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Bineeta Satpathy
Associate Professor,
Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Monalisa Behera
Scientist, Krishi Vigyan Kendra, OUAT, Odisha, India

RP Mishra
Programme Assistant, Krishi Vigyan Kendra, OUAT, Odisha, India

Corresponding Author:
Bineeta Satpathy
Associate Professor,
Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Farmers perception of drought and adaptation in mid-central table land zone of Odisha

Bineeta Satpathy, Monalisa Behera and RP Mishra

Abstract
Recurrent drought is a major catastrophic in the drought prone area of Odisha state in India. Agriculture (e.g., agriculture, horticulture and livestock) is the major income activity of over 80% of the state's population. The objective of this study is to understand the rural farming community perception of drought impacts on their socio-economic activities, their adaptation at the household level and opinions on government drought mitigation measures especially training component. This study is based on both primary and secondary data collected via a survey of 150 farming households. The results showed that food scarcity, malnutrition, seasonal migration, unemployment were the most immediate socio-economic impacts of drought as perceived by affected farmers. In spite of good perception of severity of drought impacts by farmers and their familiarity with various adaptation options, the preference given for their adaptation in agriculture was not good enough. The adaptation strategy as preferred by respondents were reducing feeding schedule of livestock (88%), seasonal migration (37%) and altering planting dates of crops (17%) to avert the risk.

Keywords: Drought, perception, impact, adaptation

Introduction
Climate change is happening in reality and is creating a measurable impact on human lives and livelihood. Odisha has been teetering from one extreme weather condition to another: from heat waves to cyclones, drought to floods **(**Bennett, 2009) [1]. The state has been disaster affected for 95 years of the last 105 years: floods have occurred for 50 years, droughts for 32 years and cyclones have struck the state for 11 years (Mohapatra, 2006) [2]. Odisha's geographic location on the east coast of India and its climatic conditions have meant that the state has historically been highly prone to climate change and multiple hazards, such as cyclones, droughts and floods (Bhatta, 1997) [3]. Drought impacts the poorest the hardest. It has been documented that a poor farmer takes a long duration of three to four years to recover from a drought, depending on the severity.
Education is an integral tool that can be used in the adaptation of the measures that have been put in place to curb climate change. When considering the adaptation of measures that have been established to curb climate change, it is important to ensure that the perception of all categories of farmers do actually go with awareness and knowledge they possess. By improving people's knowledge of climate change, it would be easier for them to adopt different mitigation measures. Also, there is a need to instil a culture among the youth involved in farming on the best practices when environment security is a concern. With this background, the present study was conducted to analyse the farmers perception on drought and various adaptation and mitigation strategies.

Materials and Methods
A cross-sectional study was conducted in two districts of mid-central table l and zone of Odisha *viz.*, Angul and Dhenkanal. The study districts were selected purposively based on occurrence of extreme climatic events in past and for comparison of the drought impacts on various dimensions of livelihood. Angul is located in the centre of the state of Odisha and lies between the latitudes of 20°31′N and 21°40′N and longitudes of 84°15′E and 85°23′E. The altitude is between 564 and 1187 metres. The district has an area of 6232 km^2. The district has a population density of 199 inhabitants/km^2. Dhenkanal district is one of the centrally located districts in Odisha. It lies between longitude: 85° 58' to 86° 2' East and latitude: 20° 29' to 21° 11' North. This district has a population density of 268 inhabitants/km^2. Out of two districts selected for study, both were considered as target population.

To select the study sites, a purposive sampling approach was employed due to the accessibility of the study sites and previous experience of drought. A total of 150 respondents, were considered for the present study for the questionnaire-based survey and the respondents were selected using simple random sampling (random walk) technique.

