Quest Journal of Management and Social Sciences
Volume 2 Issue 1: 115-131
ISSN Print: 2705-4527
ISSN Online: 2705-4535
Web: https://www.quest.edu.np

Climate Change Adaptation Undertaken by Small-scale Farmers in Nepal: A Reference from Tinau River Basin

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Received: March. 29, 2020
Revised: May. 8, 2020
Accepted: May. 9, 2020
Published: 25 June, 2020

How to cite this paper:
Khanal. G. (2020). Climate change adaptation undertaken by small-scale farmers in Nepal: A reference from Tinau river basin. *Quest Journal of Management and Social Sciences,* 2(1), 115-131.

Abstract

Background: Climate change is an emerging challenge that the global society will have to deal with over the coming decades. The task is particularly daunting to developing societies as they are considered more susceptible to climate change because of their exposures and sensitivities to climate-related extremes, and especially because of their restricted adaptive capabilities to deal with the effects of hazardous events.

Objectives: This research attempts to seek evidence of adaptation undertaken as a result of climate change-induced impacts and analyze the factors affecting the capability and strategies of climate change adaptation by small scale farmers in Nepal.

Methods: A descriptive cum correlational research design was employed in the study following a quantitative approach. Using a convenience sampling method, primary data for each variable was collected from 67 small scale farmers of Tinau River Basin located in the Western region of Nepal. 5-Point Likert Scale questions were prepared and pilot testing was conducted to collect the responses. Descriptive statistics, Kendall Rank Correlation and Cronbach's Alpha (α) Test were used while analyzing the data and testing the hypotheses. The inferences were made at 5% and 1% level of significance.

Results: The findings indicate that the small scale farmers in the Tinau River Basin are experiencing the varied level of changes in climate. It revealed the existence of some barring factors for adaptation, further, insisting that farmers are prone to suffer from capability losses due to climate change.

Conclusion: The study concludes that small scale farmers are prone to suffer from capability losses due to climate change. Climate change effects are hampering their ability to cultivate the land, increasingly damaging their production, and causing lower yields of harvests.

Implications: This study suggests that such influencing factors should be taken into prime consideration (while developing additional intervention) to enhance farmers' capabilities to better cope with climate change effects; thus improving their adaptation measures for maintaining a flourishing relationship with the changing climate.

Keywords: Climate Change Adaptation, Small Scale Farmers, Capabilities and Strategies, Nepal

JEL Classification: Q12, Q15, Q25

Introduction

Climate change, one of the emerging and most complex challenges of this century, poses a substantial danger to small-scale farmers and is a serious threat to hinder the global progress in the issues of poverty alleviation, food security, and sustainable development (Lipper et al., 2014). There is a growing concern among the scientists that it has a highly adverse effects on the agricultural sector and the farmers in the least developed and developing countries are the hardest hit (Kahsay & Hansen, 2016).

Climate change adaptation (CCA), in its simple terms, is a response to global warming. The report (IPCC, 2018) defines adaptation as "the procedure of adjustment to actual or projected climate and its special effects. Different aspects of adjustment; incremental or transformational adjustment covers a wider range from infrastructure, agriculture to education". Adaptation can also take place at the various levels: individual/farm-level, national level, or international level. Although there is some independent adaptation at the farm-level, it is normally insufficient and needs the intervention of diverse institutions in a comprehensive manner (Simane, Zaitchik, & Foltz, 2016).

Nepal is a land-locked least developed country primarily with an agrarian economy. Endowed with a mixture of landscape features characteristic of mountainous countries, Nepal has a primarily subsistence agrarian economy, high poverty levels, and narrowed government capability. Globally, Nepal is ranked thirtieth, eleventh and fourth in terms of flood risks, earthquake and vulnerability to climate change respectively (UNDP, 2020). Poudel (2015) projected the impact of climate change in Nepal for temperature, precipitation and runoff as follows:

TABLE 1: The Impact of Climate Change in Nepal from 2030 to 2090 (A.D.)

Temperature	• Significant rise in temperature (0c) 0.5 to 2 by 2030, 1.3 to 3.8 by 2060 and 1.8 to 5.8 by 2090 • Increased in the total number of days and nights considered hot by present criteria • Highest temperature increase during the period of June to August at high altitudes
Precipitation	• Widespread range of average annual precipitation variations -34 to +22% by 2030, -36 to +67% by 2060 and -43 to 80% by 2090 • Increase in rainfall during monsoon towards the end of this century -14 to 40% by 2030, -40 to +143% by 2060 and -52 to 135% by 2090
Runoff	• Higher downstream flows in the short term but lower stream flows in the long term due to retreating glacier and snowmelt and ice melt • Move from snow to rain in winter months • Increased dangerous events like floods and droughts.

The small-scale farmers in Nepal are very prone to the threats posed by climate change (Gentle & Maraseni, 2012) because of their reliance on weather-dependent rain-fed agricultural systems for their survival (Devkota, Maraseni, Cockfield, & Devkota, 2013). On the other hand, they have a very few livelihood choices and low adaptive capacity to manage the shocks (Manandhar, Vogt, Perret, & Kazama, 2011). The farmers should have a clear under-

standing of the genuine changes and trends in climatic conditions, associated hazards, and how to cope up with the potential impacts if they want to adapt effectively to the very real phenomenon of climate change (Esham & Garforth, 2013). Various cognitive structures such as trust, climate change beliefs and perceived risk help to shape people's perceptions of climate change (Arbuckle, Morton, & J, 2015), which in turn are influenced by their socio-economic and cultural backgrounds and attitudes, principles and interests (Wolf, Allice, & Bell, 2013). People's perceptions eventually shape their decision-making pathways to adapt to climate change (Evans et al., 2016).

