Climate Change Impacts and Adaptation among Women Farmers in Eastern India

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Abstract

Climate change impacted adversely to each of livelihood sectors of human being. The present paper demonstrates the perception on climate change, its impact and coping strategies adopted by female rice growers. The study was conducted in one of the vulnerable districts of the state of Meghalaya in North Eastern Region (hereafter, NER). Study involved 50 numbers of female rice growers and data were analysed using logit model. The study found that farmers have been experiencing drought in the study area. Due to climate variability scarcity of essential commodities like rice availability, water and fuel to sustain their livelihood has been experienced by the female rice growers. Consequently, women need to walk down the hill for several hours to fetch water from the springs during droughts and they need to work extra hours in their fields. It caused fatigue and drudgery among the tribal women. For adapting drought, the farmers have to migrate from their place and move to other place for work. Hence, as such there was no mitigation plan for the farmers. Therefore, study suggest the site-specific intervention like local cultivar and hand driven implements to increase the yield and reducing the drudgery of women rice grower in NER.

Key Words:

Climate, vulnerability, drudgery, adaptation, strategy and NER.

INTRODUCTION

Globally, women as farmers represent more than 25 percent of the total 7.8 billion world's population. As per estimates, they comprise around 43 per cent of the agricultural work force in developing countries, ranging from 20 per cent in Latin America to 50 per cent in Eastern Asia and Sub-Saharan Africa (FAO, 2011). Women are the backbone of agriculture and rural economy performing different roles as farmer, worker and entrepreneur in the developing countries and yet remain one of the most vulnerable groups. With far less access to education and technology, a host of other socio-economic factors have had an adverse impact on the lives of women in agriculture in recent years. These factors include globalization and economic liberalization, commercialization of agriculture, rapid population growth and urbanization, migration to urban sector, growing pressure on natural resources associated with climate change have been unfavorable to women in agriculture. Climate change poses a significant threat to

women farmers and threatens to undermine global progress toward poverty alleviation, food security, and sustainable development (*Vermeulen et al., 2012; Lipper et al. 2014*). While there is growing evidence of the vulnerability of women farmers to climate change (*Cohn et. al. 2017, Harvey et al. 2014*) and increased interest in ensuring food security under climate change (*Vermeulen et al., 2012; Lipper et al. 2014*), adaptation efforts are still hindered as they have often not been able to take advantage of opportunities from new technologies, expanding markets, lack of awareness and knowledge, and new form of access to markets like contract farming. The intensity of climate change impact on women farmers is likely to increase globally in future years, as climate models project rising temperatures, more erratic rainfall, and a potential increase in the intensity and/or frequency of extreme weather events (*Magrin et al. 2007; Imbach et al. 2017*). Recently, inter-government panel on climate change (*IPCC*) reported that human-induced warming reached approximately 1°C *(±0.2°C likely range*) above pre-industrial levels in 2017, increasing at 0.2°C *(±0.1°C*) per decade (*IPCC, 2018*). Agriculture and women farmer are the twin pillars to be impacted most by the adversaries of climate change due to less mitigation or adaptation capacity specially to delay and early monsoon, rising temperature and changes in micro-climatic agro-ecologies.

In India, various studies observed an increasing trend in temperature. Climatologists expect the number of rainfall days to decrease with significant regional variation. In the North- Eastern region (hereafter, NER) of India, the number of rainy days is likely to decrease by 1–10 days. The NER has been witnessing a series of weather anomalies. According to the Indian Meteorological Department (IMD), the eastern and NER have together received 31 per cent less rainfall than normal in south-west monsoon (SWM) season of 2018, the worst monsoon season in the past 13 years. The Central Research Institute for Dryland Agriculture (CRIDA) had identified 100 districts, which are vulnerable to climate change in India, amongst those, 17 states (*Venkateswarlu et al., 2012*) are from the NER. The districts are either vulnerable to floods, drought, heat wave or cold wave. The NER states despite falling in the high rainfall zone, yet, have many districts facing severe water scarcity during the summer months. Even during the monsoon, rainfall is deficit by 58 per cent, 33 per cent and 30 per cent in Nagaland, Meghalaya and Manipur, respectively (GoI, 2015). Majority of the population in NER India depends on agriculture and over 60 per cent of the crop area was under rainfed (GoI, 2011). The deviation in rainfall and unfavourable shifts in climate can potentially endanger the food security of the NER (Kumar *et al.,* 2011).

