



## The perception, impact and adaptation methods of farmers of rice based farming system to climate change in Banke district, Nepal

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### ABSTRACT

This study was carried in Banke district trying to explain about what are the likely impacts of climate change on crop production, to what extent these influence crop productivity, how people are responding to them, and what the potential roles of the local government and other development partners are in adaptation efforts in vulnerable sectors in that area. Result showed that farmers perceived the climate change as change in rainfall pattern, rainfall duration, onset of monsoon, and changes in summer and winter hotness and coldness etc. Some farmers realized the change in climate and its impact on their usual farming practices. But, majority of farmers (57.88%) still doesn't understand about climate change and how to deal with it. Main two problems farmers facing were delayed seed bed preparation and over aged seed transplantation due to delayed rainfall. Among them 79% of them has faced increased disease and pest infestation, 93.33% of them relies on pump for certain time or yearly irrigation, 72.2% of them said to faced decreasing production of rice which resulted in increased cost of production and lowered profit. With the changing climatic pattern there were changes in cropping pattern and cropping calendar along with crop varieties. Some peoples showed different adaption practices but mainly it was change in cropping calendar.

### INTRODUCTION

Earth's climate tends to change over the time, may it be due to natural causes or by human activities. With ever increasing population and never meeting demands of such large population, demands is increasing very rapidly causing unsustainable use of resources along with unsupervised industrialization and development of infrastructure leading to deterioration of environment resulting into climate change (Kumar 2014). Generally, Climate change is the accumulated status statistical distribution of the weather pattern which extends over very long period of time. It can be simply referred as the change in average weather condition. Climate change is becoming greater threat to sustainability of agricultural production and livelihood depends upon it along with food security. The threat and vulnerability is catastrophic mainly to marginal and remote areas. It is one of the most complex challenges that humankind has to face in the coming decades and it has already started to show

its face (Regmi and Bhandari 2013). Due to climate change, various sector of human life are affected. Effects are seen in various aspect such as Agricultural sector, forestry, glacier, fresh water and biodiversity. Today climate change is the pressing issues of 21th century due to its impact on global ecosystem. No person, no country, no place in the world is free from the challenges of climate change (Kumar 2014). Nepal's temperature has increased by 1.7<sup>o</sup> C during last 30 years (1975 to 2005), and, the average temperature increased as 0.06<sup>o</sup> C per year and in particular, 0.04<sup>o</sup>C per year in plain area and 0.08<sup>o</sup> C per year in Himalayas (Shrestha et al. 1999). Agriculture is the backbone of country and main economic activity of majority of Nepalese people (Shrestha and Shrestha 2017). Agriculture and Forestry sector contribute 38.1% to National GDP and provides employment opportunity to 65.6% of total employed population (MoAD 2012). Our system of agriculture is heavily dependent or influenced by weather. As an agriculture based nation our economy also is highly sensitive to the impact of climate change (Alam and Regmi 2004). In the recent years, change in the precipitation pattern, rising the temperature, cold waves, increasing dry spells and occurrences of prolonged drought are noticed, which directly

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affect the agricultural production. Despite negligible contribution to global greenhouse gas (GHG) emission, our country, Nepal is regarded as fourth vulnerable country from the perspective of climate change (JVS 2015). Lower crop yield due to the unfavorable climatic condition will lead to can be catastrophic to stability and prosperity of society as it can lead to food insecurity and hunger along with poor health and shorter life expectancies (Ebi et al. 2007). Climate change and its impacts are now clearly visible on ecosystem, human health, farmer's livelihoods, food security, water resources and tourism sector of Nepal (Karki et al. 2009). Smallholder farmers, which include majority of Nepalese farmer, do not have adequate resources for effectively responding to the impacts of climate change, and are highly vulnerable to its negative consequences. This study explain about what the likely impacts of climate change on crop production, to what extent these influence crop productivity and how people are responding to them.

## MATERIALS AND METHODS

### Study Area

This study was conducted in the Banke district, lying on western plain area of Nepal. The study focuses to explore the perception of smallholder farmers of Bageshwori Village Development Committee (VDC) on climate change, its impact on agricultural crops and their adaptation strategies.

