly asked whether they adopt any measure to cope up with the negative impact of climate change on the binary response 'YES' or 'NO'. Those who responded 'YES', again they were requested to put their response on a three point continuum viz. continued the adoption, discontinued the adoption and never followed/adopted with the score of 2,1, and 0 on a prelisted adaptation strategies for both the region. A list of adaptation strategies were prelisted during a pilot survey in the study area using the snowball technique (Box-I). Therefore, in order to quantify the adaptation strategies, an exclusive "*Climate Change Adaptation Index (CCAI)"* was developed by using the following formula:

$$\text{CCAI} = \frac{Obtain\ score}{Max.obtainable\ score} \times 100$$

All the sampled household were categorised into three differential level of adoption of adaptation strategies on the basis of obtained index score by the respective households. Cumulative square root frequency method was used to categories households into three categories i.e. lower level of adoption, medium level of adoption and higher level of adoption.

Determinants of differential level of adoption among the pastoral nomads: Though the outcome variable *i.e.* level of adoption was a purely ordinal variable, but, proportional odds assumption was not satisfied (χ^2 value for the test of proportional Odds Assumption was 35.5460 and significant at 0.0012 percent level of significance). Therefore, a less restrictive model *i.e.* multinominal logit was used instead of ordinal logit to assess the determinants of differential level of adoption by using the following model:

$$P\left(y = \frac{j}{x}\right) = \frac{\exp(x\beta_j)}{[1 + \sum_{h=1}^{j} \exp(x\beta_h), j = 1, \ldots . j}$$

Where β_j is K x 1, j=2.....J.

For this study, there are three categories or response probabilities for level of adoption and these are lower level of adoption (1), medium level of adoption (2) and higher level of adoption (3). Explanatory variables used in the model are presented in Table 1 with the hypothesis. The estimated coefficients of the MNL model provide only the direction of the effect of the independent variables on the dependent variables; they do not represent actual magnitude of change or probabilities. Thus, the marginal effect from the MNL, which measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable, are reported and discussed.

RESULTS AND DISCUSSION

Climate change adaptation among the Brokpa pastoral nomads who recognised changing climatic scenario: The results presented in Table 1 depicts that 81.67 per cent of the *Brokpa* pastoral nomads of western Arunachal Pradesh recognised the changing

climatic scenario. Those who, recognised the changing climatic scenario, were subsequently asked if they had responded through adaptation to reduce negative impacts of climate change and 75.51 percent of them stated that they have adopted at least one adaptation strategies to cope up with climate change. Remaining 24.49 per cent of the *Brokpa* pastoral nomads of western Arunachal Pradesh did not do any thing to cope up with climate change.

Table 1. Climate change adaptation among the *Brokpa* pastoral nomads of western Arunachal Pradesh

Particulars	Status	No.	%
Changing climatic scenario	Not recognised	44	18.33
	Recognised	196	81.67
Adaptation among those who recognised	Adopted	148	75.51
	Not adopted	48	24.49

Level of adoption of adaptation strategies among the Brokpa pastoral nomads who adopted: The entire sampled household were categorised into three differential level of adoption of adaptation strategies *i.e.* low, medium, high on the basis of obtained index score by the respective households. Cumulative square root frequency method was used to categorize households into three categories and result is presented in Table 2. It was found that 35.14 per cent of the *Brokpa* pastoral nomads were having higher and lower level of adoption, each, and remaining 29.72 per cent of pastoral nomads were having medium level of adoption.

Table 2. Differential level of adoption of adaptation strategies among the *Brokpa pastoral* nomads who adopted in western, Arunachal Pradesh

Level of adoption	categorisation	No.	%
Lower level (Low)	15.00 - 42.79	52	35.14
Medium level (Medium)	42.80-78.54	44	29.72
Higher level (High)	78.55 - 100	52	35.14

Determinants of differential level of adoption of adaptation strategies among the Brokpa pastoral nomads : Table 3 depicts that extension contact were significantly (at $p<0.05$) contributing to the adoption of the medium level adopter. It is also revealed from the same table that increasing the extension contact by one unit increases the probability of a respondent to be in medium level of adoption by 2.5 per cent. Extension officers and/or agents of state and central Govt. departments and KVK were the key informants to the medium level adopter among the *Brokpa* pastoral nomads of western Arunachal Pradesh regarding the different adaptation strategies. This may be the reason of extension contact to be a significant factor of differential level of adoption. From this result it may be concluded that having extension services increased the likelihood of farmers? adaptation to climate change. *Deressa et al. (2011), Mandleni (2011), Dhaka et al. (2010), Hassan & Nhemachena (2008)* and *Nhemachena & Hassan (2007)* also reported that access to extension service was one of the important determinants of farm level adaptation.

Higher level adopters among the *Brokpa* pastoral nomads of western Arunachal Pradesh were maintaining the proper herd composition for sustainable livestock productivity and production. Table 4 clearly stated that ratio of the productive animal in the herd were significantly (at $p<0.01$) contributing to the adoption of the higher level of adopter. It is also revealed from the same table that increasing the ratio of the productive animal in the herd by one unit increases the probability of a respondent to be in higher level of adoption from lower level of adoption by 0.9 per cent. Higher level adopters are more cosmopolite and they know very well regarding the probable negative impact of the climate change. Therefore, they used to adopt different adaptation strategies to maintain the proper ratio of productive animal in the herd.