The studies on divergence in the climate change phenomena concluded that drought is the most complex phenomenon for NER in India. It is characterized by lack of precipitation—such as rain, snow, or sleet—for a protracted period of time, resulting in a water shortage. While droughts occur naturally, human activity, such as water use and management, can exacerbate dry conditions. The agricultural drought relates to moisture deficits in the topmost one metre or so of soil (the root zone) that impact crops. Socio-economic drought is the condition when abnormal water shortage affects all aspects of established economy of a region which in turn adversely affects the social fabric of the society creating unemployment, migration, discontent and various other problems in the society (www.imd.gov.in). The occurrence of drought has been increasing over the years (IPCC, 2007) in NER; hence, enhancing farmer's vulnerability especially the women farmers. The adverse impact of drought is more on C_3 plants such as rice and

wheat (*Feroze et al., 2014*). The *Kharif* production declines significatly in lower rainfall scenario (*Webster et al., 1998; Selvaraju, 2003; Kumar et al., 2004*). The problem is further execuberated with increasing temperature that enhances transpiration, evapo-transpiration and other physiological processes which in collaboration with late monsoon or deviation in rainfall adversely affect the productivity through less moisture content in the soil. Hence, when crop calendar gets affected, the food, social and livelihood security would be affected . It has been also reported that at farm level, in NER during bad monsoon days the price of food grains increase by10 per cent and income became unstable (*Mooley et al., 1981*). Thus, the impact of climate change and its consequences would not remain confined to food production only but also would likely affect the food system including availability of food, access to food, utilisation of food and stability of food *etc.* (*Joshi, 2015*) which overall would affect the farm families and especially the most vulnerable class i.e. women farmers.

Meghalaya, one of the most agriculturally important sates in NER literally meaning 'abode of clouds' reflects the salubriousness of its climate. The state is a high rainfall zone with a subtropical type of climate. The wettest places in the world are also located here. As a result of global climate change, even high rainfall zones are facing drought-like situations in recent years. This could be ascertaining from the fact that *Kyrdem* village of Ri Bhoi district and *Marapara, Sanangre* and *Rongbokgre* of West Garo Hills Hills districts fall under the vulnerable districts to drought among the 100 districts vulnerable to climate change (*Venkateswarlu et al., 2012*). The annual mean maximum temperature is increasing at a rate of 0.04^0C per decade in the region (*Das, 2009*). At mid-altitude in Umiam (Meghalaya), the maximum temperature is increasing linearly over the years, whereas the minimum temperature has showed a gradual decreasing trend (*Ray, 2012).* There is widening gap between maximum and minimum temperature. The variation of monsoon/drought cause damages to agricultural (*Anonymous, 2011*). The state is predominantly an agrarian state with the rural population constituting 80 per cent of the total population,. As a matter of fact, nearly two-thirds of the total workforce in Meghalaya is engaged in agriculture and allied activities and it is rainfed in nature (*GoM, 2017*). The state however is matrilineal in nature where, the title and ancestral properties were being handled by the women. The women take decisions along with their male counterparts in relation to the household and farm activities except societal participation where the males hold the highest spree. They acquired to accomplish the work both at home and in their fields. This dual work causes fatigue and drudgery among the tribal women (*Singh et al., 2012*). When it comes to preserving indigenous seeds and traditional practices it is observed that women were repositories of both seeds and indigenous knowledge systems. Thus, unlike other societies, the woman have the same role and share in the process of chores and farms too. So, when there is a change in the climate, irrelevant monsoon *etc*., or other hurdles, that would hamper the whole system. Also, when the whole farming household is affected due to drought, women tends to get affected of consequences. Severe drought episodes had a dire impact on the socio-economic sector and the environment and can lead to massive famines and migration, natural resource degradation, and weak economic performance (*IPCC, 2018*). Drought could also exacerbate social tensions and fuel up civil unrest. The males may migrate to nearby villages for labour and wage, whereas, the women have to look after their families and perform other livelihood activities. Hence, with these heads, the present paper demonstrates the perceptions of

the women farmers on climate variability and its drudgery. The paper also outlined the adaptations and coping strategies adopted by women farmer to cope-up with drought and its impact on agricultural sustainability.

