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Farmer's perception of climate change and agriculture adaptation strategies in Reasi district of Jammu and Kashmir

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Abstract
Agriculture is the most important sector of the economy in India and it is highly dependent on climate. Climate change have altered and the evidences reveal trends of marked seasonal fluctuations, extreme weather events, aberrant precipitation, forest and agricultural shifts, disease outbreaks, water stress, food insecurity etc. The impacts of climate change are particularly worrying for the farmers of Himalayan state of Jammu and Kashmir as the region is ecologically highly fragile and encompass vivid livelihood based natural resources. The issue of climate change has gained increased attention in recent times due to the perceived negative repercussions it has on a range of activities chiefly agriculture. The study was conducted in the selected villages of KVK Reasi. These villages have well known farming areas and contributing significantly in agriculture to the district. This research paper analysed farmer's perception of causes, constraints and strategies towards effective climate change adaptation in district Reasi. Data were collected by survey method on 210 respondents using structured interview schedule and questionnaire. Data were analyzed with descriptive statistics and linear regression model to test farmers' perception on climate change. The targeted farmers were adult farmers with at least 10 years of farming experience in the area. Data was collected on perceptions about temperature changes and variability in precipitation over a period of 10 years. The study reveals that 70% of interviewed farmers are in a certain degree aware of climate change and 30% of farmers think the climate has not changed. But most of farmers unaware about the reasons of climate change. About 92% of the respondents perceived increases in temperature, while 87% perceived decrease in precipitation over the years. The extent of climate change on farms were revealed by changes in uncertainties of onset of farming season, including the delay in onset of rainfall, erratic rainfall pattern, higher temperature; extremities of weather events such as high sun intensity, desertification, heavy rainfall, loss of forest resources, heavy winds; and increase in farming problems, such as loss of soil fertility, reduction in farm yields and high rate of disease/pest incidence. Adaptive strategies used included change in cropping pattern, agronomic practices, and use of resistant varieties, processing to minimize post harvest loss, and reforestation. The farmer's expectation to mitigate the ill effects of climate change was to create awareness among farmers about appropriate adaptation measure. The farmer's constraints to adaptation included lack of financial resources, lack of access to weather forecasts, and limited access to improved crop varieties.

Keywords: Perception, climate change, farmer, perception, weather and temperature

Introduction
Agriculture plays a pivotal role in the Indian economy. Although, its contribution to gross domestic product (GDP) has gone down to 13.9 per cent, yet, agriculture forms the backbone of development. Fifty two per cent of India's work force is still engaged in agriculture for its livelihood and is important for food security and inclusive growth (GOI, 2012) [4]. Thus agriculture not only contributes to overall growth of the economy but also reduces poverty by providing employment and food security to the majority of the population in the country. Reduction in agricultural production will impact strongly on economy and food security of the country. Climate is one of the key factors influencing agricultural production in India and has enormous impacts on food production and the economy as a whole (Chatterjee, 2008). Research findings have shown that climate change is expected to pose a serious threat on environment, agricultural production and food security of most developing countries including India. (FAO, 2007; IFPRI, 2009) [3, 7]. In particular, rural farmers whose livelihood depends on the use of natural resources,,

are likely to bear the brunt of adverse consequences. According to LEISA (2008) [11], while climate change is a global phenomenon, those living in rural areas in the tropics would face greater risk. The rains these days are unpredictable. The world's average temperature has increased since the last century and it is expected to rise up to 4 ^{o}C by 2050AD (IPCC. 2007, Singh 2008) [9]. This is leading to rising sea surface and drastic changes in rainfall patterns thus affecting the production potential of crops. However, the extent of climate change impact on agriculture can be ameliorated by the awareness and level of adaptation to climate change by farmers. In order to adapt to climate change and mitigate its negative effects, it is imperative that farmers perceive changes in climate and appreciate the impact of climate change on agriculture. In effect, farmers' perceptions area necessary condition for their level of adaptation responses to mitigate against the effect of climate change. Keeping the above background in consideration a study to find out farmers' perception about climate change was undertaken in district Reasi of Jammu and Kashmir.