Results show that family education status, social participation, proportion of income from livestock, extreme climatic events experienced and farmer to farmer extension were positively influenced to the medium level of adoption in comparison to lower level of adoption. In case of higher level adoption, family education status, proportion of income from livestock, numbers of primary products prepared, extension contact, farmer to farmer extension and were positively influenced.

Results also shows that sources of climatic information, numbers of primary products prepared, ratio of the productive animal in the herd and proportion of expenditure to livestock negatively affect to the medium level of adoption. But, social participation, extreme climatic events experienced and proportion of expenditure to livestock were negatively influence to the higher level of adoption.

Though these variables were not statistically significant, the positive and negative influence. It is

Table 3. Estimated Multinominial Logit Coefficients of factors determining level of adoption of adaptation strategies among the *brokpa* pastoral nomads

Explanatory Variables (Xi)	Estimated Coefficient	St. Error	P > Chi squre	Odds Ratio	95% confidence interval for Odds Ratio		Predicted Marginal Effect (dP/dx)
					Lower bound	Upper bound	
Medium Level of Awareness (2)							
Family Education Status	0.035	0.106	0.743	1.035	0.841	1.275	0.009
Social Participation	0.087	0.112	0.441	1.090	0.875	1.359	0.022
Sources of Climatic Information	-0.604	0.416	0.147	0.547	0.242	1.237	-0.138
Proportion of Income from Livestock	0.030	0.018	0.103	1.030	0.994	1.068	0.007
Numbers of Primary Products Prepared	-0.652*	0.371	0.079	0.521	0.252	1.078	-0.147
Extension Contact	0.101**	0.051	0.047	1.107	1.002	1.223	0.025
Extreme Climatic Events Experienced	0.167	0.315	0.594	1.182	0.638	2.190	0.042
Farmer to Farmer Extension	0.273	0.355	0.442	1.314	0.655	2.633	0.067
Productive Animals in the Herd	-0.008	0.010	0.411	0.992	0.972	1.012	-0.002
Proportion of expenditure to livestock	-0.057	0.129	0.655	0.944	0.734	1.215	-0.014
Higher Level of Awareness (3)							
Family Education Status	0.128	0.108	0.234	1.136	0.920	1.403	0.032
Social Participation	-0.083	0.122	0.494	0.920	0.725	1.168	-0.021
Sources of Climatic Information	0.001	0.388	1.000	1.000	0.467	2.141	-5.6E-07
Proportion of Income from Livestock	0.010	0.018	0.574	1.010	0.975	1.046	0.003
Numbers of Primary Products Prepared	0.605*	0.350	0.084	1.831	0.923	3.632	0.138
Extension Contact	0.084	0.054	0.120	1.088	0.978	1.210	0.021
Extreme Climatic Events Experienced	-0.099	0.318	0.755	0.906	0.486	1.688	-0.025
Farmer to Farmer Extension	0.189	0.354	0.594	1.208	0.603	2.419	0.047
Productive Animals in the Herd	0.037***	0.009	0.000	1.038	1.021	1.055	0.009
Proportion of expenditure to livestock	-0.157	0.170	0.354	0.854	0.613	1.192	-0.039

The reference category	Lower level of adoption (1)
-2 Loglikelihood	252.832
McFadden R-squared	0.220
LR statistic (54 df)	71.476*
Probability (LR stat)	0.000
Observations	148

*** Indicates significant at 1 % level of significance, in a two tail test
** Indicates significant at 5 % level of significance, in a two tail test
* Indicates significant at 10 % level of significance, in a two tail test

expected that *Brokpa* pastoral nomads with higher level of education may leads to adopt adaptation strategies to protect their livestock from negative impact of climate change. In case of social participation, there were two different sign. The higher level adopter *i.e.* innovator are always away from the society and they don?t have much social contact. Therefore, as expected, negative sign was found in case of social participation among the higher level of adoption. But, in case of medium level of adopter, we got the sign as positive. Mainly early adopter or early majority are the medium level of adopter; and they have a good social contact. This may the reason of getting positive sign of social participation for medium level of adopter. In case of sources of climatic information, the same trend was observed. Higher level adopters were always seeking climatic information and took suitable strategies to cope up with negative impact of climate change. But, medium level adopter did not bother regarding climatic information and adopted several adaptation strategies as per the availability of the strategies. People generally adopt adaptation strategies to cope up with negative impact of climate change. The *Brokpa* pastoral nomads of western Arunachal Pradesh also did the same thing. Therefore, proportion of income from livestock were positively influencing to the adoption of adaptation strategies.

CONCLUSION

Pastoral nomads of western Arunachal Pradesh recognised changing climatic scenario and adopted several adaptation strategies mechanism to cope up with its negative impact. It is found that extension contact and ratio of the productive animal in the herd showed significant positive effect on adoption of adaptation strategies among the *Brokpa* pastoral nomads. Therefore, a dedicated team of veterinary/livestock extensionist must be trained or promoted to teach livestock rearers in different aspects of climate change including scientific adaptation strategies. Other important determinants like numbers of primary products prepared showed both positive and negative effect on adoption of adaptation strategies among the *Brokpa* pastoral nomads of Western Arunachal Pradesh.

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