Research Article

Determinants of Households' Adaptation Practices against Climate Change Impact on Off Farm Activities in Nepal

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Abstract

Study on adaptation practices against climate change impact in agriculture sector have been explored extensively globally but adaptation practices against climate change impact on off farm activities are not studied in detail. This study aims to analyze the determinants of households' adaptation practices against climate change impact on off farm activities in Nepal. It utilizes the data generated from nationally representative samples of National Climate Change Impact Survey, 2016 conducted by Central Bureau of Statistics. Total sample size of this survey was 5060 households. But for this paper, total of 4114 samples were considered. Binary logistic regression analysis was carried out to analyze households' adaptation practices against climate change impact on off-farm activities in Nepal. Most of the respondents are male of age 40-54 years, from non-Brahmin/Chhetri caste/ethnicity, illiterate, with lowest income Quintile, from tropical climate zone and without getting any services from agricultural service center. Females are less likely to have adaptation practices towards off farm activities (started more off-farm activities; shifted to non-agricultural employment; and temporary out-migration) in compared with male. Non-Brahmin/Chhetri caste/ethnicity with reference to Brahmin/Chhetri is the determining factor for the adaptation practices (shifted to non-agricultural employment; and temporary out-migration). Status of receiving any services from agricultural service center, years of experience in agricultural sector and sub-tropical climate zone with reference to tropical zone are the common determining factors for households' adaptation practices towards off farm activities against climate change impact in Nepal.

Key words: *Adaptation, binary logistic regression, climate change, determinants, off farm based activities*

Introduction

The continuous increase in greenhouse gas emission due to anthropogenic pressure would further amplify the rate of increase in temperature and intensify the frequency of extreme weather events including floods, droughts, changing rainfall pattern, water resources depletion, and severe heat/cold waves. Climate change refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC, 2007).

The scientific evidence has shown that climate change is a global challenge facing humans and their socio-economic activities, health, livelihood, and food security (Romieu et al., 2010; Amjath-Babu et al., 2016).

It is well understood that the farmers who entirely depend on farming activities need a varieties of adaptation practices to minimize the negative impact of climate change for their livelihood. Among the practices, an off farm activity may be one of the safe exits. Off farm activities are those activities which are done outside the agricultural activities. Several studies at globe have found that a large proportion of the off farm activities are in increasing trend (Oppong-Kyeremeh and Bannor, 2017).

Agriculture is one of the main economic activities of Nepal and about two-thirds of the population employs on it (CBS, 2017). Among the agricultural population, more than half (51.5%) holds less than 0.5 hector land; land is fragmented and no land management, while the poorest population are involved in agriculture and this section of the population are getting about 59.0 percent income from agriculture as compared with 21.0 percent of the richest quintiles (Satyal, 2010). Climate change is expected to significantly reduce agricultural productivity especially in tropical and subtropical regions (Jones and Thornton, 2003).The loss of yield for major crops that account for 80.0 percent of production in Africa and South Asia may reach 8.0 percent by the middle of this century. Agronomic research indicates that higher temperatures associated with climatic change will be very harmful to the production of many crop and livestock groups. The data trend from 1975 to 2005 shows that the mean annual temperature has been increasing by 0.06 °C while the mean rainfall has been decreasing by 3.7 mm (-3.2%) per

month per decade in Nepal (PAN, 2009).

Adaptation to climate changes seems to be the most appropriate means for farmers to minimize the negative impact of climate change. Adaptation strategies such as; changing crop types, changing crops varieties, tree planting, soil and water conservation, changing planting date, fertilizer application and crop diversification are in practice (Tesfaye and Seifu, 2016). There are also other types of adaption practices to the climate change such as off farm based activities which are less discussed. Hence, this study aims to analyze the determinants of households' adaptation practices against climate change impact towards off farm based activities in Nepal. We hope this study is unique in Nepal's context and fulfills the gap on adaption activities to the impact of climate change in agriculture sector of Nepal.

Data and Method

This paper utilizes the data generated from nationally representative sample of National Climate Change Impact Survey, 2016 conducted by Central Bureau of Statistics. Total sample size of this survey was 5,060 households. The sample selection strategy adopted for the NCCIS was done in three stages - I stage: selection of the districts; II stage: selection of primary sampling unit (PSU), 253 PSUs from all 16 analytical domains; and III stage: random selection of households. Age of the respondents of the households was 45 years and above and residing at least 25 years in that area. But for this study, the respondents who denied saying about income, the utilization of service regarding agriculture from service center, as well as the chosen four off-farm activities for the adaptation of climate change were excluded and total of 4114 samples were considered.