Material and Methods

Locale of the study

The study was undertaken in district Reasi of Jammu and Kashmir state as shown in Fig1. The geographical location of station is 32^{0} 22′05.13 ″ North latitude and a longitude of 75^{0} 31 ′25.03 ″ East at an elevation of 320m meters above mean sea level. The soils of the farm are sandy loam in texture with moderate soil moisture retention capacity. Most of the area of Reasi district represents the sub-tropical zone. The main crops cultivated in the district are rice, maize, and pulses during *kharif* season, while wheat, barley, and oilseed crops are grown during *rabi* season. The total gross area in Reasi district is 264.7 thousand ha. Out of which 128.0 thousand ha. is under cropped area in which 110402 ha is under rainfed and 17653 ha under irrigated condition. The maximum area under irrigation is through canal (13450 ha) followed by bore well (244 ha) and other sources (3959 ha) (DES, 2011).

Sampling Procedure

From the selected district, three villages being covered under National Initiative on Climate Resilient Agriculture (NICRA) project were purposively selected for the study. Out of these three villages two are from irrigated and one from rainfed. Sample of respondents were drawn randomly from selected villages. From each selected village, 70 farmers were selected randomly from each village, thus the total sample size was 210 farmers. The structured interview schedule was developed to collect information from the selected respondents on farming systems, perception on climate change, concerns for changes in climate, capacities of farmers to cope with climate change and the support they need to build resilience to it. Data were collected by personal interview method from the selected farmers and farmwomen. The interview was schedule in English but the interviews were conducted in the local language. Data collected focuses on farm history, memory of extreme climate events and the impact of more frequent anomalies and management responses to those anomalies. The data was collected between September 2011 and November 2012.

Results and Discussion

Description of climatic characteristics of Reas*i*

The climate of Reasi is characterised by hot humid summer and cool winter. The climate of the area is influenced by Southwest monsoon in *kharif* and western disturbance in *rabi*. On an average, the South-west monsoon contributes 76 percent of total annual rainfall in Reasi. The rainy season in the district starts from 1st week of July to September. The average annual rainfall of Reasi is 1105 mm. The temperature of the district generally ranges between 7^{o}C in winter and 40 ^{o}C in summer. The mean monthly maximum temperature ranges from 16.7 ^{o}C in January to 39.3 ^{o}C in June. While mean monthly minimum temperature varied from 5.8 ^{o}C in January to 24.6 ^{o}C in June.

Socio-economic background of the farmers

The socio-economic characteristics of the farmers and farmwomen were investigated and the results revealed that majority of the farmers (88.5%) cultivated cereal crops in the area. Most of the farming was done by male farmers 89.5% while 10.5 % farm women were also accounting with farming activities. The average age of the farmers/farmwomen was 42 years with 6.6 % less than 30 years of age; 32.4% in the range of 31-40 years; 24.3% between 41-50 years; 21.42% between 51-60 years. Only 15.23% of the farmers, were in the age group of >60 years. The education in the village was of the range of 65.78 % in which 14.76% of the respondents had obtained senior high school education; 26.66% had obtained middle school education; 35.71% had obtained primary education and only 22.85% had no formal education. The average family size of a household was 6.7 persons with details shown in Table1. However, the distribution of farm size as shown in fig.2 revealed an average of 4.3 acres with majority of the farmers (59.5%) having between 0-1ha. farmland; 28.1% having between 1-2ha; 9.5% between 2-4ha and 2.8 % >4 ha of farmland. The average farming experience of the sample respondent was 19 years with details shown in fig.3 and Table 1.

Farmers' Perception to Climate Change

An over whelming majority of respondents (97.6%) perceived that the climate was changing and was no longer as it was some years back as shown in fig.4 and 5. They indicated that these changes were mainly associated with rainfall amount, rainfall distribution and increase in temperature. The farmers/farmwomen also reported that over the years, the onset of the rainy season (Southwest monsoon) had shifted from around the third week of June to mid of July. The farmers perceived that from last most of the years they tend to receive very low rainfall in December and January. Another change they found was that unpredictability of (monsoon) rainy season. In the group discussion, the respondents in all three villages revealed that the onset of wet season was delayed, dry season had become longer and incidence of increased floods. During the study it was found that 49% of the farmers perceived increases in temperature whereas 33% perceived a decrease in temperature. However, 18% of the farmers/farmwomen did not perceived any change in temperature. The distribution of the perception of the farmers/farmwomen concerning changes in rainfall pattern revealed that 22% perceived an increase in precipitation; 37% perceived a decrease in precipitation; 30% perceived an irregular rainfall pattern. Despite higher perception of the respondents on changes in

rainfall pattern, 11% of them did not see any change in rainfall pattern.

