Assessing Livelihood Vulnerability of Farmers’ in Backward Regions of India

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ABSTRACT

Agriculture in Bundelkhand region is highly vulnerable to risks and uncertainties. Marginal and small farmers among all farm groups are most vulnerable to the effects of climatic variability. The impact of extreme weather events and natural resources on which farmers are dependent aggravates their vulnerability. The present study uses field surveyed data and IPCC- vulnerability approach, to assess the livelihood vulnerability status of two districts of Bundelkhand region, India. Data was collected using a multistage sampling technique including 200 households. The study concluded that 90% of farmers perceived (exposed) that Kharif season remained hotter and frequencies of droughts have increased over the last five years. Sample households were also highly sensitive due to lack of basic amenities. The lower adaptive capacity due to agriculture as a sole income source, lack of non-farm employment opportunities, monoculture and income diversification and illiteracy are responsible for livelihood vulnerability in the region. From the policy perspective, water conservation through rainwater harvesting, construction of new ponds and check dams would be a possible solution to the present water crisis in the region.

Key words: Adaptation strategies, Climate change, Farmers’ perception, Livelihood vulnerability index, Rainfed agriculture.

INTRODUCTION

Indian agriculture is highly vulnerable to risks prone, marginal and small land farmers among all are most vulnerable to the effects of climatic variability (Pandey and Jha, 2012; Sudha et al., 2015). The extreme weather abnormalities and exploitation of natural resources further aggravates their vulnerability (Singh et al., 2019; Singh, 2020a). Numerous studies pointed out that climate change will further intensify and smallholding farmers (more than 80%) will be the most affected one, as they entirely rely on climate sensitive livelihoods (from agriculture) and have low adaptive capacity (Gill et al., 2015; Ahlawat and Dhian, 2015; Meena et al., 2016; Alipour and Hossein, 2016; Chingala et al., 2017; Kartihka et al., 2017). Therefore, under the present situation of changing climatic scenario, there is a need of adapting climate change risk management strategies which could help the farm households to improve their productivity and livelihood security.

Livelihood vulnerability has a multidimensional subject for climate change research. It consists of three main components, viz., exposure, sensitivity and adaptive capacity. Exposure refers to stresses caused by changes in frequency, intensity, magnitude, frequency, duration and areal extent of the hazard and nature of climate stress (Nazari et al., 2015). Sensitivity measures the ability of a system to respond to the climate impacts is found by both socio-economic and ecological situations and identifies the level at which a group will be influenced by environmental stresses. Adaptive capacity refers the power of a system to global climate change (including climate variability and extremes) to moderate potential damages, to require advantage of opportunities, or to deal with the consequences.

It is important that the results of global climate change shouldn’t lead already marginalised sections of communities into further deprivation. But key development issues have been at best side-tracked and at worst blatantly omitted, from policy debates on climate change. This paper develops and tests the application of a livelihood vulnerability index (LVI) for agricultural and natural resource-dependent households in most backward agro climate zone, viz., Bundelkhand region. A practical and easy to use LVI has developed that capable to captures climate exposure (farmers’ perception), sensitivity (social and economic backwardness) and adaptive capacity (differential adaptation strategies in agriculture).

MATERIALS AND METHODS

Study area

The present study was undertaken in the Bundelkhand region of Uttar Pradesh in India. Uttar Pradesh plays a vital
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role in India’s food and nutritional security by contributing 17.83% of the country’s total food grain output in 2016-17 (GoI, 2017; Singh, 2020b). Geographically, Uttar Pradesh is divided into four economic regions, viz., Western, Central, Eastern and Bundelkhand. This study was undertaken in two districts of Bundelkhand region, viz. Jalaun and Jhansi due to the preponderance of droughts in the region (Fig 1). Historically, Bundelkhand has been more vulnerable to climate change than other regions of Uttar Pradesh. It experienced drought every 16th year during the 18th and 19th centuries. The incidence of droughts increased threefold in 1968 to 1992 and is now a recurrent annual phenomenon (GoI, 2017). Average annual rainfall was below average during 2004-2017. Farmers mainly grow wheat, soybean, tur, rapeseed, paddy, gram, maize, groundnut, jowar and bajra.