A planned questionnaire was prepared and administrated to collect and generate primary data from the participants (small holders and marginal farmers) from the study sites. The selection of respondents were done using a simple random sampling approach. The objectives of the study were discussed with the respondents and those who showed interest to participate in the study were questioned and observations were noted. The deviation from normal rainfall is used for the characterization of meteorological drought. The average annual rainfall and its deviation for the period of 2012-2020 were recorded. Conditions further deteriorated in 2012 where the rainfall deficit reached 37% (i.e., moderate drought conditions) and 42% severe drought and 21% normal deficit was ascribed. The questionnaire survey was administered on the interested participants using local language (Odia) and the questionnaire administered in the present study was categorized into four parts: (i) household demographic and socio-economic characteristics, (ii) farmers' perception of drought and its impacts, (iii) adaptation strategy and mitigation measures, and (iv) reaction towards government programmes especially training on drought. Descriptive statistical tools such as percentages, tables and graphs were used to analyse and interpret the results. To analyze the difference in perception of respondents, in addition to grouping based on sub-district wise irrigation strata [Low (<15%), medium (15–30%) – and high (>30%) – irrigated area of total cultivable area], population is grouped based on their land holding size [households with marginal <1 ha), small (1–2 ha), medium (2–4 ha), large (>4 ha) land holdings] , annual household income [low (Rs <40,000/-), middle (Rs 40,000-60,000/-) and high (Rs >60,000/-)], education (illiterate-, primary-, secondary- and higher-education) and drought intensity (severe- and moderate-drought) faced. In line with the results, it is also pertinent to mention that a farmer opts for more than one option for adapting to the drought situation and any intervention that promotes the use of adaptation measures to drought may account for location-specific factors and so aggregate of choices account for more than 100% in some cases. Data were analyzed using non-parametric significance testing, Kruskal–Wallis H-test and Mann–Whitney U-test (Gibbons and Chakraborty, 2003) [4].

Results and Discussion

Socio-economic characteristics of the respondents

In the present study, a total of 150 households were interviewed from three irrigation strata viz. less irrigated, medium irrigated and high irrigated of which 77.03% were household heads and 22.97% were relatives of household heads (Table 1). The average age of respondent was 45.6 years, which implies that majority were in the productive age group (Table 1). The average household size of 6.2 of the sampled respondents was normal in rural setting and also favours awareness level on fertility ratio. Information on education revealed that 42% respondents never received any formal education in all the categories (Table 1). It should be noted that perception is in part a subjective phenomenon, therefore, different people in the same locality might construct different perceptions of climate change even though they experience the same weather patterns. The average farming experience was about less than 37.5 years, whereas, the average land holding size was 5.13 acres (Table 1). The major source of the income was agriculture (86.1%) in the study area followed by livestock/animal husbandry (10.9%) and other sources like wages, contractual services and part time jobs to a minimum extent (3.0%) (Table 1). However, in less irrigated strata, 19.7% preferred livestock but only 3.2% in highly irrigated area. This was in conformity with similar findings of Udmale *et al.* (2014) [5].

Farmers' perception on drought issues

Preparedness for increasingly frequent droughts requires a good knowledge and different people perceive drought in different ways. This study observed the perception of farmers/respondents on drought issues upon several variables like number of rainy days, length of summer and winter days, occurrence of drought, temperature fluctuation and water availability. Majority (74.2%) mentioned decrease in number of rainy days from usual indicates drought situation, 88.7% perceived increase in length of summer days, 96.5% felt drought occurrence has increased over years, 89% of them felt temperature fluctuation and the trend for them was increasing and 86.3% perceived decline in water availability for own and farm consumption (Table 2). People's perception of climate change is shaped by learning from personal experience and by making use of statistical information (Weber, 2010) [6]. Similar findings also reported in perception studies done by Durrani *et al.* (2021) [7] in Baluchistan, Pakistan and Udmale *et al*. (2014) [5] in Maharashtra, India.

Farmers' Perception on various socio-economic impacts

An understanding of the socio-economic impacts of drought is crucial for planning and designing technological and policy interventions for effective drought mitigation. As drought brings normal farming life at stake, normal human and livestock health are at stake. The negative effects of these changes will be higher for agricultural producers that practice rainfed agriculture, as well as for those with limited access to credit and insurance, and those that are disconnected from regional or national markets (Skoufias *et al.*, 2011) [8]. Table 3 gives the results of the nonparametric statistical tests (asymptotic significance) p-values for perceived severity of socio-economic drought impacts against various respondent group. Usually, the association between two variables is statistically significant if asymptotic significance (2-sided) < 0.05 which is clearly the case here. The sig (2-tailed) item in the output is the two-tailed p-value. The p-value is the evidence against a null hypothesis. This value determines the statistical significance of the relationship between variables. In all tests of significance, if $p<0.05$, we can say that there is a statistically significant relationship between the two variables. The farmers response to drought impacts was run in SPSS against socio-economic variables of the respondents to get p-value. The p-values for irrigation strata, landholding size, HH income, education and drought intensity as against food scarcity impact were 0.43, 0.52, 0.76, 0.67 and 0.7 respectively and values denotes no as such significant relationship between these two variables. The p-values as against no food choice impact were 0.29, 0.61, 0.34, 0.05 and 0.59 respectively and there was a significant difference ($p<0.5$) observed in no choice of food preferences and education level of the respondents which indicates that less