### Sample Size, Sampling Procedure and Selection of the Respondent

All the farmers from Bageshwori VDC were the target population for this study. During the selection of the respondent only age of above 30 years and at least 10 years of settlements within this locale were included in the sample, because they provide valuable and useful information regarding the past trends on climatic variables. Careful attention was paid to make the sample more inclusive as possible (i.e. inclusions of farmers from different wealth categories, different ethnic groups). Due to budget and man power constraints only ninety households were selected as sampling respondents for this study.

### Source of Information

For the primary data, pre-tested systematic semi structured questionnaire was used for face to face interview and key informant interview. Secondary information was mainly collected through reviewing different publications published by Ministry of Agriculture Development (MoAD), Department of Agriculture (DOA), Department of Hydrology and Meteorology (DHM), Central Bureau of Statistics (CBS), Nepalese Agriculture

Research Council (NARC), District Agriculture Development Office. Other than those, published materials from different NGOs and INGOs, individual research and scholar research articles concerning climate change and its impact were considered.

### Survey Design and Data Collection

For the collection of primary data two sets of interview schedule were prepared, one set to collect the information from farmers another set to collect the information from key informants (Shrestha et al. 2018). Different variables were identified and interview schedules were prepared accordingly. The field survey was conducted in January, 2017. The respondents were interviewed using face to face method by visiting their homes. Key informants were interviewed in the same manner. Information obtained from the interview was crosschecked during the focus group discussion. Additional information on various community based adaptation strategies, difference observed in the present and past regarding the farming practices was collected through focus group discussions.

### Data Analysis

Primary data collected from the field survey and secondary data collected from other means were coded, tabulated and analyzed using Microsoft Excel. Qualitative data obtained during survey are studied and presented as tables or lists. And, obtained quantitative data are presented using simple descriptive statistics like frequency count, percentage, mean etc. Impacts and perception of farmers on the change of climatic variables over the time and their adaptation strategies were studied by estimating frequency, percentage, charts and diagrams.

### Indexing

Various problems and reasons were ranked with the use of index score scaling techniques. It gathers the direction and degree of importance that respondents provides toward problems and tasks can be used to construct index score and ultimately rank them according to that score (Shrestha 2018). The commonness of adoption methods were studied using forced ranking system with scores of 1.00, 0.80, 0.60, 0.40, and 0.20, respectively. The formula given below was used to find the index for intensity various problem/reasons.

$$I_{\text{prob}} = \frac{\sum S_i f_i}{N} \quad \text{Where, } I_{\text{prob}} = \text{Index value for intensity of problem } \sum = \text{Summation}$$

$S_i$  = Scale value of  $i^{\text{th}}$  intensity,  $f_i$  = Frequency of  $i^{\text{th}}$  response,

$N$  = Total number of respondents

## RESULTS AND DISCUSSIONS

### Study Area

Banke district lies in the western plain part of Nepal which falls in Bheri Zone. The district covers an area of 2,337 km<sup>2</sup> (225836 ha), among the total area 79.1% of area falls under lower tropics. The altitude of the district is 127 m to 1236 m from the mean sea level. Among the total area 57,252 (23.4%) ha of land is suitable for agriculture, among which 37,838 ha is occupied by lowland and 15000 ha by upland (DADO 2017). There are 47 VDCs and 94,773 households in Banke comprising population of 491,313, in which males are 244255 (49.71%) and females are 247,058 (50.29%). It has average household size of 5.18 with sex ratio of 98.9 and population density of 210. There are total nine wards in Bageshwori VDC with the household number of 2840 and average household size of 4.49 (CBS 2011).

Among total population within the study area (including family member of respondents), males comprised 45.3% and females comprised 54.7% of total population which is slight variation from the CBS data of the VDC comprising 44.2% males and 55.8% females (CBS 2011).

### Perception of Farmers on Climatic Parameters

#### Information Gain about Climate Change by the Respondents

The study showed that 42.22% of the respondents know about climate change, which is very low compared to similar study of Kenya i.e. 96.47% of population were aware about climate change (Adebayo et al. 2012). Out of 38 respondents who were aware about climate change only 18.42% of them knew climate change clearly, 34.21% knew ambiguously and majority of respondents 47.37% of them knew climate change a little bit. The study revealed that 35% of the respondents know about climate change through their self-experiences by comparing the past and present events of climatic parameters such as change in temperature, rainfall pattern etc., 27% through media such as local FM, 23% of the respondents said that they know about climate change through social organization working in that area, their relatives, neighbors and local leaders and only 15% of them got the information from extension agents which is very low compared to what Yohanna et al. (2014) reported and shows dire need of extension agents to focus on this issue. Further detailed summary are presented in Table 3.

