Determinants of forage and fodder production practices to cope with climate change adaptation strategy by farmers in Terai region of Nepal

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Abstract
Consequences generated by climate change disasters in the vulnerable agricultural system of Nepal could increase in coming days in the absence of effective adaptation strategies in the both agriculture and livestock sector. There is growing evidence that forage and fodder production activity can be a potential adaptation strategy, but adopted in a limited scale. The objective of this study was to identify the determinants of forage and fodder production activity by livestock farmers in the Terai region of Nepal. Primary data collected through household survey of 600 households, 100 from each district in Morang, Sarlahi, Bara, Chitwan, Rupandehi and Banke were analyzed using logistic regression technique. Results showed that western Terai dummy and family size were negatively affecting the adoption of forage and fodder production. Whereas access to credit, size of livestock holding and training were positively and significantly affecting the adoption of the forage and fodder production activity. The magnitude of effect of these significant variables are western Terai dummy (25.2%), family size (92.60%), access to credit dummy (74.21%), size of livestock holding (10.8%) and training dummy (188.80%). Findings of the study suggested that provided opportunity to dairy farmers for participation in training on livestock production management practices and increased access to credit for making investment in dairy enterprises. Rearing livestock at commercial scale also motivates dairy farmers to produce forage and fodder in their own farm land. It is also recommended to provide lease- in land system for dairy farmers with large size family to grow forage and fodder crops aside from promotional activities are needed in western Terai region of the country in particular.

Keywords**:** Climate change, forage and fodder production, Terai, adoption and logistic regression

Introduction
Change in the climate over a long period of time due to natural processes and anthropogenic activities is termed as climate change (IPCC, 2007). Nepal was predicted to be one of the most severely affected countries by the impacts of climate change in the years to come (Synnott, 2012). Due to impacts of climate change on agriculture, the majority of the people primarily involved in agriculture can be most severely affected. The changes in the hydrograph and water availability during the pre-monsoon, monsoon and post-monsoon seasons are known to have direct impacts in the Nepalese agricultural system (Sharma *et al.*, 2006). Climate change has multidimensional impacts on the environmental, socio-economic and development related sectors including agriculture, livestock, food security, biodiversity, water resources, energy, human health and ecosystems (Dahal, 2005; NCVST, 2009; WFP, 2009).

Crop, livestock and agro-forest are the chief elements of the Nepalese farming system making the whole agricultural system working and self-sustaining. Livestock constitute an important part of the Nepalese farming system where livestock are reared for the variety of products like milk, meat, power, manure, wool, hide that they provide. Cattle, buffalo, goat, pig and poultry are the principal animals reared in Nepal (AICC, 2019). However, in the recent years, livestock sector has become much vulnerable and prone to the disastrous impacts brought about by climate change impact. From the view point of livestock, as it has much closer ties with the nature and the ecosystem, the adverse impacts of climate change are much more severe and direct. With the livestock sector in focus, the impacts of climate change are much more evident. Reduced feed availability and feed intake, lower feed conversion efficiency, decreased productivity, changes in breeding pattern, increased heat stress, increased incidence of diseases and similar other adversities have already begun to hit the farmers' sheds. Thereby resource-poor small

farmers are more likely to get affected. Farmers have been adopting different management practices; improvement of cattle shed, fodder and forage production, mixed farming, diversification of livestock species, irrigation of forage field, management of grazing and pasture land, approach extension service providing organizations, business diversification for the adaptation of dairy farm business to cope with climate change impacts. But, levels of adoption of these practices are not at the expected levels. In this context, this study was conducted to assess the different factors which have hindered to adopt one of the important adaptation strategies, forage and fodder production in dairy farmers' own farm.

Methodology

Study area and sampling

The study was conducted in six districts across Terai; Morang, Sarlahi, Bara, Chitwan, Rupendehi and Banke of Nepal. These districts were purposively selected based on the availability of sufficient livestock farmers required for the study and having ample opportunities on expanding dairy farming. Two livestock farming pocket from each of the district were selected purposively in consultation with district level stakeholders working in the promotion of livestock. Multistage random sampling technique was used as the sampling procedure for this study. One hundred households from each district that rely on livestock for their livelihood were randomly selected i.e. from selected pocket of each districts, fifty households were selected randomly making a total of 600 samples.