educated said they ate whatever they received nearby and high educated wanted to maintain their average standard of food habit. The p-values as against reduction in HH income were 0.89, 0.69, 0.67, 0.47 and 0.65 respectively and values denotes no as such significant relationship between these two variables which also implies that farm income reduction can be for many reasons like non-adoption of technologies, lack of inputs, lack of contact with extension machinery etc. The p-values for irrigation strata, landholding size, HH income, education and drought intensity as against livelihood insecurity scores were 0.88, 0.79, 0.09, 0.68 and 0.04 respectively and a significant difference (at 1% level) was observed in perception of livelihood security and the drought severity which denotes significant relationship (p<0.05) between the two and can be inferred that livelihood security is a right-based construct to attain basic needs and assure rights at the household level. Also farmers with less education level were more open to the practice of child labour (significant at 5%level) which also signifies that practice of child labour is a daunting challenge for those who didn't receive formal education. These were in conformity with the findings of Udmale *et al.* (2014) [5]. More frequent and severe droughts leave the farmers with poor access to livelihood capital and Drought remains to be the most important threat to food production and food and nutritional security.

Drought impact as perceived by farmers

Agriculture is extremely vulnerable to climate change. Climate change may cause gains in some crops in some regions of the world, but the overall impacts of climate change on agriculture are expected to be negative (Nelson *et al.*, 2009) [9] This work investigates perception of farmers affected with drought with diversified dimensions of describing the effect. As seen Fig. 1 revealed 67% of the respondents perceives food scarcity during the time. Malnutrition affects women and children to greater extent and 80% feels the impact as very high. Drought leaves rural masses with increasing problem of loss of employment and majority (78%) perceived this factor as highest as farmers losing their farm as well off-farm activities. Livelihood security is threatened due to frequent occurrence of drought. In the study area the extended drought and lack of monsoon rain in the region severely affected the main source of income (crop production). The farmers lacked proper motivation to shift from traditional crops to the new ones particularly fruit crops. Some of the farmers were hesitant to take any risks, and others believed that the area may not be suitable. The farmers expressed lack of proper knowledge and very limited access to extension services, farmers were unable to identify and choose high yield crops. It is therefore, farmers did not have knowledge about high yield varieties and drought resistant crops. Many respondents (88%) expressed that there is reduction in household income which also has relevance to their perception that drought situation affected human health (55%), children health (75%), hampers child education (75%) and there is reduction in spending for social functions (69%). This result was corroborating with Stanke *et al.* (2013) [10].

Almost all respondents perceived drought affects availability of all resources in the mid-central tableland zone of Odisha. Drought affects availability of all resources was perceived by 65% of them and results also is similar to a study conducted by National Drought Mitigation Center University of Nebraska-Lincoln on types of drought impacts in year 2012. In order to lessen the impacts of drought and cope with drought situation farmers seek other ways like migration and 56% mentioned that, there has been migration from the study area which was also seen by Osawe (2013) [11] as an ex-ante risk management strategy. Migration in this study area occurred due to unemployment, low production due to crop loss, livestock losses and decrease in household income of respondents.

Farmers' perception on training for drought preparedness

Training and other capacity building measures are the prioritized necessity for development. The sample in the study were interviewed on their preparedness for facing the adverse challenges but response was recorded that 37% didn't receive any training as such,16% received training from Government organization though they failed to mention the department. Local panchayat officials like block advisory members provided training and KVK also played a role and 13% participated in awareness programme on climate change impact on agriculture. It was also reported that there was no drought awareness or early warning for drought issued to farmers until the drought was already in progress. Appropriate and timely information along with capacity building is expected to improve the capacity of farmers to manage the risks associated with climate variability and change (Vaughan *et al*., 2019) [12].