The literature also shows that adaptation strategies in agriculture vary across countries and among different regions within a country. In a study (Phuyal & Devkota, 2018), out of 773 rice farmers sampled, 73.7% farmers are adopting existing adaptation alternatives which are measured 94% in Terai and 55% on hilly districts . It shows farmers in Terai have more adaptation practices than the practices of Hilly farmers different adaptation strategies depending on the varying climatic, social, economic and institutional elements (Below et al., 2012). Smallholder farmers' adaptation practices were found to be influenced by both climatic and non-climatic factors (Karki, Burton, & Mackey, 2020)

The study, basically, addresses three problems faced by small-scale farmers of Tinau River Basin: What perceptions of climate change effects are held by small scale farmers? What sort of strategies are followed by farmers to adapt to changing climate? And, what are the significant factors affecting climate change adaptation? The objectives of this study are (1) to assess climate change perceptions among small-scale farmers; (2) to assess climate change impacts and strategies adopted by farming communities; and (3) to evaluate adaptation strategies of those small-scale farmers.

The study tends to remain inclined with the following hypotheses:

$H1_1$: *There is a significant relationship between farmers' level of satisfaction and their chances of following adaptive strategies.*

$H1_2$: *Small scale farmers are suffering from capability losses due to climate change.*

The study is organized as follows. Section 2 provides the review of related literature; theoretical concepts of climate change adaptation, reviews of empirical studies in international and national context along with the conceptual framework and variable matrix for the study. Section 3 presents the methodology including research design, research area, data collection procedures etc. Section 4 draws the results and discusses the results in the light of existing body of knowledge. Finally, Section 5 draws the conclusions.

Review of Literature

Studies agree that climate changes are taking place (IPCC, 2007) and these changes force us to adapt some adaptive strategies to cope up with the adverse effects caused by climate change. The theories of climate change adaptation (CCA) deal with the question of why, what and how climate change adaptation takes place. First, addressing the question of why CCA should take place, some seminal studies like (Esterling, Hurd, & Smith, 2004; Harvey et al.,

2018; Lambrou & Piana, 2006) stressed the significance of tailoring of climate adaptation policies and programs to the varied socio-economic state of affairs, biophysical backgrounds, and climatic stresses that smallholder farmers face.

Second, defining what CCA is another dimension. (IPCC, 2018) describes climate change adaptation as an adjustment in natural or human systems in regard to actual or estimated climatic stimuli or their effects, which temperate harm or exploit advantageous opportunities. However, including this, there are other definitions that are found often used in literature. These are depicted below:

TABLE 2: Self-compilation from Various Sources

Sources	Definitions
Smith and Wangdel 2006	A process, action or outcome in a system (households, groups, communities, regions, sectors, countries) to better cope with, manage or adjust to some changing conditions, stresses, risks, threats, or opportunities.
IPCC 2007	Measures and initiatives taken to lessen the susceptibility of natural and human systems against actual or anticipated climate change special effects.
UNDP, 2016	A procedure by which strategies to moderate, handle with and take advantage of the hazardous outcomes of climatic events are improved, developed, and implemented.

Third, how can we practice CCA strategies is another approach. The studies (Belay, Recha, Woldeamanuel, & Morton, 2017; Fankhauser, 2017; Levine & Jones, 2011; Zhao et al., 2018) highlighted that agriculture is one of the hardest-hit sectors by the climate change and the farmers can adapt the measures like change in time of plantation, crop diversification, concentrated use of agricultural inputs, crop and livestock integration, supplementary irrigation, soil and water management, tree plantation, etc.

Several studies on climate change adaptation have been conducted in the Nepalese context, however, with limited empirical studies. Sharma (2009) emphasized on the urgent need to frame adaptive strategies for food securities and to manage water shortages and climate change-induced catastrophes. Vij, Biesbroek, Groot and Termeer (2018) revealed that though Nepal government has been struggling to develop specific policy instruments to implement the paradigms, in Bangladesh policy goals and instruments for each CPP have emerged. Byanju and Shrestha (2015) examined agricultural livelihood in Manohara River Basin.

Poudel (2012) explored the lives people residing around of Tinau River Basin and its inter-dependence with the basin communities and ecosystems in a holistic perspective. Khanal, Wilson, Hoang and Lee (2018) investigate the elements that influence farmers' decision-making in adopting climate change adaptation strategies and how these adaptations influence on farm production. In their study, 77% of farming households responded that rice production and yield has decreased due to the changes in temperature and rainfall, which has forced them to embrace obtainable adaptation choices (Devkota, Phuyal, & D.L.Shrestha, 2018). Moreover, Budhathoki and Zander (2019) the impacts of Nepali small-scale farm-

ers' climate change understandings and perceptions on their farming activities over the time period of (1980–2014) was explored and results from a survey with 496 farmers indicated that almost all farmers recognized changes in crop varieties and cropping patterns mostly to technological and market-related issues and not to climate change.

