International Journal of Agriculture, Environment and Biotechnology
Citation: IJAEB: 9(5): 839-846, October 2016
DOI: 10.5958/2230-732X.2016.00108.X



AGRICULTURE EXTENSION

# Marginal and small farmers' climate change perception and adaptation

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Paper No. 511 Received: 14-2-2016 Accepted: 17-9-2016

**Abstract**

Climate change refers to any change in climate over time, whether due to natural variability or/and as a result of human activity and adaptation to climate change requires that farmers first notice that the climate has changed, and then identify useful adaptations and implement them. The marginal and small farmers were highly vulnerable to climate change. The likely consequences of climate change on the water front in Tripura are decrease in total annual rainfall, change in rainfall pattern resulted in crop failure. The present research was conducted in West Tripura district of Tripura state and sample size was 150. Results suggested that perception of farmers on current climate condition ranged from bad to very bad and there were increase of crop, animal and human diseases; and also number of hot days and sun's heat had increased too, whereas rainfall days and annual rainfall had decreased. Major identified adjustment factors by farmers were decreased use of irrigation water, change in planting date, find off-farm job and alternative livestock feed supplements. However, farmers' perceived barriers to climate change adjustment were lack of weather information, problem with getting inputs, lack of knowledge about adaptations and lack of information about climate change.

**Highlights**

- Farmers had clear perception on climate change effects on farming.
- Major adaptation strategies were use of irrigation water, change in planting date, find off-farm job and alternative livestock feed supplements.

**Keywords:** Farmers perception, climate change, adaptation, information sources

Climate change refers to any change in climate over time, whether due to natural variability or/and as a result of human activity (IPCC 2007a). In developing countries, climate change will cause yield declines for the most important crops and price increases for the most important agricultural produces viz. rice, wheat, maize, and soybeans (Nelson, *et al.*, 2009), biomass declining with increasing temperature (Rawson *et al.*, 1995). The climate change impacts on pests may include shifts in species distributions(Chandra 2012) and the climatic variation as occurrence of drought have significant impact on the production of rainfed crops (Asha latha *et al.*, 2012). The soil system responds to short-term events such as rainfall and also undergoes long-term changes such as physical and chemical weathering due to climate change (Chakrabarti *et al.*, 2012).

Although, most farmers attributed climate change to supernatural forces (Nyanga *et al.*, 2011), however, adaptation to climate change requires that farmers first notice that the climate has changed, and then identify useful adaptations and implement them (Maddison 2006). The small and medium rainfed farmers were highly vulnerable to climate change and to a larger extent they also adopted coping mechanisms for climate change compared to large farmers. The farmers already act to the changes in the climatic changes both by adopting the technological coping mechanisms on the positive

side and negatively through shifting to other professions (Asha latha *et al.,* 2012).

North East India is subject to climate induced vulnerability currently and in the near future. Climate change will be an additional stress and will have direct consequences on food-production systems and indirect impacts on food security. An estimated 3.5 mha is under rainfed rice cultivation in this region, which accounts for about 30% of the total area under cultivation (Judge *et al.,* 2012). Drought of 2006 in north-east which left the people in peril, amply indicate the climatic anomalies (Pathak, *et al.,* 2012), precipitation in one subdivision in the Brahmaputra basin shows a decreasing trend and another shows an increasing trend.

One of the three subdivisions in the Meghna basin shows a decreasing trend while another shows an increasing trend (Judge *et al.,* 2012). The likely consequences of climate change on the water front in Tripura are decrease in total annual rainfall, change in rainfall pattern resulting in crop failure for not getting the rain when required and sudden bursts of rain over a small period of time which may cause floods. Drought normally occurs in the State of Tripura due to delayed rainfall in the months of April-May (Tripura State Action Plan on Climate Change 2011). Climate variability and climate change could impact agriculture, water resources and forest sectors in this region. The Vulnerability Index of Agriculture, Water and Forest sectors of study area i.e. West Tripura district were calculated by Ravindranath *et al.* (2011). From their study on the basis Vulnerability Index(VI) Ranging from 0 to 5 (i.e. Low to High), the Agriculture sector current VI was 1-2 and future projection would remain same; for Water sector, current and future VI was same i.e. 4 – 5, and in forest sector VI was 3 – 4 for Current and Future. Under this backdrop present research was conducted with the following objectives:

1. To assess the farmers extension exposure.
2. To study the farmers observation on climate change.
3. To identify the farmers' climate change adjustment factors.
4. To find out the farmers' adaptation barriers under changing climate.