Sampling framework

A Multi-Stage sampling technique was used to select study sites and households. In the first step, two districts, namely Jhansi and Jalaun, were chosen from 13 districts in the Bundelkhand region. Next each of the five sub-divisions (i.e., Tehsils) in each district were selected. In the third step, one Development Block was selected purposively from each Tehsil. In the fourth step, one village from each selected block was chosen randomly. Finally, 20 households from each village were selected randomly. The result was the selection of 2 Districts, 10 Tehsils, 10 Developmental Blocks, 10 Villages and 200 farm households. Household farm holdings comprised marginal (<1.0 hectare, ha), small (1-2 ha), semi-medium (2-4 ha), medium (4-10 ha) and large (>10 ha) farms. The farmers selected comprised 20% of households from each of these farm size categories in the selected villages. A well-structured and pre-tested schedule was used to collect information about the selected farmers’ perception of climate change and variability during the past five years and the choice of adaptation strategy. The survey was undertaken during May-June 2017 soon after harvesting of the winter crop to elicit information on climate-related variables and agricultural extension services. The survey data related to the agricultural year 2016-17 (July-June).

Estimation method

The indicator-based approach is used in a specific set or combination of indicators (proxy indicators) and measures the vulnerability by computing indices, average or weighted averages for those selected variables or indicators. The suitability of this approach is that it can be applied any scale, such as household, district and at country level (Singh and Alka, 2019). The present study has adopted the IPCC-vulnerability approach. Therefore, selected rationale indicators are grouped into three groups’ viz., exposure, sensitivity and adaptive capacity of the farmers. The indicators were normalised so as to use a single scale based on their functional relationship with vulnerability: Eq. (1) was used for a positive relationship with vulnerability and Eq. (2) was used for a negative relationship with vulnerability (Pandey and Jha, 2012):

\[
\text{Index}_{sv} = \frac{S_v - S_{\text{min}}}{S_{\text{max}} - S_{\text{min}}} \quad \text{......... (1)}
\]

\[
\text{Index}_{sv} = \frac{S_{\text{max}} - S_v}{S_{\text{max}} - S_{\text{min}}} \quad \text{......... (2)}
\]

Where, \( S_v \) is the raw value of the indicator at household level and \( S_{\text{min}} \) and \( S_{\text{max}} \) are the minimum and maximum values of the indicator across all households. In this way the indicators were normalized on a scale of zero to one.
The present study uses the normalized values of farmers’ perception of climate change as proxy indicators to calculate an exposure index, normalized socioeconomic indicators to develop a sensitivity index and normalized adaptation strategy indicators to develop an adaptive capacity index (Table 1, 2 and 3) using Eq. (3, 4 and 5) as follows.

Exposure index (EI) = \( \frac{R + S + D + W}{4} \)  \hspace{1cm} (3)

Sensitivity index (SI) = \( \frac{F + DW + FAC + Ir + DH + H + T + PH + BPL}{9} \)  \hspace{1cm} (4)

Adaptive capacity index (EI) = \( \frac{FHH + Lt + NFA + BL + CPR + KKC + JF}{7} \)  \hspace{1cm} (5)

Once the values for the exposure, sensitivity and adaptive capacity for a district level were calculated, the three contributing factors were combined using the following equation adopted from Hahn et al., (2009) to obtain the district-level livelihood vulnerability index (LVI).

\[ \text{LVI}_d = (\text{Ed} - \text{Ad}) \times \text{Sd} \]  \hspace{1cm} (6)

Where, \( \text{LVI}_d \) is the livelihood vulnerability index score for the district \( d \) (obtained using the IPCC vulnerability framework, 2007), \( E_d \) is the calculated exposure score for the district \( d \), \( A_d \) is the adaptive capacity score for the district \( d \) and \( S_d \) is the sensitivity score for the district \( d \). The CVI based on the results obtained from the vulnerability index score, \( i.e., -1 \) (least vulnerable) to \(-1 \) (most vulnerable).

**Results and Discussion**

**Exposure index (EI)**

It is observed that more than 90% of the farmers experienced climate-induced events, \( \text{viz.} \), the summer season becomes more-hotter, increase in frequencies of drought events and the decline in the water table (Table 1). Further, more than 70% in the Jalaun district and 50% in Jhansi district, farmers perceived that rainfall has declined. In totality, it was observed that climatic factors are exposing to the farmers’ livelihood.