Malik, Qin and Smith (2010) emphasized that adaptation and adaptive capacity, in particular, can also be analyzed with Amartya Sen's Capability Approach (SCA), the study is also based on the same approach. The core characteristic of SCA is its focus on what people are effectively able to do and to be; that is, on their capabilities. According to (Sen, 2001), development can be defined as increasing people's choices in life referred to as capabilities. Sen differentiates between commodities, human functioning/ capability and utility as given below:

FIGURE 1: Commodities, Human Functioning/ Capability and Utility

Commodity ⟶ Capability (to function) ⟶ Function(ing) ⟶ Utility (e.g. happiness)

In the opinion of Kronlid (2009), SCA can help climate change research in identifying if, and if so which, intrinsic values of people's wellbeing are vulnerable to climate change in various social, ecological, and economic contexts and on a generic level. Similarly, IPCC third assessment claims that climate change affects resource-dependent work among the poor and among women. Furthermore, extreme weather and climate events in the mid to late 21st century will affect people's ability to execute excellence in their work in agriculture and forestry and industry, settlement and social sectors. Increased heavy precipitation is very likely to damage crops, increase soil erosion and hamper the ability to cultivate the land.

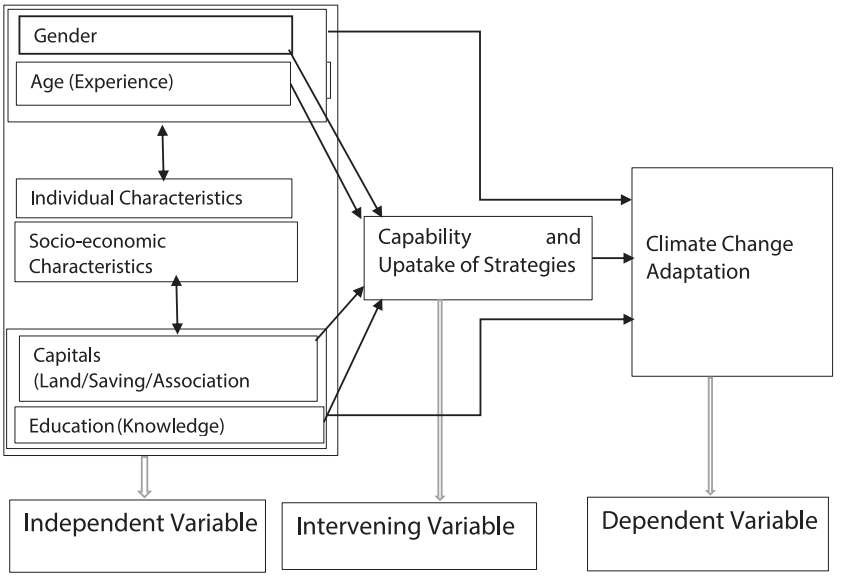
The literature review revealed that there are less than expected empirical works on climate change adaptation particularly in relation from the capability perspective, especially in the Nepalese context particularly focusing the small-scale farmers residing in the vulnerable areas of urban settlements.

Conceptual Framework

The study derives the following conceptual framework to analyze the climate change adaptation capabilities and strategies of small scale farmers:

Climate change adaptation is the dependent variable that depends upon the capabilities and strategies of farmers. It has been found from the theory and literature review that func-

FIGURE 2: Conceptual Framework



tioning(s) (in this study: up-taking of adaptation strategies) depends on internal (gender, experience or age of farmers) and external characteristics (capitals: physical such as land owning, financial such as savings and social such as association and education level or knowledge) of an individual or group (farmers). In this analytical framework, two relations were tried to establish. The two relations are as follows:

1st empirical relation: The relation between independent variables and intervening variable capability and strategies = f (individual characteristics, socio-economic characteristics)

2nd empirical relation: The relation between intervening variable and dependent variable of climate change adaptation = f (capability and use of strategies); f denotes function

Variable Matrix

TABLE 3: Variable Matrix

Variables		Indicators	Measuring indicators insisting their operational definition
Dependent	Climate Change Adaptation	Perception of climate change and adaptation decision	Climate change (precipitation/consequences (water source; flood; drought)] perceptions will be assessed by using the indicators (increase, decrease, unusual changes, no change, including being unknown of the changes)

Intervening	Capability	Ability to cultivate land and sustain livelihoods	(Lack or availability of) climate information, market access, money (the cost to tackle with the fertilizers/pesticides/ boreholes etc.) for adopting impacts.
	Uptaking of Strategies	Technical changes in farming practice	Using different varieties of the same crop; Changing planting dates, increasing the use of irrigation, adapt by moving to non-farming activities; crop diversification, resource protection, and cultivtion of stress-tolerant crop diversities
Ind ep en de nt	Individual Characteristics	Gender	Measured through attributes (Male/Female)
		Age	Number of years (current)
	Socioeconomic Characteristics	Capital	Physical Capital: Control over land (own or rented) Economic or financial capital: savings from Income Social Capital: networks or associations e.g. cooperatives
		Education	Informal and formal education

Research Method

Study Area

Originating from the Mahabharata range of Palpa District in the Western Development Region of Nepal, Tinau River emerges onto the Terai Plains until it reaches to India joining the West Rapti River near Gorakhpur. Having the catchment area of about 1,081 sq., Tinau River Basin in Nepal has a total drainage area of nearly 1,200 km2 and the river flows through two districts: Palpa in the hills and Rupandehi in the Terai (Dahal, Sharma, & Sharma, 2012). Rice, maize, and millet in summer, and wheat and barley in winter, along with cash crops and vegetables are the major cropping patterns of the basin. The population density documented around 1500 people/km2 for different areas in the basin according to Population Census 2011. Majority of people residing around the basin area are farmers and only the small-scale farmers are sampled in the study.