The selected off-farm activities for the adaptation of climate change are changed on food consumption habit; started more off-farm activities; shifted to non-agricultural employment; and temporary out-migration. These components are taken as dependent variables. Further age, sex, educational status, caste/ethnicity of the respondents, per capita yearly income quintile, if agricultural service were received from agricultural service center, years of experience in agricultural sector and climate zone are considered as independent variables.

Binary logistic regression analysis was carried out to find the determinants of adaptation practices towards off-farm activities.

$$ln\frac{P(Y_i = 1/X)}{P(Y_i = 0/X)} = \beta_0 + \sum_{k=1}^{K} \beta_k X_{ik}$$

This model is estimated by maximum likelihood estimation (MLE) method as the outcome variable is binary in nature i.e. if respondent has selected off-farm activities. If the respondent selected the activities, Y = 1, otherwise Y = 0. Similarly, X denotes independent variables. This study mainly focused if the respondents have selected off-farm activities for the adaptation of climate change.

Results and Discussion

Background Characteristics of Respondent

More than two third of the respondents (67.2%) are male whereas female accounts around one third of the total samples (32.8%). Majority of the respondents falls in the age group 45 to 54 years. Minimum age of the respondents is 45 years and the range is 50 years following the average age as 58.42 years with standard error as 0.16 years. Brahmin/Chhetri covers less than one third of the total respondents whereas other castes like Janajati, Madeshi, Dalit and others cover more than two third of the total. More than two fifth of the respondents are illiterate followed by informal education, basic education, and higher education. More than three forth of the respondents (77.4%) receive any service from agriculture service center. More than one third of the respondents have lowest income Quintile (22.8%). More than half of the respondents are from Tropical climate zone.

Table 1

Respondents Classified According to Selected Background Characteristics ((n= 4114)

Characteristics	Number	Percent
Age(Years)		
45-54	1687	41.0
55-64	1257	30.6
65-74	835	20.3

75+	335	8.1
Minimum = 45 years, Maximum = 95 years, Average = 58.42 years, S.E.= 0.16 years		
Sex		
Male	2763	67.2
Female	1351	32.8
Caste/Ethnicity		
Brahmin/Chhetri	1245	30.3
Others	2869	69.7
Per Capita Yearly Income Quintile		
First Quintile (Lowest)	936	22.8
Second Quintile	893	21.7
Third Quintile	912	22.2
Fourth Quintile	771	18.7
Fifth Quintile (Highest)	602	14.6
Receive any Service from Agriculture Service Center		
Yes	930	22.6
No	3184	77.4
Education		
Illiterate	1881	45.7
Beginner/Informal education	871	21.2
Basic education	803	19.5
Higher education	559	13.6
Climate Zone		
Tropical	2245	54.6
Sub-Tropical	1564	38.0
Temperate	285	6.9
Sub-Alpine	20	0.5
Total	**4114**	**100**

Sources: NCCIS, 2016

Determinants of adaptation practices towards off-farm activities

Change of food consumption habit

The dependent variable i.e. change on food consumption habit has two responses i.e. yes and no. No is taken as reference category for finding the determinants of adaptation practices. Table 2 shows the odds ratio of logistic regression coefficients, their P values, and 95 percent confidence interval for odds ratios for each category. From the fitted model, with reference to illiterate, basic education as well as secondary and higher education have more chance to have adaptation

practices. Similarly with reference to tropical climate zone, sub-tropical and temperate zone has less chance to have adaptation practices. With reference to the people getting agricultural service, the people without getting any agricultural service are less likely to have adaptation practices. Similarly as years of experiences on agriculture increase, there is less likely to have adaptation practices.

Table 2
Odds Ratio from Logistic Regression Model on Change of the Food Consumption Habits, (n= 4114)

			95% CI	
Characteristics	**Odds Ratio**	**Sig.**	Lower	Upper
Age	1.001	0.758	0.994	1.009
Sex				
Male (R)	1			
Female	0.919	0.306	0.781	1.080
Education				
Illiterate(R)	1			
Literate	1.108	0.269	0.924	1.330
Basic	1.587	0.000	1.285	1.961
Secondary and above	1.463	0.004	1.130	1.894
Caste/Ethnicity				
Brahmin/Chhetri(R)	1			
Others	0.939	0.425	0.804	1.096
Climate Zone				
Tropical(R)	1			
Sub-tropical	0.763	0.000	0.658	0.884
Temperate	0.391	0.000	0.301	0.506
Sub-alpine	7.163	0.998	0.000	.
Receiving any agricultural Service				