Methodology

Study area

Out of total 11 districts of Meghalaya, West Garo hills district at Tura was selected for the study as the district was highly vulnerable to drought (*Venkateswarlu et al., 2012*). The district covers an area of 3714 sq.km. with a population of 515,813 (Census, 2011) and is located at the western part of the state. The major crop in the district is rice and covers an area of 30621 hectare with annual production of around 103,515 MT, which is the highest in the state (GoM, 2018). The other agricultural and horticultural crops cultivated were maize, cotton, pineapple, arecanut, cashewnut, citrus, tapioca and potato.

Selection of the block

The study was conducted in two blocks namely Rongram and Dadenggre of West Garo Hills district (Fig 1). The total population at Rongram and Dadenggre was 58,745 and 41,595, respectively. The women population was reported to be 28,943 and 20,753 in Rongram and Dadenggre blocks, respectively. The literacy rate of women across each block was 75 per cent and 58 per cent in Rongram and Dadenggre respectively (Census, 2011). Asanang and Didanggre village were selected for the study. A sample of 50 female rice farmers were selected randomly by taking 25 female rice growers from each of selected village (Fig 1).

Figure 1: Sampling Plan of the study area

Data

Both primary and secondary data were used to meet the objectives of the study. Primary data were collected from sample farming households through personal interview methods with the help of well-structured schedule (Table 1). The primary data on cropping pattern, change in crop area, yield of rice, water and fuel availability, farming experience were collected. The secondary data on area, production and yield of rice were collected from the publications of the Department of Economics and Statistics, Government of Meghalaya, Shillong were collected.

Analytical tools

To understand the perception of the women farmers towards climate variability in-depth personal interviews were conducted with 50 respondents. Primary emphasis was given on the change in climate over the last 10 years, their view towards climatic variability, change in production of rice, availability of drinking water, food availability during climatic varied years. Tabular analysis was done to obtain the objective and display in percentage. Similarly, drudgery of women during drought was collected by personal interview with the women at household level. A total of 50 women rice farmers were interviewed. The main emphasis and questions asked were about their daily chores and problems faced at the household level like average food availability per household during drought, fuel availability situation, extra hours to fetch water, extra hours of works in the field and the distance from market. These variables have been considered as the main expectations to induce drudgery among as the district which is highly vulnerable to drought (Venkateswarlu *et al.*, 2012) women (Table 1). Tabular analysis was done for logical inferences of the data.

Table 1: Survey parameters of the study zone

Particulars	Response	Unit of measurement	Expectation
1.Average Food availability per Household		Months	Low rice availability during drought indicate more was the drudgery
2. Fuel Availability	Decrease No change	%	The lower it is, more the drudgery
3. Extra hours spend to fetch water	Tap water Upto 1 hour 1-2 hours	%	More the extra hours, more the drudgery
4. Average extra hours in the agricultural field		Hr	The more the extra hours, the more the drudgery
4. Distance from market		Km	The more the distance, more is the drudgery

Binary logit model

Binary logit model was used to estimate the factors that determine adaptation to drought among women folks in Garo Hills Meghalaya. Binary logit model is a probability model where the independent variable was dummy for undertaking any adaptation strategy (Y_i has two possible values, 1 and 0, for adopters and non-adopters, respectively). It has been used to identify the factors determining farmers decision to adapt to the changing climate. Same has been used by Abid *et al*., (2015) Laitonjam (2019) for analysing the decision for adaptation to climate change.

$$Y_i = \alpha X_i + \varepsilon_i$$

It was assumed that probability of adopting any adaptation strategy (Y_i=1) depends on independent variables (X_i), unknown parameter (α) and stochastic term (ε_i) (Gujarati *et al*., 2012). The probability of observing farmer to undertake any adaptation strategy is a function of age, farming experience, educational status, and household dependency ratio, extension contact, migration, and farmer to farmer contact, access to climatic information, irrigation and employment generation schemes.