Drought adaptation and mitigation measures by farmers

Particularly relevant for the focus of this study is the result reported by Carlos *et al.* (2020) [13] showing that there is a positive correlation between the adoption of adaptation practices and perceiving a change in climate. Changes in climatic conditions requires different adaptation strategies, in terms of both overall livelihood strategies and adjustments in agricultural production itself in order to alleviate the severity of climate change impacts. This research on perceptions on adaptation specifies that farmers prefer different livelihood options (65%) especially off-farm activities like bidi making, leaf plates making, bamboo mats making for additional income sources followed by farming with staggered planting dates for chosen crops (60%). Shifting crops in drought time was also good as perceived by 70% of the respondents which is also seen to being advocated in the contingent planning measures. Other measures included were arranging different feed types (35%), changing crop variety (30%) migration (41%) in order to get additional income and also farmers showed preference towards growing drought resilient varieties (22%) if supplied by government. Though the level of poverty has not been studied here but knowledge of these farmers need to be continuously updated based on new research findings. The similar findings have been conferred in the research on Climate Change Impacts and Adaptation Strategies in Northwest China (Zhao *et al.*, 2014) [14].

Thus, this study has specially focused on understanding of farmers' perception and attitude towards drought in the drought prone districts of Angul and Dhenkanal and provides some recommendations with an aim to determine and design effective policies by incorporating farmers' perception that may help farmers to cope with drought vulnerability.

Table 1: Socio-economic characteristics of respondent households in the study area

	Less irrigated	Medium irrigated	High irrigated	Average
Household (HH) characteristics (n=150)				
HH proportion (%)	38.1	34.2	27.7	-
HH heads interviewed (%)	75.2	76.4	79.5	77.03
Other than HH heads interviewed (%)	24.8	23.6	20.5	22.97
Avg. age of respondents (years)	41.2	46.5	49.2	45.6
Average HH family size	6.4	5.9	6.2	6.2
Years into farming	38.0	39.2	35.1	37.5
Source of HH income (%)				
Agriculture	78.5	87.4	92.5	86.1
Animal husbandry	19.7	10.0	3.2	10.9
Others mixed	1.8	2.6	4.3	3.0
Average landholding (acres)	6.5	4.7	4.2	5.13
Education	Primary (87.7%)	Higher secondary (76.2%)	Senior secondary (69.5%)	-

Table 2: Farmers perception on drought issues

Variables	Increased	Decreased	Normal	No idea
No. of rainy days	0	74.2%	17.8%	8%
Length of summer days	88.7%	7%	10%	5%
Length of winter days	9%	81%	7.5%	2.5%
Drought occurrence	96.5%	0	0	3.5%
Temperature fluctuation	89%	0	11%	0
Water availability	0	86.3%	0	12.7%

Table 3: Farmers perception of various socioeconomic impacts (asymptotic significance values, *n*=150)

Impact of drought	Irrigation strata	Landholding size	HH income	Education	Drought intensity
Food scarcity	0.43	0.52	0.76	0.67	0.76
No choice in food preference	0.29	0.61	0.34	0.05*	0.59
Malnutrition	0.34	0.42	0.90	0.78	0.89
Affects human health	0.65	0.65	0.54	0.56	0.49
Affects livestock health	0.76	0.70	0.65	0.59	0.56
Reduction in HH income	0.89	0.69	0.67	0.47	0.65
Affects child education	0.54	0.67	0.57	0.54	0.79
Unemployment	0.77	0.21	0.54	0.65	0.38
Migration	0.79	0.46	0.78	0.87	0.76
Reduction in social functions	0.27	0.67	0.63	0.76	0.59
Livelihood insecurity	0.88	0.79	0.09	0.68	0.04**
Increase in child labour	0.23	0.57	0.69	0.05*	0.59
Affects availability of other resources	0.66	0.54	0.48	0.54	0.83