Yes(R)	1			
No	0.780	0.004	0.658	0.924
Per Capita Yearly Income Quintile				
First Quintile (Lowest) (R)	1			
Second Quintile	1.015	.885	.830	1.241
Third Quintile	0.965	.732	.789	1.181
Fourth Quintile	1.045	.691	.841	1.299
Fifth Quintile (Highest)	1.253	.080	.973	1.614
Years of experience on agriculture	0.994	0.018	0.988	0.999

Final -2loglikelihood =4849.10; Hosmer and Lemeshow - Chi-square value =13.92(P = 0.084) ; Nagelkerke R^2 = 0.054; Cox-Snell R^2= 0.038

Start of more off -farm Activities

The dependent variable i.e. started more off farm activities has two responses i.e. yes and no. No is taken as reference category for finding the determinants of adaptation practices. Table 3 shows the odds ratio of logistic regression coefficients, their P values, and 95 percent confidence interval for odds ratios for each category. From the fitted model, female are less likely to have adaptation practice than male. Further, with reference to illiterate, people with secondary and higher education have more chance to have adaptation practices. Similarly with reference to tropical climate zone, sub-tropical and temperate zone has less chance to have adaptation practices. The people with income as second quintile are less likely to have adaptation practices than the people with income as first quintile (lowest). With reference to the people getting agricultural service, the people without getting any agricultural service are less likely to have adaptation practices. Similarly as years of experiences on agriculture increase, there is less likely to have adaptation practices.

Table 3

Odds Ratio from Logistic Regression Model of Starting of More Off Farm Activities (n = 4114)

			95% CI	
Characteristics	**Odds Ratio**	**Sig.**	**Lower**	**Upper**
Age	1.005	0.243	.997	1.012
Sex				
Male (R)	1			
Female	.806	0.013	.681	.955
Education				
Illiterate(R)	1			
Literate	.953	.624	.784	1.157
Basic	.991	.930	.807	1.216
Secondary and above	1.438	.003	1.133	1.825
Caste/Ethnicity				
Brahmin/Chhetri(R)	1			
Others	1.139	.109	.971	1.335
Climate Zone				
Tropical(R)	1			
Sub-tropical	.548	.000	.471	.637
Temperate	.471	.000	.340	.651
Sub-alpine	.912	.855	.341	2.439
Receiving any agricultural Service				
Yes(R)	1			
No	0.564	0.001	.481	.662
Per Capita Yearly Income Quintile				
First Quintile(R)	1			
Second Quintile	0.763	0.013	0.616	.945
Third Quintile	0.879	0.228	0.713	1.084

Fourth Quintile	1.014	0.902	0.815	1.261
Fifth Quintile	1.169	0.201	0.920	1.485
Years of experience on Agriculture	0.977	0.001	.972	.982
Hosmer and Lemeshow: P = 0.048 Chi-square value =15.645			Nagelkerke R^2 = 0.112	
Cox-Snell R^2= 0.080	R=Reference		-2loglikelihood =4776.09	

Shifting to Non-Agricultural Employment

The dependent variable i.e. shifted to non-agricultural employment has two responses i.e. yes and no. No is taken as reference category for finding the determinants of adaptation practices. Table 4 shows the odds ratio of logistic regression coefficients, their P values, and 95 percent confidence interval for odds ratios for each category. From the fitted model, with reference to illiterate, literate people have less chance to have adaptation practices. Similarly people with other caste than Brahmin/Chhetri are more likely to have adaptation practices. With reference to tropical climate zone, sub-tropical zone has less chance to have adaptation practices. The people with higher income are more likely to have adaptation practices than the people with lowest income. With reference to the people getting agricultural service, the people without getting any agricultural service are less likely to have adaptation practices. Similarly as years of experiences on agriculture increase, there is less likely to have adaptation practices.