Assuming the cumulative distribution of ε_i is logistic, the probability that a farmer adapt to climate change was estimated using the logistic probability model (Woodridge, 2001).

$$P(Y = \frac{1}{X} = {}^{\wedge X'\alpha} = \frac{eX'\alpha}{1 + eX'\alpha}$$

Where, ^= logistic cumulative distribution function

The model indicates diminishing marginal effects for the independent variables and the sign of coefficients indicates marginal effect of each of the independent variables on the probability of farmers undertaking any adoption strategy to climate change. The log likelihood function for probability is

$$Ln\ L = \sum_{i=1}^{N} \quad Ii\ ln\ [\ \hat{}(X'\alpha)] + (1 - li)\ ln\ [1 - \hat{}(X'\alpha)]$$

Where 'li' indicated dummy indicator (0 and 1, for adopters and non adopters respectively). The estimators of maximum likelihood parameters were obtained through maximization of the log likelihood function stated above.

Independent or exogenous variables used in the model

Age and farming experience were interrelated to each other, the more the age the more will be the farming experience. Other researchers also reported that age and rate of adoption of improved technologies have positive relationship (Kebede et al., 1990). It was assumed that educational status/level and access to use of technology or information were directly linked to higher productivity (Norris and Batie, 1987). Age also has been reported to have a positive influence on the adaptation of the farmers to climate change (Maddison 2007, and Deressa *et al.,* 2008). Dependency ratio indicates the age-population ratio of persons in a household who are not in the labour force, the more the dependency ratio, indicate that the family have more non labour farmer force thus adaptation strategy was accounted to have a negative relationship (Laitonjam, 2019) (Table 2). The other variables like extension contact, farmer to farmer contact, irrigation and employment generation schemes were assumed to have a positive relationship to the adaptation strategies of the farmers.

Table2 : Description of explanatory variables used in the logit model

Particulars	Measurement	Expectation
Age	Years	+
Farming experience	Years	+/-
Educational status	Dummy	+/-
Household dependency ratio	No.	-
Extension contact	Dummy	+/-
Migration	Dummy	+/-
Farmer to farmer contact	Dummy	+/-
Access to climatic	Dummy	+/-

information		
Irrigation	Dummy	+/-
Employment generation schemes	Dummy	+/-

Results and Discussion

Perceptions of the women farmers on climate variability and its related drudgery

Rice was a dominant food grain in the state and accounting for about 80 per cent production among all food grains. It was reflected from the Directorate of statistics, Government of Meghalaya that during 2016-17, at West Garo Hills District the total area under rice was 30621 hectare with a total production under rice of 103515 MT (GoM, 2017). Among the respondents, the average area under rice was reported to be 1.17 hectare with an average productivity of 1129.74 Kg/ha. The varieties grown in Dedangere were local varieties like *Miongma* and other varities like *Ranjit, Bahadur* whereas in Rongram block, local varieties like *mibelat, mimagisi,* and *Ranga kishor* were cultivated (Table 3).

Table 3. Area and production of rice among the respondents

	Particulars	Unit of measurement	Amount
1.	Average area under rice	ha	1.17 hectare
2.	Average Productivity of rice/ha	Kg/ha	1129.74

As reported, farming was the primary occupation of the people in the study area and the maximum of the inhabitants were tribals. The maximum of their harvest especially food grains were mainly for family consumption. Wild vegetables and vegetables like edible ferns, banana flowers and stem, leafy vegetables like mustard *etc*., from *jhum* lands were consumed and also sold at weekly markets, road side and national highways connecting Tura and Assam. The respondents reported that the average income from their own farms was Rs. 26191.67 annually. The respondents also reported to own livestock like cattle, poultry and pigs. These animals were mainly reared for manure, milk, egg and for meat purposes. On an average, livestock contributed Rs. 22075.04 to the sample farmers annual income. The district was also privileged through jobs card, some of the respondents owns shops and countable of them were in Government services. The average income through these other services was calculated to be 77025.79 annually. On an average, a household earned a total annual income of Rs.125292.50 (Table 4).