Literature review and preliminary field visit was done to develop coordination scheme which was developed covering complex variables broken down to the simplest variables along with their unit. This was used to develop the questionnaire. Questionnaire prepared in this manner was finalized after having pretested it in two districts one each from eastern (Morang) and western Terai (Banke) of Nepal. Data collected from interview schedule by well oriented enumerators were then verified by organizing a focal group discussion in each district under study. Collected data were entered in the SPSS spread sheet and managed for units, missing value, outliers etc. Data analysis was done using Stata and SPSS software wherever applicable.

Descriptive analysis of primary data

Socio-economic and farm characteristics of the respondents like family size, age, occupational pattern, education, caste, gender roles in livestock activities, land size, livestock holding were analyzed by using simple descriptive statistics like frequency count, percentage, mean, standard deviation etc. Similarly, descriptive statistics of different variables which were used in logistic regression model were studied using arithmetic mean and standard error**.**

Analytical technique

Logistic regression is a popular statistical technique in which the probability of a dichotomous outcome like adoption or non adoption is associated with the group of independent variables assumed in the relationship. To accomplish the objective of factors affecting adoption of forage and fodder production logistic regression technique was used considering adoption as the function of different personal, social, economic and institutional factors. Maddison (2006), Seo and Mendelsohn (2008), and Hassan and Nhemachena (2008) studied the impact of climate change and factors affecting the adaptation measures in livestock and mixed crop livestock production in different parts of the world using this technique. Decision of farmers to practice forage and fodder production was estimated through logistic regression to derive the several factors that govern the probability to practicing more adaptation strategies (Yi =1). Maximum likelihood method leads to least square function under linear regression model (under the conditions of normally distributed error term) and gives value for the unknown parameters which maximizes the probability of obtaining the observed set of data (Wooldridge, 2003). In this process marginal effects were estimated to determine the probability of different factors under study to determine the adoption of particulars adaptation strategy. It was hypothesized that there could be several factors that

affect for the practicing different adaptation strategies in the farm level. Decision to practice forage and fodder production at own farm might be influenced by several socioeconomic, demographic, institutional, and financial conditions (Deressa *et al.,* 2009). The logistic model was used to analyze the binary or dichotomous response and allows examining how a change in any independent variable changes all the outcome probabilities following Regmi (2010).

If $Y_i = 1$; $P(Y_i = 1) = P_i$

$Y_i = 0$; $P(Y_i = 0) = 1 - P_i$

Where, $P_i = E(Y = 1/X)$ represents the conditional mean of Y given certain values of X.

The logistic transformation of the probability of the practicing adaptation strategies by farmers were represented as follows (Gujarati, 2003).

$$L_i = \ln [P_i / 1-P_i] = Z_i = \beta_0 + \sum_{i=1}^{n} \beta i \, Xi + \varepsilon_i$$

Where Y_i = a binary dependent variable (1, if farmers practice forage and fodder production, and 0 otherwise), X_i includes the vector of explanatory variables used in the model, β_i = parameters to be estimated, β_0 = a constant term , ε_i = error term of the model, exp (e) =base of the natural logarithms, L_i = Logit and $[P_i/1-P_i]$= odd ratios for i= 1, 2, 3, 4,……n farm households. Thus, the binary logistic regression model used in the study was expressed as:

$Y_i = f(\beta_i X_i)$ = f (central region dummy, western region dummy, age of household head, sex of household head, ethnicity of respondent household, education of household head, number of family members with above secondary level education, family size, household with engage in abroad job, total land owned by household, livestock holding by household, access to credit, training taken, membership in group). The details of these variables used in the model are shown in Table 1.