Table 4

Odds Ratio from Logistic Regression Model of Shifting to Non-agricultural Employment (n = 4114)

			95% CI	
Characteristics	**Odds Ratio (B)**	**Sig.**	Lower	Upper
Age	1	.987	.993	1.007
Sex				
Male (R)	1			
Female	0.856	0.049	0.733	0.999

Education				
Illiterate(R)	1			
Literate	0.725	0.000	0.606	0.866
Basic	0.942	0.543	0.779	1.141
Secondary and above	0.967	0.777	0.768	1.218
Caste/Ethnicity				
Brahmin/Chhetri(R)	1			
Others	1.314	0.001	1.135	1.522
Climate Zone				
Tropical(R)	1			
Sub-tropical	0.660	0.000	0.575	0.759
Temperate	0.993	0.961	0.764	1.291
Sub-alpine	0.476	0.122	0.186	1.220
Receiving any agricultural Service				
Yes(R)	1			
No	0.788	0.002	0.677	0.918
Per Capita Yearly Income Quintile				
First Quintile (R)	1			
Second Quintile	1.006	0.951	0.827	1.225
Third Quintile	1.526	0.000	1.258	1.852
Fourth Quintile	1.992	0.000	1.623	2.446
Fifth Quintile	2.198	0.000	1.747	2.765
Years of experience on agriculture	0.979	0.001	.974	.984

Hosmer and Lemeshow - Chi-square value =16.77(P = 0.033) Nagelkerke R^2 = 0.104

Cox-Snell R^2= 0.077 R=Reference Final -2loglikelihood =5330.194

Adapting Temporary Out-Migration

The dependent variable i.e. temporary out-migration has two responses i.e. yes and no. No is taken as reference category for finding the determinants of adaptation practices. Table 5 shows the odds ratio of logistic regression coefficients with their P values and 95 percent confidence interval. Analyses reveal that, females are less likely to have adaptation practice than male. Educated people have less likely to have adaptation practices than illiterate people. Similarly people with other castes than Brahmin/Chhetri are more likely to have adaptation practices. With reference to tropical climate zone, sub-tropical and temperate zone have less chance to have adaptation practices. The people with second quantile income are less likely to have adaptation practices than the people with lowest income. With reference to the people getting agricultural service, the people without getting any agricultural service are less likely to have adaptation practices. Similarly as years of experiences on agriculture increase, there is less likely to have adaptation practices.

Table 5

Odds Ratio from Logistic Regression Model of Adapting Temporary Out-migration (n =4114)

			95% CI	
Characteristics	**Odds Ratio (B)**	**Sig.**	Lower	Upper
Age	1.002	.610	.995	1.009
Sex				
Male (R)	1			
Female	.759	.001	.648	.889
Education				
Illiterate(R)	1			
Literate	.793	.011	.663	.948
Basic	.679	.000	.558	.825
Secondary and above	.536	.000	.423	.679
Caste/Ethnicity				

Brahmin/Chhetri(R)	1			
Others	1.356	.001	1.167	1.575
Climate Zone				
Tropical(R)	1			
Sub-tropical	.442	0.001	.383	.509
Temperate	.259	0.001	.190	.355
Sub-alpine	2.176	0.117	.822	5.761
Receiving any agricultural Service				
Yes(R)	1			
No	0.782	0.002	.670	.914
Per Capita Yearly Income Quintile				
First Quintile (R)	1			
Second Quintile	.825	.056	.678	1.005
Third Quintile	.779	.013	.640	.949
Fourth Quintile	.927	.473	.754	1.140
Fifth Quintile	1.258	.051	.999	1.583
Years of experience on agriculture	0.994	0.01	.989	.998

Hosmer and Lemeshow- Chi-square value =8.662(P = 0.372) Nagelkerke R^2 = 0.099

Cox-Snell R^2 = 0.073 R= Reference Final -2loglikelihood =5211.85

Conclusion

Majority of the respondents considered for the study are male of age 40-54 years, from non-Brahmin/Chhetri caste/ethnicity, illiterate, with lowest income Quintile, from tropical climate zone and without getting any services from agricultural service center.

Among the variables; age, sex, educational status, caste/ethnicity, per capita yearly income quintile, service received from agricultural service center, years of experience in agricultural

sector and climate zone considered as independent variables, age does not show a statistically significant relationship with the households' adaptation practices towards all off farm activities considered for the analyses. Female is less likely to have the adaptation practices towards off farm activities (started more off-farm activities; shifted to non-agricultural employment; and temporary out-migration) as compared with male while it does not matter for changed on food consumption habit. Non-Brahmin/Chhetri caste/ethnicity with reference to Brahmin/Chhetri is the common factor for determining the adaptation practices (shifting to non-agricultural employment; and temporary out-migration). Status of receiving any services from agricultural service center, years of experience in agricultural sector and sub-tropical climate zone with reference to tropical zone are the common determining factors for households' adaptation practices towards off farm activities against climate change impact in Nepal.

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