Table 4. Average Income of the respondents:

	Particulars	Unit of measurement	Amount
1.	Average Income from own farms	in Rs.	26191.67
2.	Average Income from livestock's		22075.04
3.	Average Income from other sources		77025.79
	Total		125292.50

Among the respondents, majority of the farmers, (80 percent) have responded that there was climatic variability during the past 10 years like late onset of monsoon and the rainfall intensity was erratic accompanied with a drought like situation during 2012. The same situation was reported in the region by Ray *et al* (2012) during the same year. They reported that the increase in temperature during summer and winter has added up to the late onset of monsoon. This has resulted in hurdles to the farming community and the farming households especially for rice agricultural practices. Most of the farmers depend on rain fall for transplanting and thus have resulted to the problems related to late sowing and low yield of rice. Hence, when crop calendar gets affected, the yield would be a disaster and so the food security of the people and their livelihood would automatically be affected too. However, it was interesting that 12 per cent perceived that there was no climatic variability in the region as they are settled near the forest areas and there were no hurdles for water availability in this region. They also argued that climate change was not felt as such as the climate adjusted itself over the years. About, 8 per cent of them were confused of the climate variability over the years and have given no response to the question asked. When asked about the drought situation in the study area, the respondent perceived like there was a drought like situation especially during the year 2012. Nongbri *et al.,* (2016) also reported that there was a severe drought during 2012 in Nagaland . They have reported that during 2012, there was much problem in the farming system of the region. Those who perceived that there is no drought situation or have not been affected have irrigation facilities for their fields and are located nearby the water sources like wells, ponds and rivers (Table 5 and Table 6).

Table 5. Perception of respondents towards climatic variability:

	Perception	Unit of measurement	Results
1.	Climatic variability	Percentage	80
2.	No response		8
3.	No climatic variability		12

Table 6. Perception of respondents towards Drought:

Perception	Unit of measurement	Results
1. Drought	Percentage	66
2. No drought		34

Even though, farmers perception in drought and climate change has been a confusing scenario, yet, 100 per cent of them realised and reported that rice availability and production decreased. The reason may be due to erratic rainfall or late onset of rainfall especially during harvesting period. The water for drinking and irrigation has been reported to be less and some of the streams and ponds dried up when there was no rain. Fuel accessibility was nevertheless a problem as the area was mainly covered with forests (Table 7)

Table 7. Perception to the change in rice, water and fuel availability

Particulars	Unit of measurement	Results
1. Change in rice availability	Percentage	100
2. Change in the availability of water (drinking+irrigation)		100
3. Change in the availability of fuel		44

Thus, it can be concluded that farmers have been experiencing drought in the study area. The hue and cry of the farmers is related to the availability of essential commodities to sustain their livelihood *i.e.,* rice availability, water and fuel. . It has been also reported that at farm level, in India during bad monsoon days the price of food grains increased 10 per cent and income became unstable (*Mooley et al., 1981).* Thus, the impact of climate change and its consequences would not remain confined to food production only but also would likely to affect the food system including availability of food, access to food, utilization of food and stability of food *etc.* (*Joshi, 2015*) which overall would affect the farm families.

The women contribute the most in almost all rice operations and household chores. Like any other women farmers, Garo women actively participate in agricultural activities. (*Das and Lahiri, 2013*) also reported that more than eighty per cent of the rural women are engaged in agricultural, animal husbandry and other allied activities. In terms of rice availability for family consumption, it was reported that during drought years, there was a deficit in rice for the households. The households could hardly make up-to 9 months of rice self sufficiency due to drought. This has resulted in extra burden to them by making up the deficit through market accessibility by undergoing wage works and by borrowing from their neighbours.

In the study area, bamboo and shrubs have been mostly used as fuel. When there is no rain, the firewood availability also pertains to go down. About 44 per cent of the respondents reported that decreased in the firewood availability during drought and 56 per cent of them reported no change in fuel availability.

The women reported that they have to spend extra time doing the entire household and agriculture related chores especially when water scarcity prevails. Such is the shortage of water in the months between February – August that the women have to walk down the hill for several hours to fetch water from the springs. It is hard work, with buckets placed in wooden carts which are dragged uphill with some effort says one of the respondents. About 36 per cent of the women reported that they have spent an extra hour to fetch drinking water and 14 per cent of them reported that they have spent almost 2 hours when there is no rain (Table 8). Women rush to the taps in the localities and fill up as many buckets as possible says a community elder. For washing and bathing, women go down to the springs.