## Materials and Methods

Tripura is the third smallest State of India located in the North Eastern Region of the country. West Tripura district was purposively selected and there were six blocks in West Tripura district. From six blocks Mohanpur and Lefunga blocks were selected randomly. The Questionnaire was pretested over 15 number non-respondent marginal and small farmers (i.e. 10% of total respondents) and pertinent changes were made. Marginal and small farmers having farming was main occupation and minimum 15 years of farming experiences were within the sample frame. From this sample frame 150 farmers were selected randomly. Although questionnaire were prepared in English language, but during interview it was translated to local language. The study was carried out during March, 2014 to August, 2014. The questionnaire developed by Gbetibouo (2009) with some modification were employed for the study. The statistical tools included were mean, percentage, Standard Deviation, Rank and Pearson's correlation coefficient. For analysis of data IBM SPSS 21 was employed.

## Results and Discussion

It was noted that the most of the respondents belonged to the middle age group i.e. 72%, and old age group was 16.67%, however, young age group included 11.33% with CV 21.68%. It was also noted that 44.00% respondents were from Scheduled Caste family and OBC category respondents were 34.67%, whereas Scheduled Tribe were only 2% and General Category was only 19.33%. The perusal of the table indicated that 41.33% respondents had the education upto primary level, while 14.67% respondents were in the education level of upto $12^{th}$ standard. The CV was 42.13%. Most of the households' family members ranged between 3 to 6 and in quantification, it was 58.00%.

However, more than 6 members family category was only 7.33% and the CV was 32.85%. It was interesting to note that most of the family were nuclear type (83.33%). It was observed that 79.33% respondents houses were *Kutcha*, only 9.34% respondents house were *Pucca*. (Table 1). It was noted that 62.35% and 34.83% respondents had Television and radio in their household respectively and it was also observed that 90.69% farmers had cell phone. It was also noted that 23.26% and

**Table 1:** Distribution of respondents according to their Demographic profiles

**n = 150**

| Demographic profiles | Categories | Frequency | Per cent | Cumulative Percent | Mean | SD | CV |
|---|---|---|---|---|---|---|---|
| Age Group | Young[≤(Mean-SD)] | 17 | 11.33 | 11.33 | 44.14 | 9.65 | 21.86 |
| | Middle(Mean±SD) | 108 | 72.00 | 83.33 | | | |
| | Old[>(Mean+SD)] | 25 | 16.67 | 100 | | | |
| Category | General | 29 | 19.33 | 19.33 | | | |
| | Other Backward Class (OBC) | 52 | 34.67 | 54.00 | | | |
| | Scheduled Caste | 66 | 44.00 | 98.00 | | | |
| | Scheduled Tribe | 03 | 2.00 | 100.00 | | | |
| Educational Level | Upto primary | 62 | 41.33 | 41.33 | 6.05 | 2.56 | 42.13 |
| | Upto VIII$^{th}$ Std. | 35 | 23.33 | 64.66 | | | |
| | Upto 10$^{th}$ Std. | 31 | 20.67 | 85.33 | | | |
| | Upto 12$^{th}$ Std. | 22 | 14.67 | 100.00 | | | |
| Family Size | Upto 3 | 52 | 34.67 | 34.67 | 4.14 | 1.36 | 32.85 |
| | From 3 to 6 | 87 | 58.00 | 92.67 | | | |
| | More than 6 | 11 | 07.33 | 100.00 | | | |
| Family Types | Nuclear | 125 | 83.33 | 83.33 | | | |
| | Joint | 25 | 16.67 | 100.00 | | | |
| Type of Houses | Kutcha | 119 | 79.33 | 79.33 | | | |
| | Semi Pucca | 17 | 11.33 | 90.66 | | | |
| | Pucca | 14 | 9.34 | 100.00 | | | |

65.12% respondents had motorbikes and bicycles respectively. Concerning agricultural implements, it was found that 18.60%, 53.49% and 81.40% respondents had power tiller, country plough and sprayers respectively.