Table 1. Description of explanatory variables used in the climate change adaptation strategies adoption model

Variable name	Description
Central region (dummy)	Central region dummy (value 1 if the household is from central region, 0 otherwise) [a]
Western region (dummy)	Western region dummy (value 1 if the household is from western region, 0 otherwise) [a]
Age (years)	Age of household head (years)
Sex (dummy)	Sex of household head (value 1 if the household head is male, 0 otherwise)
Brahmin-Kshetri (dummy)	Ethnicity dummy (value 1 if the household is brahmin or kshetri, 0 otherwise)
Education of household head (dummy)	Years of schooling of household head (years.)
Number of family member with above secondary level education (number)	Number of members with above secondary level education in the household (numbers)
Family size (number)	Family size (numbers)
Abroad job (dummy)	Abroad job dummy (value 1 if the family member is in abroad job, 0 otherwise)
Total land (Kattha)	Total land owned by household (Kattha)
Livestock holding (LSU)	Size of livestock holding (LSU)
Access to credit (dummy)	Access to credit dummy (value 1 if the household has access to agricultural credit, 0 otherwise)
Training (dummy)	Training dummy (value 1 if the member from household has taken training on livestock related areas, 0 otherwise)
Attachment in group (dummy)	Involvement in farmers' group and co-operatives dummy (value 1 if the member from household has membership in farmers' group and cooperatives, 0 otherwise

[a] *Eastern region is treated as the reference region.*

Results and Discussions

Socio-demographic and economic characteristics

This sub-section deals with the major findings on socio-demographic and economic characteristics of respondents and respondent households. These are summarized in terms of sex, size of family, land and livestock holding, occupation, income structure etc. The average age of respondent was found least in Banke (42.34 years) and the highest in Morang (49.57years), whereas the overall average within the study area was 45.71 years Years of schooling of respondent within the study area was overall averaged as 5.36 years which is lower than the national overall average (8.1years) of adults above 15 years (CBS, 2011). Similarly, male and female per household were 3.3 and 3.1, respectively in study area which was more than male and female numbers in household of country, 2.3 and 2.5, respectively (CBS, 2011). The study on age distribution of family members in surveyed districts which depicted economically active population was 64.5 % which found higher than national economically active population level i.e. 57% (CBS, 2011). Average number of family members with primary, secondary, school level education, higher secondary and university was found 0.84 (14%), 1.49 (24.83%), 0.67 (11.12%) and 0.54 (9%), respectively in the study area. The dominant inhabitance of the Brahmin-Kshetri community (46.50%) was found in study area. The highest cultivated land holding per household was found in Rupandehi, followed by Banke, Morang, Sarlahi, Chitwan and the least at Bara. Being the districts of Terai, on an average about two third of land holding was lowland. Area under year round irrigation was found highest (14.98 kattha) in Rupandehi, while the lowest (0.01 kattha) in Banke which is quite below the national average of 18% (ADS, 2015). It was found that, Chitwan, Banke and Bara district have greater number of cow holding than overall average (2.93). Household income based on natural resources of Chitwan district was highest among all districts (65.35%) and least in Bara district (54.40%). Whereas, income from non-natural resource based was highest in Bara (45.60%) and the lowest was in Chitwan district (34.65%).

Adoption of different adaptation strategies by farmers in study area

Different adaptation strategies adopted by dairy farmers in the study area to cope climate change effects are shown in Table 2. Mixed farming system of different species of livestock as a climate change adaptation strategy has been adopted by the largest number of respondents (93%) and water harvest scheme was the least adopted climate change adaptation strategy, being adopted by just over 8% of the respondents. Popular adaptation strategies adopted by more than half of the total number of respondents were found as reduction in herd size (60.67%), diversification of livestock species (77.33%), feeding feed supplement to livestock (75.83%), forage and fodder cultivation (54.67%), improved shed construction (59.16%), diversification of farm activities (82%) and mixed farming (93%).

Mean and standard error of different variables used in the study of factors affecting adoption of forage and fodder production are presented in Table 3. These included both the dummy and continuous variables used in the logistic regression.