Research Design, data collection techniques and tools

Based on a descriptive cum correlational research design following a quantitative approach, this study employed descriptive and inferential statistics. Primary data were collected by opting mixed methods by developing appropriate instruments for field surveys with a 5-Point Likert Scale question. Following a non-probability sampling by using convenience sampling, 67 small scale farmers farming in Tinau River Basin were sampled.

The data collected for the study were presented and analyzed by using Microsoft Word (2010), Microsoft Excel (2013) and SPSS (IBM SPSS Statistics, Version 20). Cronbach's Alpha Test is used to measure internal consistency (reliability) with cutoff value 0.7 as per (George & Mallery, 2003). Inferential statistics were used while testing the hypotheses and the inferences were made on 1 percent and 5 percent level of significance.

The study employed Kendall Rank Correlation, a non-parametric test, to measure the strength of dependence between two variables. Additionally, this study employed a non-parametric Chi-square test for testing the present hypothesis. The Chi-square statistic is defined as:

$$X^2 = \sum_i \frac{(O_i - E_i)^2}{E_i}$$

Where O_i is the observed number of cases in category i, and E_i is the expected number of cases in category i. Using this methodology, presentation and analysis of data are performed.

Duration of the Study

I administered a total of 67 questionnaires to 67 small-scale farmers involving in the farming activities in Tinau River Basin. The period of data collection was from November 2018 to February 2019.

Data Analysis and Results

Farmers' perception on climate change impacts

Climate change affects farmers and other agricultural workers in a varied manner including: hampering their ability to cultivate land, increasingly damaging the crops, causing lower yields of crops, and increased risk of water shortage for harvesting etc. However, as climate change manifest itself differently at regional and local levels, this effects may vary across the socio-economic conditions. The association between the given socio-economic characteristics of farmers and their perceptions of climate change effects is presented in Table 4. It revealed that gender and saving factors are significantly associated with the climate change effects that hamper the farmers' ability to cultivate the land. The negative correlation with gender denotes that climate change is hampering their ability to cultivate the land. Gender factor is significant for the analysis, probably due to the reason that generally females are the ones to appear in the cultivating the land rather than males. Similarly, average savings (per month) of farmers showed a positive and significant correlation with the climate change effect that is hampering the ability to cultivate land. This indicated that higher the savings higher is the perceptions that climate change is hampering their ability to cultivate the land, and vice versa. Likewise, land ownership or tenancy status is positively and significantly correlated with the perception that climate change is increasingly damaging the crops or vegetables. This implies that the perceptions differ accordingly the farmers are either farming on their own land, rented land or both (owned as well as rented). These results can be compared with a study (Khanal & Wilson, 2019) which revealed that the variables found significant are age and education of the household head, family size, income sources, and other 7 variables used in the study.

TABLE 4: Socio-economic Characteristics and Adaptation Strategies

Socio-economic Characteristics	Autonomous Adaptation Strategies (Adaptive actions)				
	Using different varieties of seeds for same crop	Increasing Use of Irrigation	Planting drug-resistant varieties	Changing Planting dates	Using pesticides/ insecticides/ chemical fertilizers
Gender	0.163 0.185	0.139 0.258	0.034 0.785	0.086 0.486	0.079 0.520
Age(Years)	-0.344** 0.003	-0.141 0.901	-0.296** 0.010	-0.369** 0.001	-0.326** 0.005
Education	0.296** 0.008	-0.198 0.080	0.156 0.169	0.213 0.059	0.370** 0.001
Land Ownership (Tenancy of land)	0.096 0.414	-0.104 0.375	0.016 0.894	-0.048 0.685	0.029 0.806
Average Saving per Month	-0.016 0.888	-0.010 0.929	0.063 0.586	-0.081 0.484	0.097 0.405
Associations with organization/co-operatives	0.025 0.843	0.042 0.733	-0.104 0.400	0.060 0.629	-0.072 0.558
Training	0.166 0.181	-0.124 0.316	0.043 0.725	0.036 0.772	0.055 0.657

*** Correlation is significant at 0.01 level*

Adaptation Strategies Adopted by Farmers in Tinau River Basin

In this study two types of adaptation strategies that farmers undertake are assessed – autonomous adaptation strategies and others (probably induced) adaptation strategies.