Impact of climate change on crop production as Perceived by the Farmers

Climate change is the dominant factor impacting crop yield. Eight percent of the respondents perceived change in crop yield by changing climate; 37.2% perceived low in crop yield; 31.1% perceived stunted growth of crop; 26.9% perceived increase in infestation of insect pest and diseases attack on crops and drying of seedling after germination and 22% perceived ineffectiveness of agriculture chemicals due to delayed of rainfall as shown in fig.6. These findings are in consonance with Mertz *et al*., 2009, who reported that performance of agriculture sector depends largely on good rainfall and the timely and adequate provision of agricultural inputs.

Causes of climate change as perceived by the farmers

The farmers perceived that the change in farming activities like intensified agriculture, wrong cropping practices, use of chemical fertilizers, excess irrigation, population explosion, deforestation, soil degradation and erosion, increased use of fossil fuels and loss of indigenous knowledge practices as being causes of climate change as shown in fig.7. LEISA (2008) [11] also found that climate change is mainly due to change in land use patterns *viz.* intensified agriculture coupled with deforestation, soil degradation and erosion. Deforestation and erosion result in considerable quantities of carbon dioxide being released into the atmosphere, a total complemented by the production and use of fertilizer.

Adaption measures reported by the farmers

Attempts were made to find out whether the farmers use some climate change adaptation measures and subsequently the types and reasons for their choice of adaptation over other options as depicted in fig.8. Of the farmers and farmwomen interviewed, 76.4% use some form of adaptation options climate change and 23.6% do not use adaptation measures. Changing planting dates, using different crop varieties, tree planting, changing irrigation practices, soil conservation, water harvesting were the main adaptation measures used by the respondents. Of the total number of respondents, 96.4% shifted planting dates as their method of adaptation while 3.6% do not believed on this method. The respondents used different crop varieties (97.8%) as their option to reduce climate change impacts while 2.8% have never used this measure. Water harvesting as adaptation measures was adopted by 22.5 % of the respondents while77.5% do not use this method. With regards to irrigation and tree planting, 86.5% of the respondents change irrigation practices to adapt climate impacts and 37.4% of total respondents use tree planting as an adaptation measure. Soil conservation practices were also adopted by 63.2% of the farmers and farmwomen to cope up from climate change impacts. All the farmers applied more inputs regarding seed rate, chemical fertilizers, insecticides/pesticides and application of soil amendments e.g. farmyard manure as the strategies to mitigate effect of climate change. However, 29.3% of the farmers use mixed cropping and 44.8% use mixed farming as a measure of adaptation and vice versa. The fig.7 below depicts the distribution of various measures of adaptation used by farmers in selected villages of Reasi. When asked why they preferred their choice of adaptation over the other options, 67% indicated that their choice of adaptation was most economical or less costly and easy to use; 24.3% responded that their choice of adaptation improves the soil fertility and prevent erosion; 10.2% said their practices of adaptation was environmentally friendly and 5.1% adapt such practices for early maturity of crops.

Barriers to adoptation strategies

The farmers generally gave many reasons for the failure to adapt to climate change and thus barriers preventing farmers from adapting to climate change was investigated. Results as shown in the fig.9 identified lack of information on climate change; lack of knowledge about adaptation measures; lack of access to credit; no access to water, high cost of adaptation; insecure property rights and insufficient access to inputs as the major barriers inhibiting their ability to adapt and mitigate climate change impacts.

With regards to lack of information, 67.9% of the respondents identified this as the main barrier to effectively adaptation to climate change whereas 32.1% did not think so. Of the respondents 68.6% identified lack knowledge regarding adaptation measures were the main barrier. Very difficult access of credit facilities 65.7% and no access to water for irrigation and other farming activities were identified by 86.4% of the farmers as a barrier to adaptation. However, 13.6% did not see access to water as a problem.

High cost involved in adapting such practices was identified by 98.2% of the farmers as the reason for their poor adaptation ability. Inadequate and untimely availability of inputs (88.6%) was the major barrier to adaptation. However, 56.5% revealed that adequate access to extension facilities are the strategies adopted to mitigate effects of climate change on crop production in the study area.