Table 1. Matrix Ranking of Problems Associated with Rice Cultivation (FGD 2017)

Problems	Unable to set up the seed bed on time	Transplantation of old aged seedling due to delayed rainfall	Unavailability of fertilizers on time	Problems of weeds, pest and disease	Flood and hailstorm
Unable to set up the seed bed on time	X	Transplantation of old aged seedling due to delayed rainfall	Unable to set up the seed bed on time	Unable to set up the seed bed on time	Unable to set up the seed bed on time
Transplantation of old aged seedling due to delayed rainfall	Transplantation of old aged seedling due to delayed rainfall	X	Transplantation of old aged seedling due to delayed rainfall	Transplantation of old aged seedling due to delayed rainfall	Transplantation of old aged seedling due to delayed rainfall
Un-availability of fertilizers on time	Unable to set up the seed bed on time	Transplantation of old aged seedling due to delayed rainfall	X	Unavailability of fertilizers on time	Unavailability of fertilizers on time
Problems of weeds, pest and disease	Unable to set up the seed bed on time	Transplantation of old aged seedling due to delayed rainfall	Unavailability of fertilizers on time	X	Problems of weeds, pest and disease
Flood and hailstorm	Unable to set up the seed bed on time	Transplantation of old aged seedling due to delayed rainfall	Unavailability of fertilizers on time	Problems of weeds/pest and disease	X
Score value	6	8	4	1	0
Ranking Value	II	I	III	IV	V

### **Perception of Farmers about Change in Temperature Level**

The study revealed that most of the respondents perceived that the temperature level is increasing. 88.89% of respondents agreed that the level of temperature is increasing with compared to previous years, which is similar to findings of Adebayo et al. (2012). 4.44% of the respondents did not feel that the temperature is changing, 2.2% of respondents said that the temperature level is decreasing and 3.3% of respondents were indifference about the change in level of temperature. The claim of respondents that temperature is increasing is supported by the MoPE (2004), since it says that Nepal's temperature is rising by about 0.41 degrees Celsius per decade. Further detailed summary are presented in Table 3.

### **Perception of Farmers on Change in Rainfall Pattern in Major Monsoon Season (June-September)**

Farmers perceived that there was wide variation in the rainfall patterns as compared to the past. Majority of the farmers, 76.67% perceived that the numbers of rainy days in monsoon season (June-September) are decreasing. Ajaymohan and Sabberali (2017) claimed length of rainfall season is lowering in their article which strengthens the claim of respondents about decreasing monsoon period. Only the 16.67% of them perceived that the monsoon season rainy days are increasing and 6.66% of them were indifference about change in number of rainy days. Majority of the farmers, 72.2% perceived that the duration on monsoon season rainfall was decreasing, 13.3% of respondents observed that there was no change in duration of monsoon season rainfall, 9% of them perceived that the duration on monsoon season rainfall are increasing and 5.55% of them were indifference about duration on monsoon season rainfall, which is very similar to what reported by Adebayo et al. (2012). Majority of respondents, 78.89% and 69.8% perceived that the amount and intensity of rainfall respectively at monsoon season is increasing. While, 21.11% and 9.7% of them were perceived that the amount and intensity respectively is in decreasing order. Further detailed summary are presented in Table 3. Similar result was obtained in research carried to understand view of eleven African Countries' Farmers (Maddison 2006). The claim of respondents that monsoon rain is decreasing is also supported by the MoPE (2004), since it says that Nepal's plains in the south are experiencing negative trends in precipitation.

### **Perception of Farmers on Change in Rainfall Pattern in Winter Season (Oct-May)**

The study showed, farmers perceived that there was wide variation in the rainfall patterns as compared to the past in winter season as well.