In terms of autonomous adaptation strategies (as in Table 5), the bivariate correlation indicated that age is negatively and significantly (at 0.01 level) related to farmers' adaptive strategies to climate change effects. This implies an interesting findings that the probability of adaptation significantly decreases with the age of the farmers which contradicted that as experience (age-wise) accumulates adaptation strategies is less likely to be on focus for farmers. Further, it is found that education is positive and significantly (at 0.01 level) related to adaptation strategies to climate change effects. From this statistics, I infer that the likelihood of adaptation to climate change is much greater for those who have higher educational accomplishment than to less-educated or illiterate farmers. Focusing on gender factor, this study showed that there is no correlation and statistically significant data to show its relation with adaptive strategies. Moreover, tenancy status has a negative correlation sign for most of the adaptation measures which indicate that tenants are more likely to adapt their farming to perceived climate change compared to the self-operating farmers (owners). More surprisingly, in this study there is no any correlation and statistically significant association between income, involvement with co-operatives, trainings and adaptation strategies by farmers.

TABLE 5: Farmers Autonomous Adaptation Strategies

Variables	Autonomous Adaptation Strategies (Adaptive actions)				
	Using different varieties of seeds for same crop	**Increasing Use of Irrigation**	**Planting drug-resistant varieties**	**Changing Planting dates**	**Using pesticides/ insecticides/ chemical fertilizers**
Gender	0.163 0.185	0.139 0.258	0.034 0.785	0.086 0.486	0.079 0.520
Age(Years)	-0.344** 0.003	-0.141 0.901	-0.296** 0.010	-0.369** 0.001	-0.326** 0.005
Education	0.296** 0.008	-0.198 0.080	0.156 0.169	0.213 0.059	0.370** 0.001
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Training	0.166 0.181	-0.124 0.316	0.043 0.725	0.036 0.772	0.055 0.657

*** Correlation is significant at 0.01 level*

Similarly, Table 6 reveals other adaptation strategies adopted by the small-scale farmers living around Tinau River Basin. It shows that age factor has negative correlation (r = -0.227*) but statistically significant at 0.05 level (p = 0.009) implying that the younger the farmer the higher the chance for exiting farming activities. It is believed that the age of head of household have an important effect on livelihood transition (exit from farm). Likewise, it is found that education has a negative correlation with r = -0.294** and statistically significant at 0.01 level. It is implied that educated individuals may be more likely to leave farming since the earnings and benefits from agriculture are rather seasonal and relatively less rewarding than off-farm jobs. Interestingly, in this study, adaptive actions showed no (significant) correlation with the gender factor. Similarly, there is no correlation and statistically significant association between income, involvement with co-operatives, training and adaptation strategies by farmers.

TABLE 6: Other Adaptation Strategies

Variables	Other Strategies (Adaptive actions)			
	Hoping to increasing farming by increasing the size of land	Diversifying the livelihood (starting a business, part-time job etc.)	Forming networks (co-operatives)	Moving to non-farming activities leaving the current farming
Gender	-0.103 0.401	0.164 0.182	-0.031 0.803	0.183 0.137
Age(Years)	0.130 0.257	0.208 0.070	0.049 0.668	-0.227* 0.009
Education	-0.022 0.848	-0.294** 0.009	-0.067 0.555	-0.193 0.088
Land Ownership / Tenancy Status	-0.262* 0.026	-0.200 0.089	-0.063 0.593	-0.299* 0.011
Average Saving per Month	0.057 0.625	0.063 0.589	0.110 0.342	0.002 0.987
Association with Organizations	-0.112 0.365	-0.078 0.527	-0.116 0.348	-0.023 0.841
Training	-0.175 0.156	0.025 0.841	0.043 0.725	-0.035 0.776

***Correlation is significant at 0.01 level; * Correlation is significant at 0.05 level*

These facts tend to lead to the inference that being male or female is rarely associated with organizations (cooperatives) and that receiving less farming training and making lower-income with lower savings may limit farmers for up-taking alternative adaptation strategies. Alternative adaptation strategies, other than that of autonomous strategies, may comprise of diversifying their livelihood strategies, choose other occupations, and hope to increase their farm size, or form networks etc., in order to cope the effects of the climate change sustainably. However, various adaptation barriers may affect adoption of these strategies and directly or indirectly hampers the capabilities of farmers to cope with the changes in climatic patterns. These may encompass various limitations, including but not limited to, such as lack of - money or savings or access to credit, access to land, infrastructural inputs such as sand dams, and climate information.

Barriers to Climate Change Adaptation

This study also attempts to examine the association between some adaptation barriers like small scale farmers may be lacking money, savings or access to credits (for adaptive capacity) and strategies. For this also, a bivariate correlation was performed and the result is presented in Table 7.

TABLE 7: Adaptation Barriers and Other Adaptation Strategies

Variables	Strategies to climate change adaptation			
	Hoping to increasing farming by increasing the size of land	Diversifying the livelihood (starting a business, part-time job etc.)	Forming networks (co-operatives)	Moving to non-farming activities leaving the current farming
Lack of savings/access to credit	0.343** 0.002	0.279* 0.012	0.201 0.071	0.227* 0.045
Lack of access to land	0.368** 0.001	0.227* 0.041	0.369** 0.001	0.221 0.050
Lack of infrastructure / inputs	0.144 0.193	0.438** 0.000	0.216 0.053	0.335* 0.003
Lack of climate information	0.077 0.486	0.211 0.058	0.291* 0.009	0.221 0.050

*** Correlation is significant at 0.01 level; * Correlation is significant at 0.05 level*

The results show that almost all the limitations of adaptation strategies have positive correlation coefficient with statistically significant association at 0.01 and 0.05 level respectively. Lack of money /access to credit and savings hinders agricultural inputs thereby influencing farmers in diversifying their livelihood, moving to non-farming activities and willingness to renting more land. Other limitations such as access to land and infrastructure also influence the farmers in the same manner. Climate information via involvement with cooperatives supports decision making on which option to invest in, when and how much to invest. So, climate information in Table 7 shows the positive correlation with statistically significance $r = 0.291^*$ $p = 0.009 < 0.05$ with forming networks and co-operatives.