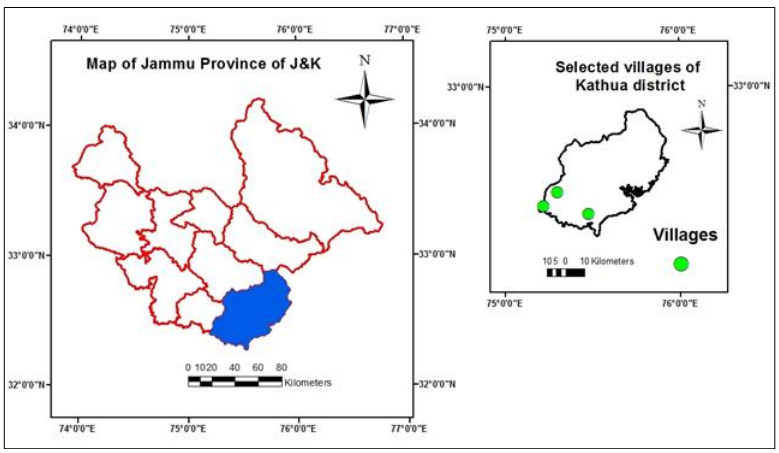

Fig 1: Map of Reasi district showing the location of the study villages

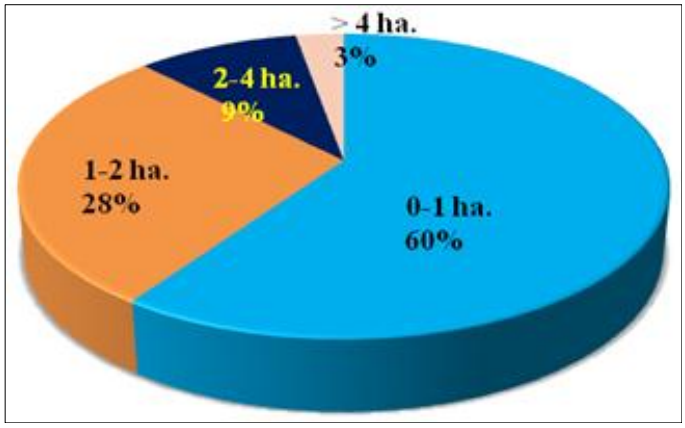

Fig 2: Average land holoding of respondent

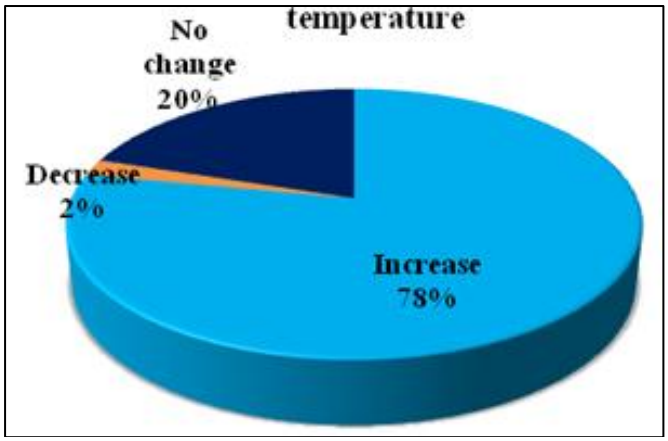

Fig 4: Farmer's perception of changes in temperature

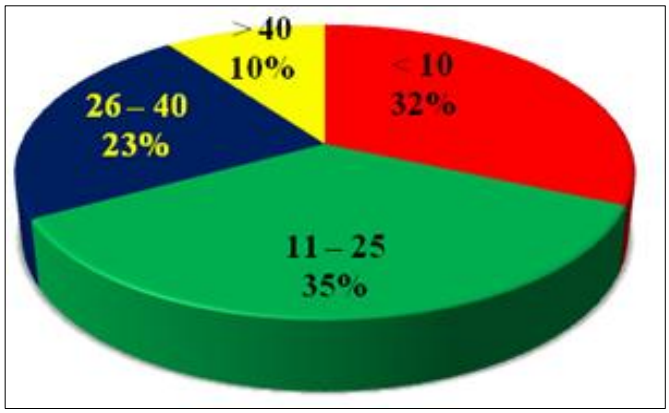

Fig 3: Farming experience (years) of respondents

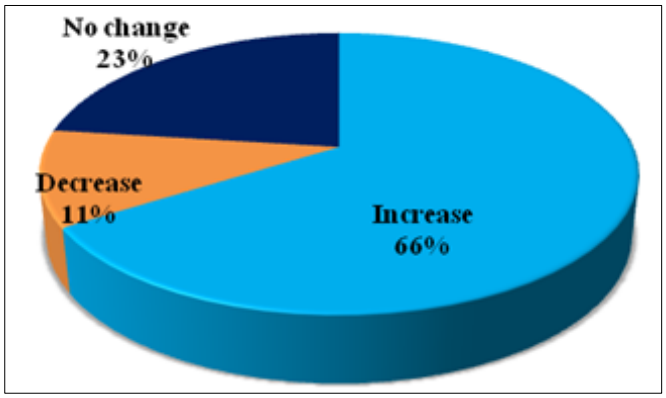

Fig 5: Farmers perception of changes in rainfall

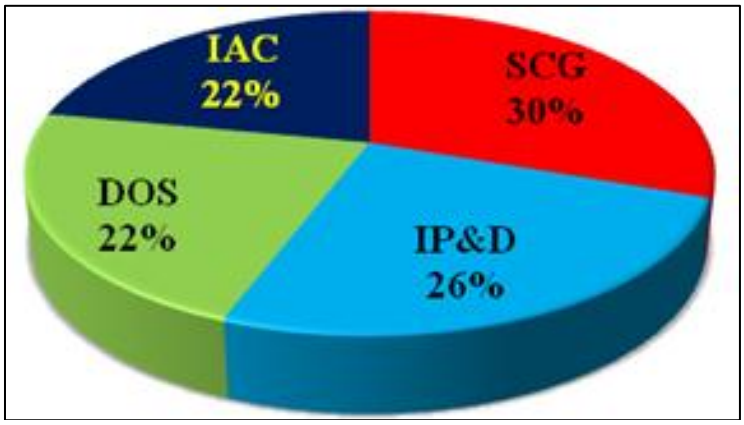

Fig 6: Impact of climate change on crop production

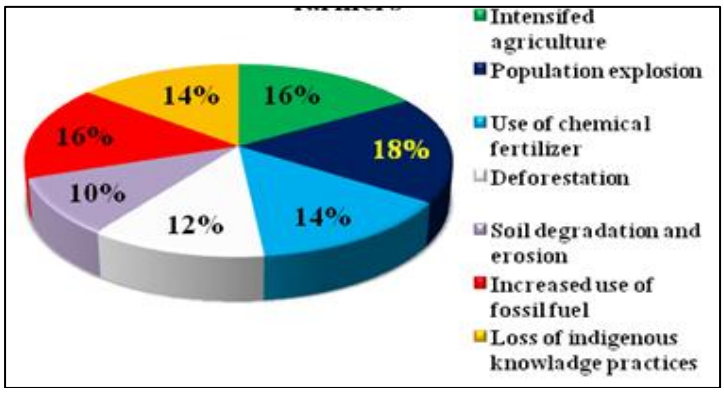

Fig 7: Cause of climate change a perceived by farmer