**Table 2:** Distribution of respondents as per their Wealth occupancy

**n = 150**

| Types of Wealth | Per cent |
|---|---|
| Television | 62.35 |
| Radio | 34.83 |
| Cell phone | 90.69 |
| Motorbike | 23.26 |
| Bicycle | 65.12 |
| Power tiller | 18.60 |
| Country Plough | 53.49 |
| Sprayer | 81.40 |
| Cattle | 62.79 |
| Pig | 9.30 |
| Hen | 67.44 |

Animal resources recorded were cattle, pig and hen, however, it was noted that 9.30% respondents had pig, it might be due to the fact that pig rearing was predominant among tribal farmers, whereas only 2% respondents belonged to tribal category (Table 2). The perusal of table 3 revealed that 39.33% farmers had the farming experience in between 20 to 25 years and 32.67% respondents had 25 to 30 years of farming experience.

**Table 3:** Distribution of respondents according to their farming experiences

**n = 150**

| Farming experience (Years) | Frequency | Percent | Cumulative Percent | Mean | SD | CV |
|---|---|---|---|---|---|---|
| 15 to20 | 21 | 14.00 | 14.00 | 22.91 | 1.01 | 4.40 |
| >20 to ≤25 | 59 | 39.33 | 53.33 | | | |
| >25 to ≤30 | 49 | 32.67 | 86.00 | | | |
| >30 | 21 | 14.00 | 100. | | | |

There were different sources for receiving information in rural domain and for the present study twelve sources were selected and five point Likert Scale (i.e. Most often, Often, Sometime, Rarely and Never) were used for receiving the response. One the basis of the response Weighted Means were calculated. As the Cronbach's alpha was 0.725(N=12) which higher than 0.70, hence the scale had passed the reliability or internal consistence test (Table 4).

**Table 4:** Ranking on extend of Information Sources utilization by farmers

**n = 150**

| Sl. No. | Information Sources | Weighted Means | Rank |
|---|---|---|---|
| 1 | Neighbours | 3.19 | I |
| 2 | Input Dealers | 2.95 | II |
| 3 | Panchayat office | 2.28 | III |
| 4 | Govt. Extension officials in village (Village Level Workers, Krishi Bandhu *etc.*) | 1.88 | IV |
| 5 | Meeting in village | 1.88 | V |
| 6 | Block office | 1.73 | VI |
| 7 | Company Representatives | 1.71 | VII |
| 8 | Television | 1.51 | VIII |
| 9 | Village fair | 1.19 | IX |
| 10 | Radio | 1.15 | X |
| 11 | Newspapers | 0.77 | XI |
| 12 | Printed materials ( viz. leaflets, folder, bulletins *etc.*) | 0.41 | XII |

It was noted that *neighbours* were the most important source of information for the respondents and accordingly it was ranked *first*. Input Dealers, Panchayat Office and Government Extension officials were *second, third and fourth* important sources of information to the farmers. However, it was surprised to note that *Printed materials* were least important information source; it might be due to its scarce availability in rural domain. Again, it was more surprised to note that, the radio was also least important information sources along with newspapers too. This might be another important topic of future research. Although, it was fact that the two blocks were adjacent to India-Bangladesh International Boarder where, radio broadcasting might have restriction (Table 4).

It was observed that *own observation* was the paramount weather related information source to the farmers and weighted mean was highest. Hence, it was ranked first. The second most important weather information sources were *Neighbour* and it implied that till now in rural ambience neighbour played proactive communication role for information sharing and percolation. *Television* and *VLWs* were third and fourth important sources for weather related information to the respondents. However, the *Newspaper* was least important weather information source, it might be due to the price of newspaper was recurring investment and as most of the respondents education up to primary level (Table 5).