*Significant at 5%
**Significant at1%

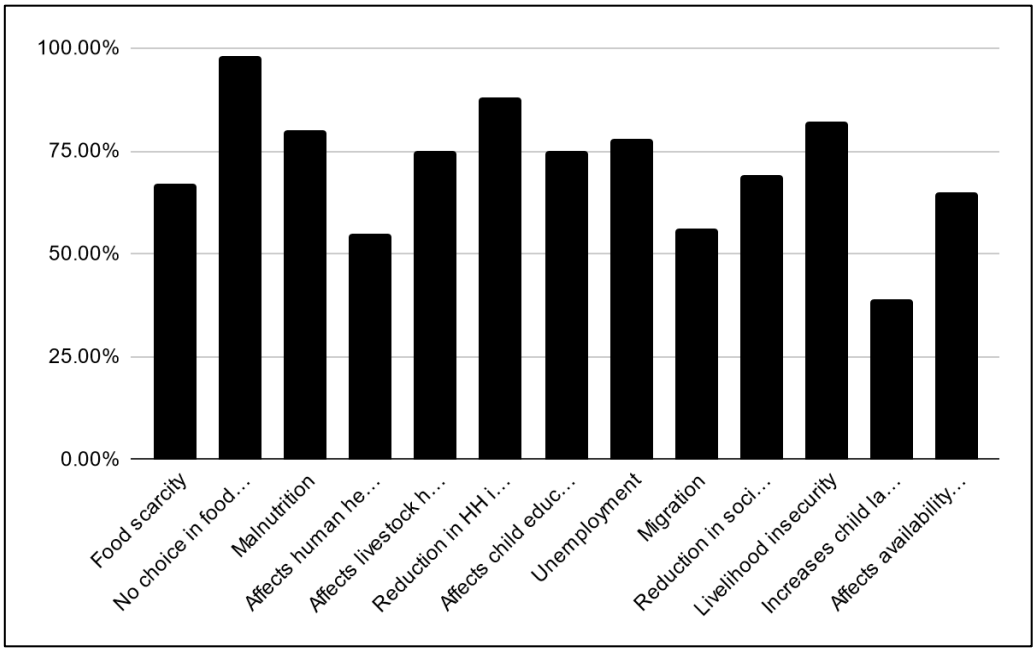

Fig 1: Drought impacts as perceived by the farmers

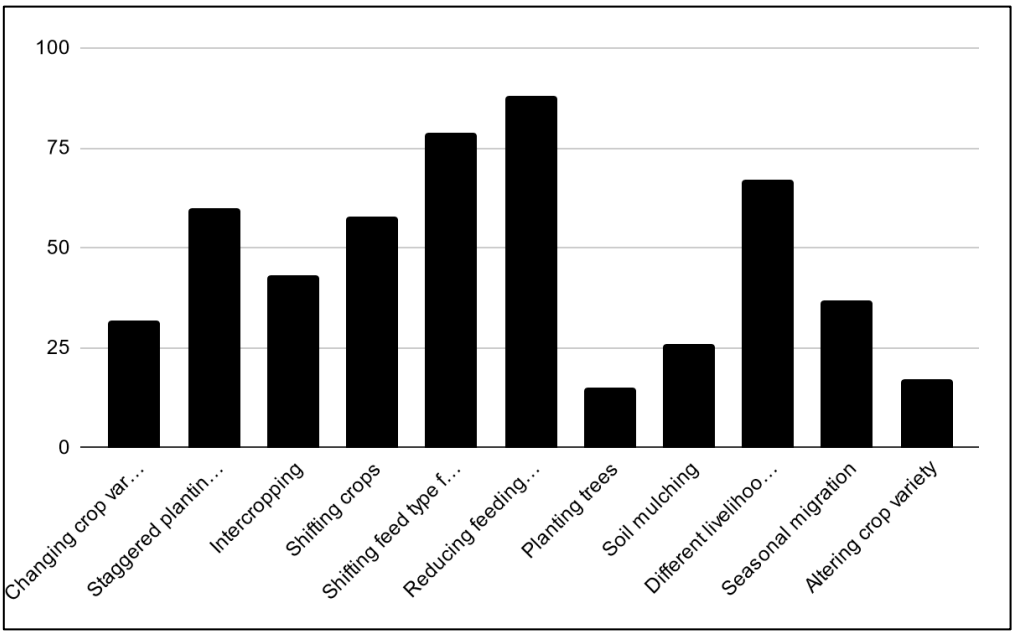

Fig 2: Drought adaptation and mitigation measures by farmers

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