Testing of Hypothesis

This study, basically, sets two hypotheses (H11 and H12) with regard to climate change adaptation strategies by farmers.

H11: There is a significant relation between farmers' level of satisfaction and their chances of following adaptive strategies.

Satisfaction, in general, is operationalized for this study as the fulfilment of one's (farmers) wishes, expectations, or needs, or the pleasure derived from their occupation. Hence farmers' satisfaction with their occupation could probably reflect most of the (their) socio-economic characteristics included in this study. Thus, Chi-square test was performed to test this hypothesis.

TABLE 8: Chi-square Test for Level of Satisfaction and Adaptive Actions (H11)

Non-Parametric Test	Chances of following adaptive strategies	P-value	Level of Significance
	Hoping to increasing farming by increasing the size of land	0.029	0.05
	Diversifying the livelihood (starting a business, part-time job, etc.)	0.008	0.05
	Forming networks (co-operatives)	0.002	0.05
	Moving to non-farming activities leaving the current farming	0.034	0.05

Table 8 shows that there is a significant association between satisfaction level and farmer's chances of adapting strategies as $p<0.05$. Hence we accept alternative hypothesis i.e. there is a significant relationship between the level of satisfaction and farmer's chances of following adaptive strategies. The more satisfied a farmer is with his/her occupation, the higher the probability for adapting climate change issues or devising adaptation strategies. This may be interpreted as the farmers who were less satisfied tend to follow lesser adaptation strategies. This probably may be due to the reason that they tend to exit farming practices.

H12: Small scale farmers are suffering from capability losses due to climate change

In order to examine this hypothesis, the notion of Sen's Capability Approach was followed. However, in the case of statistical testing, this hypothesis appeared difficult due to the problems in capability measurement. As highlighted by Grasso (2006), Sen himself suggests that at a practical level the most appropriate focus of attention should not always be the measurement of capabilities: "Some capabilities are harder to quantify than others and efforts to put them on a 'metric' might sometimes hide more than they disclose" (Sen, 1999). Thus, testing this hypothesis statistically appeared difficult but rather requires logical justification based on theoretical concepts.

Hence, some findings are summarized in Table 9 to see if they can produce evidence for capability losses. Statements that may contradict the Capability Approach are indicated by negative (-) sign and that may support are indicated by positive (+) signals. Accordingly, an attempt has been made to analyze and justify the hypothesis as well:

TABLE 9: Findings' Signals (Positive/Negative) for Justifying the Hypothesis (H12)

Variables (Factors)	Statements of findings for justifying signals	Sign +/-	
Satisfaction/ well-being factors	Majority of the farmers were satisfied (happy) with their occupation	+	
	Almost all farmers were somehow able to perceive and predict changes in climate	+	
	Most farmers tend to take adaptation decisions	+	
Effects	Climate change was hampering the ability to cultivate land (77.6%)		-
	Climate change had increased risk of water shortage for harvesting (44.8%)		-
	Climate change was causing lower yields of crops or vegetables (80.6%)		-
	Climate change was increasingly damaging the crops or vegetables (83.6%)		-

Variables (Factors)	Statements of findings for justifying signals	Sign +/-	
Autonomous strategies	Most farmers were using different varieties of seed for the same crop (74.6%)	+	
	Majority of farmers were changing planting dates (53.7%)	+	
	Most farmers were increasing use of irrigation (61.2%)	+	
	Most farmers were planting drought-resistant varieties (67.2%)	+	
Other Strategies	There were low chances for farmers to diversify their livelihood (64.2%)		-
	Low chances for exiting farming completely (74.6%)		-
	Low chances for forming networks like cooperatives (67.2%)		-
Capability Factors	There was a lack of money /savings/access to credit (76.1%)		-
	There was a lack of infrastructural inputs (64.2%)		-
	There was a lack of access to the land (73.1%)		-
Age	The younger the farmer more they tend to devise adaptation strategies.	+	
	The younger the farmer the higher the chance for exiting farming activities by moving to non-farming activities	+	
Education	Higher the education better is the climate change adaptation strategies.	+	
	The more educated a farmer is the more chances for diversifying livelihoods.		-
Gender	Male and female are likely to have opposite perceptions in case of climate change effects that hamper their ability to cultivate the land		-
	Correlation between gender characteristics of farmers and adaptation strategies they follow.		-
Land Ownership	farmers with rented land have more chances to exit farm activities	+	
	Tenancy status of land for farming was mostly rented (55.2%), owned (25.4%), both (19.4%)		-
	Farmers with rented land are likely to perceive that climate change increasingly damaging crops.	+	
Savings	Average monthly savings from farming income was mostly adequate to meet the ends and maintain current expenses.	+	
	The lesser the savings lesser they perceive that climate change is hampering their ability to cultivate the land.	+	
Social Capital	Farmers had less training access (7.5% only)		-
	Fewer farmers (only 25.4%) had an association with organizations or cooperatives		-
	Correlation between savings, involvement with co-operatives, training and adaptation strategies		-
	There was easy access to market	+	
Total		**15**	**17**

Remarks	The summary of findings in this study signaled mixed results (positive as well as negative) in case of their capability to follow climate change adaptation strategies. The result, however, revealed that small scale farmers are somehow suffering (or prone to suffer) from capability losses due to climate change impact i.e. to accept alternative hypotheses.