**Table 5:** Ranking on extend of Information Sources utilization by farmers for getting weather information

**n = 150**

| Information Sources | Weighted mean | Rank |
|---|---|---|
| Own observation | 3.6 | I |
| Neighbours | 2.99 | II |
| Television | 1.23 | III |
| Village Level Workers (VLWs) | 1.18 | IV |
| Radio | 0.87 | V |
| Newspaper | 0.62 | VI |

**Table 6:** Farmers observation on climate change

**n = 150**

| Perception on climate change | Level of perception | | | |
|---|---|---|---|---|
| | **Increased** | **Decreased** | **Constant** | **Unsure** |
| Wind speed last 15 years | 14.63% | 12.19% | 36.59% | 36.59% |
| Frequency of dry days in monsoon period last 10 years | 69.05% | 16.67% | 2.38% | 11.90% |
| Incidence of crop diseases last 10 years | 82.92% | 4.88% | 4.88% | 7.32% |
| Incidence of animal disease last 10 years | 52.38% | 28.57% | 11.91% | 7.14% |
| Incidence of human diseases last 15 years | 80.00% | 5.00% | 5.00% | 10.00% |
| | **Increased** | **Decreased** | **Constant** | |
| Number of hot days last 15 years | 95.35% | 4.65% | .00 | |
| Sun's heat last 15 years | 83.33% | 4.76% | 11.91% | |
| Number of rainfall days last 15 years | 11.64% | 79.06% | 9.30% | |
| Rainfall last 15 years | 13.95% | 76.75% | 9.30% | |
| Temperature last 15 years | 100% | .00 | .00 | |
| | **Good** | **Bad** | **Very bad** | **Constant** |
| Current perception on climate | 23.26% | 46.51% | 25.58% | 4.65% |

**Table 7:** Farmers perception on climate change adjustment practices and factors (From agreement to disagreement)

**n = 150**

| Climate change Adjustment factors | Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree | Weighted mean | Rank |
|---|---|---|---|---|---|---|---|
| Decrease use of irrigation water | 3.28 | 5.70 | 4.65 | 36.21 | 50.16 | 4.32 | I |
| Change planting date | 11.63 | 60.47 | 18.60 | 4.65 | 4.65 | 3.74 | II |
| Find off-farm job | 32.56 | 39.53 | 6.97 | 11.64 | 9.30 | 3.74 | III |
| Alternative livestock feed supplements | 16.28 | 53.49 | 20.93 | 4.65 | 4.65 | 3.72 | IV |
| Change crop variety | 2.32 | 80.02 | 6.03 | 3.47 | 8.16 | 3.70 | V |
| Crop diversification | 18.61 | 48.83 | 16.28 | 11.63 | 4.65 | 3.65 | VI |
| Implement soil conservation techniques | 6.97 | 67.44 | 13.95 | 6.98 | 4.66 | 3.65 | VII |
| Following Water-harvesting scheme | 11.63 | 44.19 | 37.21 | 2.30 | 4.67 | 3.53 | VIII |
| Increase use of irrigation water | 2.32 | 68.87 | 10.20 | 3.20 | 15.41 | 3.49 | IX |
| Buy insurance | 9.30 | 34.88 | 32.56 | 17.61 | 5.65 | 3.26 | X |
| Prayer or ritual offering | 10.30 | 36.21 | 18.60 | 31.24 | 3.65 | 3.16 | XI |
| Lengthening growing season of crop | 6.98 | 27.91 | 41.86 | 13.95 | 9.30 | 3.09 | XII |
| Reduce number of livestock | 27.91 | 11.63 | 18.60 | 21.93 | 19.93 | 3.05 | XIII |
| Lease your land | 6.97 | 44.19 | 4.65 | 32.56 | 11.63 | 3.02 | XIV |
| Change from livestock rearing to crops cultivation | 6.97 | 39.53 | 20.93 | 9.31 | 23.26 | 2.98 | XV |
| Change from crop cultivation to livestock rearing | 6.97 | 20.93 | 23.26 | 44.19 | 4.65 | 2.81 | XVI |
| No adaptation | 4.65 | 6.98 | 55.81 | 23.26 | 9.30 | 2.74 | XVII |
| Change amount of land for crop cultivation | 6.97 | 44.19 | 27.91 | 16.28 | 4.65 | 2.40 | XVIII |
| Moving to a different site for farming | 9.31 | 16.28 | 13.95 | 53.49 | 6.97 | 2.33 | XIX |

Cronbach's alpha 0.821(N=19)

The perusal of table 6 showed that the respondents current perception on climate change is consolidated from bad to very bad and it was 46.51% and 25.58% respectively, whereas 23.26% farmers perceived that the climate was good, although 4.65% farmers considered it was constant. It was also noted that the diseases of crop and human were inclined in trend as perceived by majority of the respondents, however 52.38% respondents deemed that animal disease had increased. It was also noted that frequency of dry days in monsoon period had increased in last 10 years as perceived by 69.05% respondents. It was noted from the above table that 95.35% and 83.33% respondents perceived that number of hot days and sun's heat had increased respectively, whereas rainfall days and annual rainfall had decreased as reported by 79.06% and 76.75% respondents. It was interesting to note 100% farmers perceived that temperature had increased last 15 years.