Table 2. Adoption of different adaptation strategies to cope with effect of climate change by farmers in study area

Adaptation strategies	Number						Total	
	Morang	Sarlahi	Bara	Chitwan	Rupendahi	Banke	F	%
Reduction in herd size	56	73	52	43	73	67	364	60.67
Water harvest scheme	18	1	5	19	3	3	49	8.17
Diversification of livestock species	78	79	72	81	75	79	464	77.33
Feeding feed supplement to livestock	66	63	88	83	93	62	455	75.83
Adoption of improved	38	17	23	58	68	27	231	38.50

Adaptation strategies	Number						Total	
	Morang	Sarlahi	Bara	Chitwan	Rupendahi	Banke	F	%
dairy breeds								
Livestock insurance	0	4	51	24	12	15	106	17.67
Maintaining of grazing land	28	3	15	8	23	61	138	23.00
Forage and fodder cultivation	55	88	83	87	6	9	328	54.67
Irrigation	54	3	18	62	8	8	153	25.50

Table 3. Descriptive statistics for the explanatory variables used in estimating adoption model

Variable	Descriptive statistics (n=600)	
	Mean	S.E.
Central region (dummy)	0.33	0.01
Western region (dummy)	0.33	0.01
Age (years)	50.34	0.55
Sex (dummy)	0.76	0.01
Brahmin-Kshetri (dummy)	0.77	0.01
Education of household head (dummy)	2.42	0.17
Number of family member with above secondary level education (number)	1.86	0.06
Family size (number)	6.40	0.11
Abroad job (dummy)	0.31	0.01
Total land (Kattha)	18.82	0.98
Livestock holding (LSU)	6.35	0.38
Access to credit (dummy)	0.81	0.01
Training (dummy)	0.28	0.01
Attachment in group (dummy)	0.54	0.02

Factors affecting adoption of forage and fodder production

The result from logistic regression model for adoption of fodder and forage cultivation are presented in Table 4. Results showed that out of fourteen explanatory variables, five factors were significantly contributing adoption of fodder and forage cultivation as climate change adaptation strategy and leaving others non significant. These factors affecting the adoption are western dummy, family size, livestock holding, access to credit and training. Among these, all the factors except western dummy and family size are contributing the diversification of farm activities in positive direction. Access to credit and training are more influencing factors for adoption as compared with other among positively contributing factors.

Table 4. Regression coefficients of logistic regression model for fodder and forage cultivation

Variable[a]	Odds Ratio	SE	Z	P>IzI
Central region (dummy)	1.833	0.688	1.61	0.107
Western region (dummy)	0.252**	0.075	-4.59	0.000
Age (years)	1.004	0.009	0.50	0.617
Sex (dummy)	1.136	0.325	0.45	0.655
Brahmin-Kshetri (dummy)	0.641	0.195	-1.45	0.146
Education of household head (dummy)	1.005	0.031	0.17	0.869
Number of family member with above secondary level education (number)	0.904	0.069	-1.30	0.195
Family size (number)	0.926*	0.039	-1.77	0.076

Variable[a]	Odds Ratio	SE	Z	P>IzI
Abroad job (dummy)	1.265	0.338	0.88	0.379
Total land (Kattha)	1.008	0.005	1.06	0.292
Livestock holding (LSU)	1.108**	0.044	2.57	0.010
Access to credit (dummy)	8.421**	2.396	7.49	0.000
Training (dummy)	2.888**	0.791	2.39	0.017
Attachment in group (dummy)	1.362	0.390	1.08	0.280
Constant	0.732	0.517	-0.45	0.650
Pseudo R^2	0.314			
Log likelihood	-223.43			
Observation	600			

[a]*Prob (Y = 1): adopted forage and fodder cultivation.*
***, *Significance level at P <0. 0.05 and P<0.010, respectively*

The role of different variables on adoption of forage and fodder production are presented and discussed hereunder in separate sub-headings.

Central/western Terai
The cultivation of forage and fodder in central Terai as compared to eastern Terai was statistically non-significant and correlated positively. Similarly, forage and fodder cultivation in western Terai found statistically highly significant (P<0.05) but negatively correlated. This implies forage and fodder cultivation in western Terai as compared with eastern Terai decreased by 74.8%. It may be due to high family size in western Terai which demands the family to produce more crops instead of fodder ultimately leading to decrease in fodder cultivation. The other possible explanation might be small hand holding, lack of training facilities and poor extension services which prevents small farmers from driving towards modern approaches of farming and climate change adaptation strategies.