During drought, the women also reported that they have to work extra hours in their fields by almost 2.5 hours to perform agricultural operations. Apart from village markets in Dadenggre and Jiljang, the women folk performed their marketing manoeuvre at Tura. The average distance of the households from Tura market was calculated to be 16 Km. They acquired to accomplish the work both at home and in their fields. This dual work causes fatigue and drudgery among the tribal women (Singh *et al*., 2012). Thus, unlike other societies, the woman had the same role and had a share in the process of chores and farms too. Also, when the whole farming household would be affected due to drought, women tends to get affected more of the consequences.

Table 8. Drudgery of the women during drought

Particulars	Response	Unit of measurement	Expectation	Results
1.Average Food availability per Household		Months	Low rice availability during drought indicate more was the drudgery	9.22
	Decrease			44
2. Fuel Availability		%		
	No change			56
3. Extra hours spend to fetch water	Tap water			5
	Upto 1 hour	%		36
	1-2 hours			14

4. Average extra hours in the agricultural field	hr	The more the extra hours, the more the drudgery	2.5
4. Distance from market	Km	The more the distance, more is the drudgery	16

Adaptations and coping strategies adopted by women farmer during drought

When asked about the adaptation and coping strategies during drought, it was astonished to hear that farmers were blank of such during climate shocks. To be relevant with the regular crop calendar, the women farmers reported that they mostly wait for the first monsoon rains which happened during the month of June or early July. If the first monsoon rains happens, they also start with their rice transplantation. The women reported that when there was late monsoon there will be problems for regular cropping patterns, enhancing irrelevant rice productivity, disease and pests. However, the farmers reported that they never changed their crops due to drought.

In order to cope up with their regular farming systems, the farmers have different spheres of attainment irrigation facilities, access to climatic information, crop diversification, income from other sources other than agriculture, and access to credit facilities. In terms of extension contact, 76 per cent of the farmers have contacts and 24 per cent of them do not have any contact with the extension personnel regarding weather and other farm related issues. The main extension contact with the women farmers in the area were Agricultural Technology Management Agency (ATMA), KVK, Indian Council of Agricultural Research (ICAR) and Agriculture department *etc.*

It has been assumed that for adapting drought, the farmers have to migrate from their place and move to other place for work but 90 per cent of the farmers in the study area reported of not migrating due to drought and those who migrated have been working as wage workers in Tura and Shillong. The maximum of the farmers (72%) share information among each other about various adaptation strategies due to climate change. 62 per cent of the farmers responded to have access to climatic information *viz*., newspaper, radio and even text messages by India Meteorological Department (IMD) and various institutions. The maximum of the farmers (64%) least diversified their crops and cropping pattern. As their main crop is rice, during rice off season the field has been left barren. This may result in risk due to climate change and during drought years as there is no mitigation plan for the farmers or in attaining other income sources in case the diversify and cropping pattern was sought. About 92 per cent of the farmers have no access to credit systems and 76 per cent have no irrigation facilities. In order to sustain their agricultural production systems, credit and irrigation were the main catalysts which are lacking among the farmers of the district. In the case of cash for work schemes, the Mahatma Gandhi National Employment Guarantee Act (MGNREGA) could

not materialise the 100 days of work as per the regulations. However, only 62 days of work has been provided through (MGNREGA) in the study area with Rs. 187 per day/person irrespective of male or female wage worker (Table 9).

Table 9. Descriptive statistics of the independent variable used in the binary logit model

1.	Extension contact	No= 0	24
		Yes=1	76
2.	Migration	No= 0	90
		Yes=1	10
3.	Farmer to farmer contact	No= 0	28
		Yes=1	72
4.	Access to climatic information	No= 0	38
		Yes=1	62
		Percentage	
5.	Crop Diversification	No= 0	64
		Yes=1	36
6.	Income from other source	No= 0	24
		Yes=1	76
7.	Access to credit	No= 0	92
		Yes=1	8
8.	Irrigation	nirrigated=0, Irrigated=1	76
			24
9.	Employment generation schemes (MGNREGA)	er of days	61.94

Farmer age

As expected, higher the age, farming experience also will be more. It has been reported that these variables were significant to the adaptation strategies by the farmers. Similarly, Laitonjam (2019) reported that the more the age and experience, the more was the adaptive capacity.