Table 7 represented the farmers' perception on climate change adjustment practices and factors. It was noted that decrease use of irrigation water was the most appropriate agronomic practice might help in climate change adjustment and it was ranked *First*. Change of planting date was the *second* most important practices as perceived the respondents. Find off-farm job and alternative livestock feed supplements were *third* and *fourth* ranked perceived adjustment factors to the farmers. Change of crop variety and crop diversification were also the adjustment factors as observed by the farmers and those were ranked *fifth* and *sixth* respectively. However, moving to a different site for farming were least perceived adjustment factors as reported by farmers. Thomas *et al.* (2007) also

**Table 8:** Farmer's perceived barriers to adaptation under changing climate

**n = 150**

| Barriers to adaptation | Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree | Weighted mean | Rank |
|---|---|---|---|---|---|---|---|
| Lack of weather information | 30.23 | 51.16 | 6.98 | 5.65 | 5.98 | 3.93 | I |
| Problem with getting inputs | 30.23 | 46.51 | 11.64 | 6.97 | 4.65 | 3.91 | II |
| Lack of knowledge about adaptations | 20.93 | 58.15 | 10.63 | 5.64 | 4.65 | 3.86 | III |
| Lack of information about climate change | 18.61 | 62.79 | 7.97 | 5.98 | 4.65 | 3.84 | IV |
| Lack of appropriate seed | 23.26 | 53.49 | 10.31 | 5.96 | 6.98 | 3.79 | V |
| Lack of own fund for adjustment | 16.28 | 46.51 | 24.27 | 5.96 | 6.98 | 3.58 | VI |
| Lack of credit or savings | 31.89 | 41.86 | 11.64 | 6.65 | 7.96 | 3.51 | VII |
| Lack of market access | 25.58 | 32.56 | 11.63 | 20.93 | 9.30 | 3.44 | VIII |
| No access to water | 13.95 | 46.51 | 6.97 | 27.92 | 4.65 | 3.37 | IX |
| Adaptation not cost effective | 11.63 | 16.28 | 51.16 | 11.63 | 9.30 | 2.58 | X |

noted that adaptation strategies used by farmers were changing farming practices (such as plant drought resistant varieties, have more livestock and less livestock, build cattle shelter), diversifying livelihood (get off farm work, start a business) and forming networks (cooperatives, community horticultural projects).

Barriers are defined as factors, conditions or obstacles that reduce the effectiveness of adaptation strategies (Moser and Ekstrom 2010). The perusal of table 8 revealed that out of ten perceived barriers to climate change adaptation factors, it was noted that lack of weather information was most felt barriers among climate change adaption factors as reported by farmers and accordingly it was ranked *first* and followed by problem with getting inputs, lack of knowledge about adaptations and lack of information about climate change were ranked *second, third and fourth* as calculated on the basis of responses received from the farmers. Whereas least perceived barriers to climate change adaptation was 'adaptation not cost effective' statement. However, Antwi-Agyei *et al.* (2013) noted financial barriers, institutional barriers and lack of information on climate change characteristics.

Adaptation strategies to climate change depends on the socioeconomic characteristics of the farmers viz. education, farm size, farming experiences, and contact with extension service agents (Uddin *et al.* 2014). Keeping this in consideration correlation was calculated (Table 9**)**. It was noted that the variables Change of crop variety ($X_1$), Decrease use of irrigation water ($X_3$), Crop diversification ($X_5$), Change planting date ($X_6$), Change from crop cultivation to livestock rearing ($X_{12}$), Reduce number of livestock ($X_{14}$) and Find off-farm job ($X_{15}$) were positively and significantly correlated with the variable Extension Exposure of farmers. The result might imply that these adjustment factors were strongly substantiated among farmers due to extension exposure. It was interesting to note that the respondents level of education was positively and significantly correlated with the $X_{15}$ variable, the result might be indicative that respondents with higher education might seek Off-farm job as adjustment factor. It was further surprised to note that fatalism i.e. prayer or ritual offering ($X_{18}$) as adjustment factors was significantly positively related with the farming experience. Furthermore, it was also noted that leasing out of land ($X_{16}$) was another option for adjustment to the experience farmers, it may be indicative that farming not remain remunerative now with escalating price of inputs. The adjustment practices i.e. Change crop variety ($X_1$), Change amount of land for crop cultivation ($X_8$) and Implement soil conservation techniques ($X_{11}$) were positively and significantly correlated with the cultivable lands of the farmers (Table 9).