Age of household head
The age household head for adoption of fodder and forage cultivation was found non-significant but positively correlated. The result showed that 1 year increase in age of household head, the adoption of fodder and forage cultivation increases by 0.4%. The implication of this result is that with increasing age of household head improves likelihood of adaptation to climatic situations through various strategies. This is consistent with the findings of (Apata, 2011) who reported perceiving climate change increases with age, thus adopting suitable options.

Sex of household head
Similarly the sex of household head was non-significant but is positively correlated to affect fodder and forage cultivation adoption. Household head headed by male increases adoption of fodder and forage cultivation by 13.6% than household head headed by female. The justification behind the fact might be due to most of the families are male headed. It is because culturally conditioned to involve farming activity that required intensive male labor forces like land preparation etc. This is consistent with the finding of Obayelu *et. al.,* 2014 in which being a female head of household head had negative effect on likelihood of adoption of climate change strategies due to lack of information and resource constraint.

Ethnicity of household
The regression model explained fodder and forage cultivation was found non-significantly and negatively associated with adaptation strategies by Bhrahmin and Kshetri communities. It implies if the household ethnicity is Brahmins or Kshetri, the chance of adopting forage and fodder cultivation reduced by 35.9%

as compared to other ethnic groups. This may be due to the engagement of *Brahmins and Kshetris* in nonfarm activities than agriculture.

Education of household head

Many studies on adaptation to climate change showed that education is positively affected by the decision to take climate change adaptation measures. But the result showed education was non-significant for adaptation to climate change but positively correlated. The explanation of non significance in education may be due to lower literacy rate in study areas. It was found that increase in schooling by 1 year adoption of forage and fodder cultivation to adapt climate change increases by 0.5%. This implies that farmers with higher levels of education are more likely to adapt better to climate change due to higher knowledge on adoption strategies. This result is consistent with the findings of Teklay and Teklay (2015). Madison (2016) argued that a person with higher level of education increases the probability of adopting the strategies for climate change.

Education level of family members

The number of family member of household above secondary level of education was non-significant and correlated negatively for adoption of forage and fodder cultivation as a mean to adapt climate change. The result showed that members above secondary level of education odds of for adopting forage and fodder production decreases by 9.6%. The years of formal education of the farmers was positively related to diversification to non-farm activities (Obayelu *et al.,* 2014). It can be justified as the increases in education level of family members usually shift their occupation from agriculture to nonfarm activities. It is because most of uneducated, unemployed and poor people engaged in agriculture sector.

Family size of study households

The family size was found significant ($P<0.1$) but correlated negatively with adoption of fodder and forage cultivation. This implies when the family size increases by 1 member the adoption of fodder and forage cultivation decreases by 7.4%. This result found contrary with the findings of Teklay and Teklay (2015) which pointed out that having sufficient labor in family (economically active members) the adoption of improved forage cultivation increases by factor of 19.09. However, Apata (2011) reported result contrary to our findings which assumes that a large family size is normally associated with a higher labor endowment, which would enable a household to accomplish various agricultural tasks, especially during peak seasons. The negative relation between family size and forage/ fodder cultivation may be due to increase in number of economically inactive members in family, which increases family size but actual working labor force decreases. It can be further explained as the family size increases the likelihood of adopting forage and fodder cultivation decreases due to higher demand of food crops rather livestock commodities.

Abroad job of family members

Abroad job for adoption of forage and fodder cultivation as a measure for adaptation of climate change was found non-significant but associated positively. The family with a member in abroad for adopting forages and fodder cultivation increased by 26.5% than a family without member in abroad. Abroad job increases family income. Family income had positive and significant relationship with adoption of adaptive strategies to climate change effects (Uddin *et al.,* 2014). According to Shiferaw and Holden (1998) households with higher income and greater assets are in a better position to adopt techniques for coping climate which is consistent with above result. Wealth has positive implication to adoption of climate change adaptation strategies (Gbetibouo, 2009).

Land size

Land holding was found non-significant with adoption of forage and fodder cultivation. Works by (Teklay and Teklay, 2015) explained similar results. It may be due to similar land distribution in survey areas. This may also reflect that it is not size of land that affect adoption but specific characteristics of the farm that dictate the need for a specific adaptation method to climate change. However the logistic model

revealed land holding was positively correlated to forage and fodder cultivation. It was found that an increase in total lands holding by 1 kattha increased the adoption of forage and fodder cultivation by 0.8%. This might be due to increased opportunity for farmers to expand forage and fodder cultivation as a result of increased land holding.