Educational status

The higher the education, the more was the adaptive capacity of the woman to drought was reported by Fadina and Barjolle (2018), Deressa *et al*., (2008), Maddison (2007) and Laitonjam (2019). In the present study, the educational status was significant indicating that the more the education, the more was the adaptive capacity of the women folk to drought.

Household dependency ratio

The household dependency ratio was reported to be insignifant. The reason behind was by the fact that with the increase in the number or individual's dependant, the more the hurdles to cope especially during drought.

Extension contact

It was expected that the households who receive more support from the institutions like ICAR, State agriculture department and KVK will adapt more. The farmers attended the training programmes on agricultural and horticulture production also. The more the farmers are being connected to the agricultural institution systems, the more will be their adaptation to drought as they may be aware through different trainings and agricultural schools.

Farmer to farmer contact

The more the farmer contact, the more will be the adaptation to drought by the farmer folks. Farmers share their problems and interactions felt with one another hence was significant in the adaptation of them to drought.

Access to climatic information

When farmers have access to climatic information, they will be able to cope to the wrath of drought situation in the area. It has been found in the model that this particular variable was significant indicating that the farmers had climatic information and news through KVK, Tura which has helped them in adapting drought.

Irrigation

Irrigation was also found to be significant indicating the more accessed to irrigation, the more the farmers can mitigate drought related issues (Table 10).

Table 10. Dependent variable: Adaptation

	Coefficient	Std. Error	z	p-value
Age	0.31	0.14	2.16	0.031**
Farming experience	0.05	0.13	0.39	0.70
Educational status	1.96	0.88	2.23	0.025**
Household dependency ratio	16.32	7.43	2.20	0.067
Extension contact	4.17	2.28	1.83	0.028**
Migration	−3.04	2.10	−1.45	0.15
Farmer to farmer contact	9.12	3.96	2.30	0.021**
Access to climatic information	5.70	2.53	2.26	0.024**
Irrigation	−6.12	3.42	−1.7927	0.023**

Mean dependent var	0.500000	S.D. dependent var	0.505076
McFadden R-squared	0.670509	Adjusted R-squared	0.353116
Log-likelihood	−11.41930	Akaike criterion	44.83860
Schwarz criterion	65.87085	Hannan-Quinn	52.84780

(Figure in parenthesis indicates the significant level)

Conclusions:

Thus, it can be concluded that farmers have been experiencing drought in the study area. The hue and cry of the farmers is related to the availability of essential commodities to sustain their livelihood *i.e.,* rice availability, water and fuel. Garo women actively participate in agricultural activities. Women need to walk down the hill for several hours to fetch water from the springs during droughts. It is hard work, with buckets placed in wooden carts which are dragged uphill with some effort says one of the respondents. During drought, the women also reported that they have to work extra hours in their fields. the women folk performed their marketing manoeuvre at Tura. This dual work causes fatigue and drudgery among the tribal women. For adapting drought, the farmers have to migrate from their place and move to other place for work. Share information among each other about various adaptation strategies due to climate change. Rarely least diversify their crops and cropping pattern. As their main crop is rice, during rice off season the field has been left barren. This may result in risk due to climate change and during drought years as there

is no mitigation plan for the farmers or in attaining other income sources in case the diversify and cropping pattern was sought.

Acknowledgements

References:

Cohn AS, Newton P, Gil JD, Kuhl L, Samberg L, Ricciardi V, Manly JR, Northrop S. Smallholder agriculture and climate change. Annu Revi Environ Resour. 2017. https://doi.org/10.1146/annurev-environ-10201 6-060946.

Deressa, T.T, Hassan, R.M., Ringler, C., Alemu, T., and Yesuf, M. (2009). Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Glob. Environ. Chang.,* **19**: 248-255.

FAO. 2011. The state of food and agriculture: women in agriculture closing the gander gaps for development. FAO publication 2010-11. 1-148.

Feroze, S.M., Aheibam, M., Singh, R., Ray, L.I.P., Rai, M., Singh, J.K., and Singh, R.J. (2014). Assessment of agricultural vulnerability to climate change in Manipur: A district level analysis. *Indian J. Hill Farming,* **27**(1): 22-29.