Note: Stunted crop growth=SCG, Increase in Infestation of pest/diseases=IP&D, Drying of seedling after germination =DOS and Ineffectiveness of agriculture chemicals =IAC

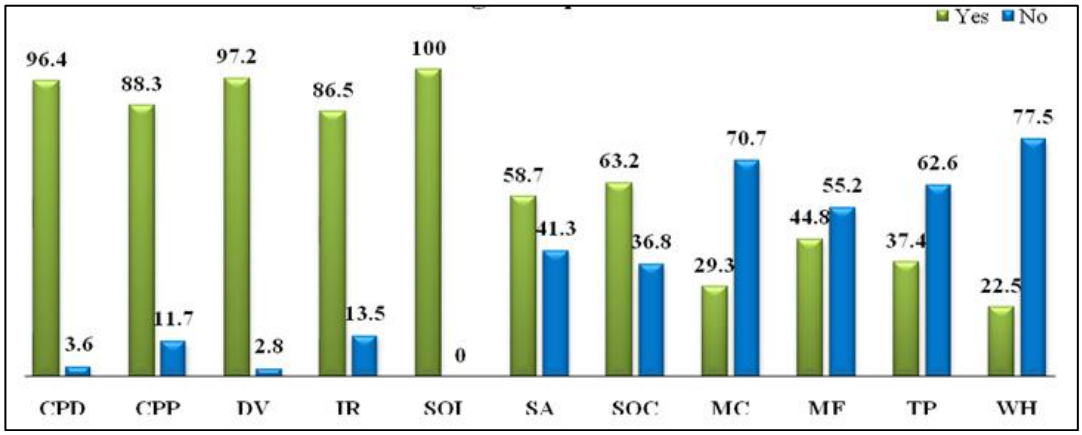

Fig 8: Climate change adaptation measures

Note: Change in planting dates/ Early planting =CPD, Changing Planting pattern / row orientation=CPP, Use different crop varieties=DV, Increase irrigation=IR, Supply more inputs (fertilizers/chemical) =SOI, Application of Soil amendments (Farm yard manure) =SA, Soil conservation measures=SOC, Mixed cropping=MC, Mixed farming=MF, Tree planting=TP and Water harvesting =WH