Among them, 83.33% perceived that the numbers of rainy days in winter season are decreasing, 8.89% of them perceived that the winter season rainy days are increasing and 7.88% of them were indifference about change in number of rainy days. Majority of the farmers, 66.67% perceived that the duration on winter season rainfall was decreasing, 14.44% of respondents observed that there was no change in duration of winter season rainfall, 8.9% of them perceived that the duration on winter season rainfall are increasing and 10% of them were indifference about duration on winter season rainfall. Majority of respondents, 64.44% and 69.8% perceived that the amount of rainfall in winter season is decreasing, 13.33% perceived that its increasing, 12.22% believed it's same and 10% were indifference about it. While, 75.56% of the respondent perceived that the intensity is in decreasing order 24.44% of them perceived it to be in increasing order. Similar to our result, response of farmers was also administered in West Bengal (Padaria and Sarkar 2010).

### **Major Problems Associated With Rice Cultivation**

Transplantation of old aged seeding due to delayed rainfall was one of the major challenges in the Bageshwori VDC faced by the farmers. This delayed transplantation reduced the rice yield significantly. Unable to set up the seeding on time was another problem occurred in Bageshwori VDC. In some cases farmers sow the rice seed on time by using the electric motors, but they were unable to transplant appropriate aged seedlings. Most of the problems were associated with the rainfall. Unavailability of fertilizers on time, problems of weeds, disease and pest and problem of flood and hail stone were secondary problems. Further details of problems associated rice cultivation are shown in Table 1. John and Fielding (2014) favors the change in rainfall pattern as main problem, as they reported abiotic factor as rainfall to be the main constraints of rice farming.

### **Perception about Numbers of Hotter and Colder Days**

This study revealed that most of the respondents perceived that the numbers of hotter days are in increasing orders. Among them, 91.1% of respondent said that the numbers of hotter days are increasing, supported by data of DHM, Khajura (MoE 2013) and 5.56% of them believed hotter days are same and 3.33% of them were indifference about that. Where, 83.3% of the respondents perceived that the colder days are decreasing, which is in line with the response of the study in case of Sankhuwasabha (Dahal and Sharma 2011) and 7.78% of respondent perceived that the colder days are increasing and 6.67% of respondents said that there was no change in the numbers of colder

days as compared with previous years and 2.22% of respondents were unable to say about number of colder days.

### **Impact of Climate Change on Major Agricultural Crops**

#### **Changes in the Source of Irrigation over the Time in the Study Area**

In the study area, there was irrigation facilities available only some partial area and majority farmers had managed the irrigation in small scale through electric motors in hand pumps. The trend of using the electric motor pump was in increasing trend. The study revealed that most of the respondents had electric motor pump for the irrigation purpose in rice seedling establishment, wheat cultivation and vegetable production. At present, 93.33% of respondents had their own electric pump, but before 10 years, only 12.22% of respondents had electric pumps. Regmi (2010) favors the result of increasing proportion of pump for irrigation.

#### **Experienced of Changing Problem of Disease and Pest**

Majority of the farmers had faced the increasing problems of disease and pest in rice crop comparing with previous years. 79% of the respondents said that the infestation of disease and pest on rice is increasing and 21% of respondents said that there was no change in the disease and pest infestation. In Batticaloa, Sri Lanka, majority of farmers didn't believe that climate change is causing increase in pest infestation (Muthucumaran 2012), which is just opposite to our result.

#### **Changes in Rice Performance before 10 Years and Present**

Majority of the respondents (72.2%) said that they have been observing the changes in the rice performances, remaining 27.8% stated that they have no idea about these changes on rice performance. In Batticaloa, Srilanka, majority of farmers didn't believe that climate change is causing decreased productivity (Muthucumaran 2012), which is just opposite to our result. Majority of respondents believed productivity is decreasing in case of rice with changing environment and climate which is also supported by data of Krishi Dairy (MoAD, 2017). But in some special cases both the grain and straw yield is increasing this may be due to use of high yielding varieties, use of more chemical fertilizers and supplying water through forced irrigation by using deep borings.

#### **Changes in Rice Varieties in Study Area**

Local landraces of many crops were lost in the study area. Farmers said that they had lost the long duration rice varieties. The long duration rice

varieties require longer vegetative growth period for obtaining good yield, due to the late onset of monsoon they were not able to transplant the rice on right time and in the later stage of crop growth there was no adequate moisture in the field and consequently lower crop yield. Farmers adopted improved and hybrid crop varieties instead of local landraces to obtain more yield. There were various reasons behind the change in the rice varieties. Farmers had started to cultivate different varieties due their different varietal characteristics. Some of the farmers said that they started to cultivate hybrid varieties for its better yield, even it require more water and fertilizers. *Survi* variety was being planted due to its pest resistant nature against such as rice stem borer, leaf folder. *Radha-4* was cultivated due to it requires less water. In some extent it is drought tolerant rice varieties. Other than that variety *Satha* was also commonly seen in that area due to its drought tolerant nature.