Livestock holding of study households

The livestock holding found highly significant (P<0.05) for adoption of forage and fodder cultivation. It implied that increase in livestock by 1 unit the adoption of fodder and forage cultivation as a means for adaptation to climate change increases by 10.8%. This result indicated that famers who have more livestock holding tend to establish fodder/ forage pasture to increase the quality and quantity of feed available for their animals. It is consistent with the findings of (Jera and Ajayi, 2008) farmers' adoption of tree-based fodder technology in Zimbabwe. It is obvious that higher size of livestock holding demands for higher forage and fodder which might encourages fodder and forage cultivation. Herd size is an asset and indication of wealth that may have been considered by farmers as an insurance against innovation risk.

Access to credit for livestock production

Access to credit found highly significant (P<0.05) for adoption of forage and fodder cultivation. The result showed that family with access to agricultural credit increases the adoption of cultivation of forage and fodder for adaptation to climate change by 742.1 % than the family without access to agricultural credit. This is consistent with the findings of (Shongwe, 2014) who mentioned access to credit is an important variable which commonly has a positive effect on adaptation behavior. The access to credit may enables farmers with better availability of inputs, resources and farm decisions to adopt strategies for climate change adaptation.

Training on livestock production and management

The training was found highly significant (P<0.05) for adoption of forage and fodder cultivation. This showed that member of family with training related to livestock increases the adoption of fodder and forage cultivation by 188.8 % than a household without training. Training or any other contact with extension workers might provide information about the impacts of climate change, enhances knowledge of farmers, ultimately lead to adoption of climate change adaptation strategies.

Membership in farmers' group

Group found statistically non-significant for adoption of forage and fodder cultivation but with positive coefficient. The result showed involvement in group (farmers group or cooperatives or organizations) increased the adoption of forage and fodder cultivation by 36.2%. Similar results found by (Teklay and Teklay, 2015) in Ethiopia which shows participation of farmers in local organization increased the probability of adopting forage by a factor of 0.363. Perhaps, the possible explanation is that those who participate in local organization might have been easy to enforce and follow up. Farmers in local organization have commitments, and given maximum attention to farming technologies because they are easily accessed for new technology and strict follow. The social groups such as farmers' cooperatives provide information on farming, credits and resources that can be used when adapting to climate change (Shongwe, 2014).

Conclusion and recommendations

The findings of the study explained that out of fourteen variables five of them (Western Terai dummy, family size, access to credit, size of livestock holding, and training) were statistically significant factors for adoption of forage and fodder cultivation in the study area. The result showed that increase in farmers' access to credit was statistically highly significant and correlated positively with adoption of forage and fodder cultivation as a strategy for adaptation to adverse impact of climate change. The adequate access of credit in form of soft loan should be provided by government to overcome major barrier for adaptation to climate change. Farmers with trainings increase chance of adopting forage and fodder cultivation.

Therefore, identification of target group and provision of regular need based trainings by competent and qualified extension agents should be encouraged in order to sensitize the farmers about the impacts of climate change in livestock and adaptation strategies. Association of farmers in group affects farmers to adopt improved forage production due to its impact to work cooperatively and in an organized manner.
Forage and fodder cultivation increases with increase in livestock holdings in farm. Thus, cultivation practices need to be focused in areas of higher livestock size farms through provision of inputs and resources for better adaptation. The increase in family size reduces the adoption of cultivation of fodder and forage. The research station should focus on development of improved forage production techniques that requires low labor. Addressing the problem of land fragmentation is necessary for improving adoption of fodder and forage cultivation. The government should focus on the development of appropriate land utilization and management policy. Furthermore, the access to credit, improved extension services, training and better management of land should be provided to farmers as a measure to adapt in the context of adverse impact of climate change. Hence, livestock production is sensitive to climate change implying that there is an impact of climate change on livestock production system. Thus, it needs to address the impact of climate change through development of sustainable adaptation strategies incorporating suitable policies.

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References

ADS. 2015. Agriculture Development Strategy, Government of Nepal.