## Conclusion

Adaptation to climate change requires that farmers first notice that the climate has changed and accordingly efforts will be directed in individual and group level to prepare for or adjust to climate change. Throughout history, human societies have repeatedly demonstrated a strong capacity for

**Table 9:** Correlation coefficient of perceived climate change adjustment factors with four selected demographic variables

**n = 150**

| Climate change Adjustment factors | Extension exposure (r-value) | Education level (r-value) | Farming Experience (r-value) | Cultivable land (r-value) |
|---|---|---|---|---|
| Change of crop variety($X_1$) | 0.305* | 0.057 | 0.274 | 0.385* |
| Increase use of irrigation water ($X_2$) | -0.159 | 0.176 | .117 | 0.198 |
| Decrease use of irrigation water ($X_3$) | 0.320* | .007 | .021 | .049 |
| Following Water-harvesting scheme($X_4$) | 0.049 | .061 | .028 | .057 |
| Crop diversification($X_5$) | 0.559** | 0.183 | 0.379 | 0.211 |
| Change planting date($X_6$) | 0.525** | 0.149 | 0.203 | 0.128 |
| Lengthening growing season of crop($X_7$) | 0.287 | 0.204 | 0.153 | 0.139 |
| Change amount of land for crop cultivation($X_8$) | -.048 | 0.274 | 0.243 | 0.349* |
| Moving to a different site for farming($X_9$) | 0.110 | 0.194 | 0.057 | 0.152 |
| Alternative livestock feed supplements($X_{10}$) | 0.207 | 0.015 | 0.093 | 0.090 |
| Implement soil conservation techniques($X_{11}$) | 0.257 | .0138 | 0.043 | 0.334* |
| Change from crop cultivation to livestock rearing($X_{12}$) | 0.444** | 0.046 | 0.019 | 0.200 |
| Change from livestock rearing to crops cultivation($X_{13}$) | -.052 | .004 | 0.181 | 0.119 |
| Reduce number of livestock($X_{14}$) | 0.362* | 0.195 | 0.491** | 0.116 |
| Find off-farm job($X_{15}$) | 0.358* | 0.390* | 0.414** | 0.107 |
| Lease your land($X_{16}$) | 0.118 | 0.212 | 0.393* | 0.160 |
| Buy insurance($X_{17}$) | -0.242 | 0.107 | 0.038 | 0.015 |
| Prayer or ritual offering($X_{18}$) | 0.003 | 0.180 | 0.315* | 0.10 |
| No adaptation($X_{19}$) | -.149 | 0.018 | 0.121 | 0.120 |

*Significant at the 0.05 level. ** Significant at the 0.01 level.

adapting to different climates and environmental changes-whether by migration to new areas, changing the crops we cultivate, or building different types of shelter. However, the current rate of global climate change is unusually high compared to past changes that society has experienced. Fact is that, climate change is ubiquitous and its multifarious ramification is also omnipresent. The micro level study in the West Tripura on farmers Perception and adaptations to climate change might be not be the reflection of entire gamut of north east India, however, it would indicate the present trend. From this empirical research, it can be concluded that farmers had to rely on own observation and neighbours' view for weather related prescience, whereas science and technology had reached to the calibre of early weather predication with more precision. It was also noted that disease of man, animal and crops were in inclined trend, and annual rainfall and rainfall days also had unfavourable changed, these result alarm for pre-emptive action road map with taking farmers as partner. The major adjustment practices and factors farmers were following under changing climatic context were decrease use of irrigation water, change planting date, find off-farm job, alternative livestock feed supplements, change crop varieties and crop diversification, however, barriers bristle in their adjustment were lack of weather information, problem with getting inputs, lack of knowledge about adaptations, lack of information about climate change and lack of appropriate seed.

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