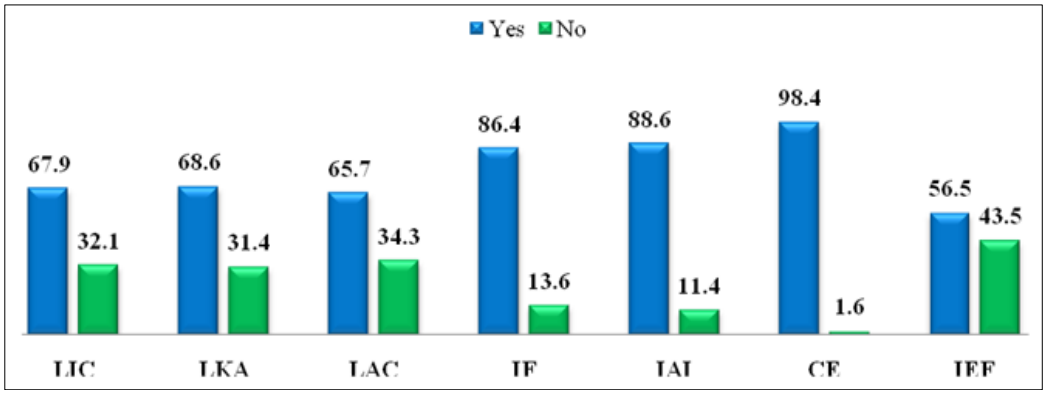

Fig 9: Barriers to adaptation strategies

Note: Lack of information on adaption options=LIC, Lack of knowledge on adaption=LKA, Lack of access to credit / Insurance facilities=LAC, No access to water /Irrigation facilities=IF, Insufficient and untimely availability of inputs=IAI, Changes are expensive=CE and Insufficient extension facilities=IEF

Table 1: Distribution of respondents by socio-economic characteristics n = 210

Characteristics	Frequency	Percentage
Age (Years)		
< 30	14	6.6
1- 40	68	32.38
41- 50	51	24.28
51-60	45	21.42
>60	32	15.23
Mean age = 42 years		
Education		
Non- formal	48	22.85
Basic (Primary)	75	35.71
Middle school	56	26.66
High School	31	14.76
Sex		
Male	188	89.52
Female	22	10.47
Farming experience (Years)		
< 10	66	31.42
11 – 25	75	35.71
26 – 40	48	22.85
> 40	21	10
Mean = 19years		
Farm size (Acres)		

0-0.3 ha.	125	59.5
1-2 ha.	59	28.1
2-4 ha.	20	9.5
> 4 ha.	6	2.85
Mean =		
Household size (persons)		
4-7	141	67.1
8-11	39	18.57
12-15	22	10.47
>15	8	3.8
Mean = 7 persons		

Conclusion

Farmers' perception of climate change and its impact on agriculture and crop production is an important condition for farmers adaptation responses to cope with climatic changes and its impact. This study therefore, examined farmers perception and impact of climate change on food crop production in Reasi district of Jammu and Kashmir. Empirical results revealed that the socio-economic characteristics of the farmers were mostly characterized by active labour force, small farm sizes, high farming experience, large household size, and low level of formal education. The study revealed that most farmers/farmwomen perceived an increase in temperature and decrease in rainfall in Reasi district. Major impacts of climate change were perceived as increased risk of weed and insect/pest challenges, decline in soil fertility. Results suggest changing of planting dates, crop varieties, and use of drought and heat resistant varieties as the widely used adaptation measures. However, tree planting was the least interested method of adaptation employed by the respondents. Despite having some form of adaptation, lack of information, lack of credit, lack of access to irrigation facilities, high cost of adaptation measures and insufficient access to inputs. The Ministry Agriculture through different projects should implement educational programs to educate and encourage farmers to undertake scientific practices in order to increase the adaptive capacity of farmers to climate change impacts on agriculture.

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