#### **Adaptation Measures Practiced by Farmers in the Study Area**

Farmers in the study area seems to being adapted with the changing climate without total understanding of climate change and its impact in their farm with their own experience and adjusting their farming practices (Table 2). Farmers use weed species for preparing compost and mulch material, some of them used plastic tunnel for vegetable cultivation in the winter period, construction of deep tube well and motor pump for irrigation purpose. In order to increase the agricultural production they apply more chemical fertilizers and pesticides in their crop field along with the use of hybrid crop varieties, they were willing to use short duration crop varieties in order to respond the impacts of pronounced drought. But due to lack of capital most of them seems to preferring adjusting of cropping time with the prevailing climatic scenario. They are changing the varieties of rice. Some farmers diversified their livelihood options in fruits and vegetable farming instead of cultivating cereal crop only. Delayed calendar, changed crop rotation and pattern found to be similar as reported by Regmi (2010). Main method of adaption to climate change was found to be altering cropping calendar which found to be second most used method in Kenya too (Adebayo et al. 2012).

Table 2. Indexing of the Adaptation Measures Undertaken by Farmers in the Study Area (2017)

<b>Particular</b>	<b>Index value</b>	<b>Rank</b>
Irrigation practices	0.70	III
Poly house	0.31	V
Mulching	0.65	IV
Use of resistant varieties	0.71	II
Change in Cultivation Calendar	0.78	I

Table 3. Summary Table

Parameters		Parameters	
Population	435	Awareness about climate change	
Male	197 (45.3%)	Yes	38 (42.22%)
Female	238 (54.7%)	No	52 (58.88%)
Level of awareness about climate change		Perception about change in Rainfall pattern in Monsoon	
Ambiguously	13 (34.21%)	Decreasing monsoon	76.67%
Little	18 (47.37%)	Increasing monsoon	16.67%
Clear	7 (13.42)	Indifferent	6.66%
Perception about change in temperature		Source of Information about Climate Change	
Increasing	88.89%	Self-Experience	35%
No change	4.44%	Local FM	27%
Decreasing	2.22%	Social Organizations and Society	23%
Indifferent	3.33%	Extension worker	15%
Perception about change in Rainfall pattern in Winter		Perception about Hotter days	
Decreasing Rainfall	83.33%	Increasing	91.1%
Increasing Rainfall	8.89%	No change	5.56%
Indifferent	7.88%	Indifferent	3.33%
Perception about Hotter days		Experience of change in disease and pest occurrence	
		Increasing	79%
		Decreasing	21%
Decreasing	83.3%	Experience of change in Yield of rice	
Increasing	7.78%	Changes in performance	72.2%
No change	6.67%	No experience	27.8%
Indifferent	2.22%		

## CONCLUSIONS

Climate Change is real, no one can deny that and none of us are free from its impact. This result shows that there is need of awareness about climate change. Farmers perceived the climate change as change in rainfall pattern, length of monsoon season, rainfall intensity, rainfall frequency, onset and offset of monsoon, and variation in summer and winter temperatures. Farmers realized the change in climate and their usual farming practices. Changes in climatic condition affecting the crop rotation and normal cropping calendar followed in the past by the farmers. Changes in cropping calendar hinder the crop growth and poor yields. Total monsoon rainfall, minimum temperature and maximum temperature were increasing over the times as perceived by the farmers. Farmers are practicing different adaptation methods and strategies in their farm as per their understanding and experience, which are not sufficient, so, it seems important to plan sustainable adaptation strategies and make farmers prepared to tackle the emerging impacts of climate change in forthcoming days. The empirical result reveals that educational level of the household head, if gender as male,

major occupation of household head as agriculture and access to information about climate change would increase the increase probability to practice different adaptation strategies increases. There should be promotion of local and indigenous adaptation practices followed by farmers with the use of local skills and resource which are economically feasible, ecologically sound and environmentally acceptable.

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