AICC. 2019. Krishi Diary. Agriculture Information and Communication Centre, Hariharbhawan, Lalitpur, Nepal.

Apata TG. 2011. Factors influencing the perception and choice of adaptation measures to climate change among farmers in Nigeria.Evidence from farm households in Southwest Nigeria. *Environmental Economics*, 2(4).

CBS. 2011. *Statistical Year Book of Nepal* . Kathmandu, Nepal: Central Bureau of Statistics.

Collier RJ; SJ Doelger; HH Head; WW Thatcher and C Wilcox. 1982. Effect of heat stress during Pregnancy on maternal hormone concentrations, calf weight and postpartum yield of Holstein cow. *Journal of animal science*.

Dahal N. 2005. Perceptions of climate change in Himalayas. Tiempo Bulletin. Issue number 26. pp. 19-24. Available at: www.tiempocyberclimate.org/newswatch/feature050910.htm Retrieved on 12 December 2015.

Deressa TT; RM Hassan; CAT Ringler and M Yesu. 2009. Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change*.

Gbetibouo GA. 2009. Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability:The Case of the Limpopo Basin, South Africa. Washington DC: International Food and Policy Research Institute.

Gujarati DN. 2003. *Basic econometrics*. 4th ed. United States Military Academy.

Hassan R and C Nhemachena. 2008. Determinants of African farmers' strategies for adapting to climate change: multinomial choice analysis. *African Journal of Agricultural and Resource Economics*, 2: 83-104.

IPCC. 2007. Climate change 2007. Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom.

Jera R and O Ajayi. 2008. Logistic modelling of smallholder livestock farmers' adoption of tree-based fodder technology in Zimbabwe. *Agrekon*, 47(3) .

Maddison D. 2006. The Perception of and Adaptation to Climate Change in Africa. *Special Series on Climate Change and Agriculture in Africa* .

Nkondze MS. 2014. The Impact of Climate Change on Livestock Production in Swaziland: The case of Mpolonjeni Area Development Programme. *Journal of Agricultural Studies*, 2(1): 1-15.

Obayelu OA; AO Adepoju and T Idowu. 2014. Factors influencing farmers' choices of adaptation to climate change in Ekiti State, Nigeria. *Journal of Agriculture and Environment for International Development* .

Regmi HR. 2010. Farmers' perception and adaptation to climate change and its implication in agriculture in Riu-Rapti water basin, Chitwan, Nepal. Thesis, M. Sc. Tribhuwan University, IAAS, Chitwan, Nepal.

Seo SN and R Mendelsohn. 2008. Animal husbandry in Africa: Climate change impacts and adaptations. *African Journal of Agricultural and Resource Economics*, 2(1): 65-82.

Sharma RJ and NM Shakya. 2006. Hydrological changes and its impact on water resources of Bagmati watershed, Nepal. *Journal of Hydrology* 327: 315-322.

Shiferaw B and ST Holden. 1998. Resource degradation and adoption of land conservation technologies 1n the Ethiopian Highlands: A case study in Andit Tid, North Shewa. *Agricultural Economics* .

Shongwe P. 2014. Factors Influencing the Choice of Climate Change Adaptation Strategies by Households: A Case of Mpolonjeni Area Development Programme (ADP) in Swaziland. *Journal of Agricultural Studies* , 91-96.

Synnott P. 2012. Climate change, agriculture and food security in Nepal: Developing adaptation strategies and cultivating resilience. Nepal.

Teklay Y and Z Teklay. 2015. Assessment on Farmers' Willingness to Adopt Improved Forage Improved Forage Production in South Tigray, Ethiopia. *Journal of Economics and Sustainable Development* , 47-56.

Uddin MN; W Bokelmann and JS Entsminger,. 2014. Factors Affecting Farmers' Adaptation Strategies to Environmental Degradation and Climate Change Effects:A Farm Level Study in Bangladesh. *Climate* .

WFP. 2009. The cost of coping: a collision of crises and the impact of sustained food security deterioration in Nepal. Food Security Monitoring System, United Nations World Food Programme, Nepal.

Wooldridge JM. 2003. Introductory econometrics: a modern approach. South-Western College Publication.