GoM. (2017). Statistical handbook of Meghalaya. Directorate of Economics and Statistics. Government of Meghalaya.

GoM. (2018). Directorate of Agriculture. Government of Meghalaya. http://www.megagriculture.gov.in. Accessed on 21 May 2018

Harvey CA, Rakotobe ZL, Rao NS, Dave R, Razafimahatratra H, Rabari- john RH, Rajaofara H, MacKinnon JL. Extreme vulnerability of small- holder farmers to agricultural risks and climate change in Madagascar. Philos Trans R Soc. 2014. https://doi.org/10.1098/rstb.2013.0089.

Imbach P, Beardsley M, Bouroncle C, Medellín C, Läderach P, Hidalgo H, Alfaro E, Van Etten J, Allan R, Hemming D, Stone R, Hannah L, Donatti CI. Climate change, ecosystems and smallholder agriculture: an introduction to the special issue. Clim Change. 2017. https://doi.org/10.1007/s1058 4-017-1920-5.

IPCC. (2007). Climate Change 2007: The physical science basis, Contribution of working group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M., and Miller, H.L. (ed) Intergovernmental Panel on Climate Change, Cambridge University Press, UK.

Joshi, P.K. (2015). Has Indian agriculture become crowded and risky? Status, implications and the way forward. *Indian J. Agric. Econ.*, **70**(1):1-41.

Kumar, K.K., Kumar, K., Ashrit, R.G., Deshpande, N.R., and Hansen, J.W. (2004). Climate impact on Indian agriculture. *Int. J. Climatol.,* **24**:1375-1393.

Lipper L, Thornton P, Campbell BM, Baedeker T, Braimoh A, Bwalya M, Caron P, Cattaneo A, Garrity D, Henry K, Hottle R. Climate-smart agriculture for food security. Nat Clim Change. 2014. https://doi.org/10.1038/nclimate2437.

Magrin G, Gay García C, Cruz Choque D, Giménez JC, Moreno AR, Nagy GJ, Nobre C, Villamizar A. Latin America. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE, editors. Climate change 2007: impacts, adaptation and vulnerability, contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. Cambridge: Cambridge University Press; 2007. p. 581–615.

Mooley, D.A., Parthasarathy, B., Sontakke, N.A., and Munot, A.A. (1981). Annual rain water over India, its variability and impact on the economy. *J. Clim.,* **1**:167–186.

NOAA. (2015). National centres for environmental information. National Oceanic and Atmospheric Administration. https://www.ncdc.noaa.gov/sotc/drought/201507. Accessed on 21 May 2018.

Nongbri. B., Feroze, S.M., Ray, L.I.P., and Devarani, L. (2016). Assessment of risk due to exposure to drought: A study of farm households of Nagaland. *Indian J. Agric. Econ.*, **7**(3): 325-334.

Selvaraju, R. (2003). Impact of El Niño-Southern oscillation on Indian food grain production. *International J. of Climatology.,* **23**:187–206.

Singh, R., Saravanan, R., Feroze, S.M., Devarani, L., and Paris, T.R. (2012). A case study of drought and its impact on rural livelihood in Meghalaya. *Indian J. Dryland Agric. Res. & Dev.,* **27**(1): 90-94.

Venkateswarlu, B., Kumar, S., Dixit, S., Rao, C.S., Kokate, K.D., and Singh, A.K. (2012). Demonstration of climate resilient technologies on farmers' fields action plan for 100 vulnerable districts. Central Research Institute for Dryland Agriculture, Hyderabad.

Vermeulen SJ, Aggarwal PK, Ainslie A, Angelone C, Campbell BM, Chal- linor AJ, Hansen JW, Ingram JSI, Jarvis A, Kristjanson P, Lau C. Options for support to agriculture and food security under climate change. Environ Sci Policy. 2012. https://doi.org/10.1016/j.envsci.2011.09.003.

Webster, P.J., Magana, V.O., Palmer, T.N., Shukla, J., Tomas, R.A., Yanai, M., and Yasuna, T. (1998). Monsoons: processes, predictability and the prospects for prediction. *J. of Geophysics Res.*, **103**:14451–14510.