Conclusion

The findings of the study led to the conclusion that small scale farmers are prone to suffer from capability losses due to climate change. Climate change is a reality to them and an unavoidable challenge that they (will) have to deal with overcoming days. Climate change

effects are hampering their ability to cultivate the land, increasingly damaging their production, and causing lower yields of harvests. Knowingly or unknowingly, farmers are engaging in autonomous adaptation strategies. However, they are facing limitations to adopt other alternative adaptation strategies such as by expanding farming activities, diversifying livelihoods, forming networks to minimize effects, or even for moving to non-farming activities. These limitations are significantly related to lacking of access to credit, land, and infrastructural inputs. In addition, all these factors are significantly related to the age, gender, level of education, tenancy status of the land at the basic level. This study, by implication, suggests that such influencing factors should be taken into prime consideration (while developing additional intervention) to enhance farmers' capabilities to better cope with climate change effects; thus improving their adaptation measures for maintaining a flourishing relationship with the changing climate.

Conflict of Interest

No conflict of interest existed between authors while preparing this article

References

Arbuckle, J. J. G., Morton, L. W., & J, H. (2015). Understanding farmers' perspectives on climate change adaptation and mitigation: The roles of trust in sources of climate information, cli- mate change beliefs, and perceived risk. Environment and Behavior, 47(42), 205–234. DOI: 210.1177/0013916513503832.

Belay, A., Recha, J. W., Woldeamanuel, T., & Morton, J. F. (2017). Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia. Agriculture & Food Security, 6, 24. HTTPS://DOI.ORG/10.1186/S40066-40017-40100-40061.

Below, T. B., Mutabazi, K. D., D.Kirschke, Franke, C., Sieber, S., Siebert, R., & Tscherning, K. (2012). Can farmers' adaptation to climate change be explained by socio-economic household-level variables? Global Environmental Change, 22(21), 223-235. HTTPS://DOI.ORG/210.1016/J. GLOENVCHA.2011.1011.1012.

Budhathoki, N. K., & Zander, K. K. (2019). Nepalese farmers' climate change perceptions, reality and farming strategies. Climate and Development, 12 (3), 204-215. HTTPS://DOI.ORG/10.1080/17565529.17562019.116 12317.

Byanju, R., & Shrestha, H. K. (2015). Changing pattern of water flow in Manohara River and the livelihood adaptation strategy of people to that changes. In: Sharma K.R. et al., (Eds). Research Highlights. Nepal Engineering College. 20.

Dahal, K., Sharma, S., & Sharma, C. (2012). A Review of riverbed extraction and its effects on aquatic environment with special reference to Tinau River, Nepal. Hydro Nepal, 11, 49-56.

Devkota, N., Maraseni, T. N., Cockfield, G., & Devkota, L. P. (2013). Flood vulnerability through the eyes of vulnerable people in mid-western Terai of Nepal. *Journal of Earth Science and Climatic Change,* 4(1), 1–7. DOI: 10.4172/2157-7617.1000132.

Devkota, N., Phuyal, R. K., & D.L.Shrestha. (2018). Perception, determinants and barriers for the adoption of climate change adaptation options among Nepalese rice farmers. *Agricultural Sciences,*

9(3), 272-298. DOI: 210.4236/AS.2018.93021.

Esham, M., & Garforth, C. (2013). Agricultural adaptation to climate change: Insights from a farming community in Sri Lanka. *Mitigation and Adaptation Strategies for Global Change,* 18(15), 535–549. DOI: 510.1007/S11027-11012-19374-11026.

Esterling, W. E., Hurd, B. H., & Smith, J. B. (2004). Coping with global climate change: The role of adaptation in the United States. Arlington, VA Pew Center on Global Climate Change.

Evans, L. S., Hicks, C. C., Adger, W. N., Barnett, J., Perry, A. L., Fidelman, P., & Tobin, R. (2016). Structural and psycho-social limits to climate change adaptation in the great barrier reef region. PLoS One, 11(13), E0150575. HTTPS://DOI.ORG/0150510.0151371/JOURNAL.PONE.0150575.

Fankhauser, S. (2017). Adaptation to climate change. Annual Review of Resource Economics, 9(1), 209-230. https://doi.org/10.1146/annurev-resource-100516-033554.

Gentle, P., & Maraseni, T. N. (2012). Climate change, poverty and livelihoods: Adaptation practices by rural mountain communities in Nepal. *Environmental Science and Policy,* 21, 24-34. https:// DOI.ORG/10.1016/J.ENVSCI.2012.1003.1007.

George, D., & Mallery, P. (2003). SPSS for Windows step by step: A simple guide and reference. Fourth Edition. Bostan: Allyn and Bacon.

Grasso, M. (2006). A normative ethical framework in climate change: Climate Change. City of publication: Springer.

Harvey, C. A., Rodríguez, M. S., Martinez-Rodríguez, M. R., Viguera, B., Guadarrama, A. C., Vignola, F., & Alpizar, F. (2018). Climate change impacts and adaptation among smallholder farmers in Central America. Agriculture & Food Security, 7 (57). https://doi. ORG/10.1186/S40066-40018-40209-X.

IPCC. (2007). Impacts, adaptation and vulnerability. Cambridge: Cambridge University Press. IPCC. (2018). Global warming of 1.5 °C. Cambridge: Cambridge University Press.

Kahsay, G. A., & Hansen, L. G. (2016). The effect of climate change and adaptation policy on agri- cultural production in Eastern Africa. Elsevier (Ecological Economics), 121(C), 154-164. DOI: 110.1016/J.ECOLECON.2015.1011.1016.

Karki, S., Burton, P., & Mackey, B. (2020). Climate change adaptation by subsistence and smallholder farmers: Insights from three agro-ecological regions of Nepal. Cogent Social Sciences, 6(1), 1-23. doi: 10.1080/23311886.2020.1720555.

Khanal, U., & Wilson, C. (2019). Derivation of a climate change adaptation index and assessing determinants. Environmental Science and Policy, 101 (3), 156-165.

Khanal, U., Wilson, C., Hoang, V., & Lee, B. (2018). Farmers' adaptation to climate change: Its determi- nants and impacts on rice yield in Nepal. Ecological Economics, 144, 139-147. https:// DOI. ORG/110.1016/J.ECOLECON.2017.1008.1006.

Kronlid, D. (2009). Sigtuna think piece 2: Climate capabilities and climate change education research. Southern African Journal of Environmental Education, 26, 27-37.

Lambrou, Y., & Piana, G. (2006). Gender: The missing component on the response to climate change. Rome: Food and Agriculture Organization.

Levine, S., & Jones, L. (2011). Rethinking support for adaptive capacity to climate change: The role of development interventions: African Climate Resilience Alliance.

Lipper, L., Thornton, P., B, C., & Baedeker, T. (2014). Climate-smart agriculture for food security. Nature Climate Change, 4, 1068–1072. HTTPS://DOI.ORG/1010.1038/NCLIMATE2437.

Malik, A., Qin, X., & Smith, S. (2010). Autonomous adaptation to climate change: A literature review. Washington DC: Institute for International Economic Policy Working Paper Series.

Manandhar, S., Vogt, D., Perret, S., & Kazama, F. (2011). Adapting cropping systems to climate change in Nepal: A cross-regional study of farmers' perception and practices. Regional Environmental Change, 2, 335–348.

Phuyal, R. K., & Devkota, N. (2018). Rice farmers' climate change adaptation in Nepal: Exploring link- age to water availability and water sharing practice. *Journal of Agriculture and Crops,* 4 (4), 36-42.

Poudel, M. N. (2015). Global effect of climate change and food security with respect to Nepal. *The Journal of Agriculture and Environment, Vol. 16. Technical Paper,* Government of Nepal. Ministry of Agricultural Development, Food Security and Environment Division, Environment and Climate Change Section, Singh Durbar, Kathmandu.

Poudel, S. N. (2012). Tinau River conservation and integrated. Hydro Nepal, 10, 24-31. Sen, A. (1999). Development as freedom. New York: Anchor.

Sen, A. (2001). Development as freedom. Oxford: Oxford University Press.

Sharma, A. R. (2009). Community vulnerabilities to climate change and local coping mechanisms in Khudi watershed: An unpublished Master's Thesis, Central Department of Environmental Sciences, Tribhuvan University, Kirtipur, Kathmandu, Nepal.

Simane, B., Zaitchik, B. F., & Foltz, J. D. (2016). Agro-ecosystem specific climate vulnerability analysis: application of the livelihood vulnerability index to a tropical highland region. Mitigation and Adaptation Strategies for Global Change, 21, 39–65. HTTPS://DOI.ORG/10.1007/S11027-11014- 19568-11021.

UNDP. (2020). Energy, environment, climate change and disaster-risk management: Kathmandu: UNDP Nepal.

Vij, S., Biesbroek, R., Groot, A., & Termeer, K. (2018). Changing climate policy paradigms in Bangladesh and Nepal. Elsevier *(Environmental Science & Policy),* 81, 77-85.

Wolf, J., Allice, I., & Bell, T. (2013). Values, climate change, and implications for adaptation: Evidence from two communities in Labrador, Canada. *Global Environmental Change,* 23(22), 548–562. DOI: 510.1016/J.GLOENVCHA.2012.1011.1007.

Zhao, C., Yan, Y., Wang, C., Tang, M., Wu, G., & Ding, D. (2018). Adaptation and mitigation for combating climate change – from single to joint. *Ecosystem Health and Sustainability,* 4 (4), 85-94. HTTPS://DOI.ORG/10.1080/20964129.20962018.21466632.