**Sensitivity index (SI)**

The calculated sensitivity indices for Jhansi and Jalaun districts have confirmed that farmers in the Bundelkhand region are highly sensitive and potentially vulnerable to climate change (Table 2). Drinking untreated water is not only increases the degree of sensitivity to climate change but also increases medical expenditure. Further, the extra burden of medical expenses also reduces the degree of adaptive capacity of the farmers. Similarly, in the absence of improved-hybrid sanitation, housing and cooking facilities in the premises, added layer of sensitivity in the system.

**Adaptive capacity index (SI)**

The calculated adaptive capacity indices for Jalaun districts show that the burden of loan (index scores, 0.27), less crop diversification (0.20), less engaged in non-farm activities (0.40) and less population living in the joint families (0.34)
### Table 3: District wise indicators and indices for adaptive capacity index.

| Sensitivity indicators                                      | Jalaun District | Jhansi District |
|-------------------------------------------------------------|-----------------|-----------------|
| Percentage of female-headed households (FHH)                | 0.16            | 0.10            |
| Percentage of head of household does not attained school (Lt)| 0.34            | 0.25            |
| Percentage of households engaged in non-farm activities (NFA)| 0.40            | 0.43            |
| Average number of households who have burden of loan (BL)   | 0.24            | 0.29            |
| Percentage of households changed their cropping pattern (CPR)| 0.20            | 0.74            |
| Percentage of households call kisan call centre (KKC)       | 0.38            | 0.34            |
| Percentage of households live as a joint family (JF)        | 0.34            | 0.50            |
| Adaptive capacity index                                    | 0.29            | 0.38            |

### Table 4: District wise exposure, sensitivity, adaptive capacity and livelihood vulnerability indices.

| Sensitivity indicators                                      | Jalaun District | Jhansi District |
|-------------------------------------------------------------|-----------------|-----------------|
| Exposure index                                              | 0.88            | 0.86            |
| Sensitivity index                                            | 0.48            | 0.46            |
| Adaptive capacity index                                     | 0.29            | 0.38            |
| Livelihood vulnerability index                               | 0.28            | 0.22            |

Jalaun district has the least adaptive capacity to tackle climate-related exposure and to secure livelihoods of the population (Table 3).

### Livelihood Vulnerability Index (LVI)

The calculated indices show that the degree of exposure is much higher in both surveyed districts, i.e., 0.88 and 0.86 (Table 4). Sensitivity indices show that surveyed households are equally sensitive, whereas adaptive capacity indices show that surveyed households have a lower adaptive capacity compared with exposure and sensitivity indices. Further, Table 4 clearly shows that Jalaun (least developed) district has a higher livelihood vulnerability compared to Jhansi (developed) district. Three major reasons were identified that were responsible for the higher degree of livelihood vulnerability. First, a district with the highest adaptive capacity also has the most exposed to climate variability. Second, the Jalaun district deemed to be most vulnerable to sensitivity in extreme events (drought and heat waves) and climate variability does not always overlap with the most vulnerable population. Third, the present study confirms that the degree of livelihood vulnerability varies from district to district and community to community. This suggests that households with less exposure and sensitivity to climate risks are unlikely to invest in risk reduction strategies, while households with relatively highly exposed and sensitivity are more likely to respond to this exposure and sensitivities through options available for them.

### CONCLUSION AND POLICY PRESCRIPTION

The study has attempted to investigate the nature and magnitude of livelihood vulnerability in the Bundelkhand region. Farmers are extremely exposed and sensitive to climate change. The decline in land size, water table and rainfall added a layer of vulnerability. The least basic amenities, income source and literacy rate are the main barriers and responsible for a lower adaptive capacity of the surveyed households in the Jalaun and Jhansi districts. There is an urgent need for climate policy intervention in the region. Based on the present study’s findings, the following policy interventions are prescribed: (i) the water table continuously declining and this creating water crisis, even in the rainy season. Therefore, there is an immediate policy intervention that is required to conserve water-bodies using a community participation model; (ii) lower farm productivity also has a main barrier in the path of sustainable and secure livelihoods, where agriculture has an only source of income. Therefore, it is recommended that less water consuming and early maturing varieties are prescribed to the farmers to increase farm productivity with the least input cost, (iii) it was found that the majority of the surveyed households have relied on forest resources for cooking, for the collection of wood for cooking. It takes a lot of time and resources. By tapping solar energy for cooking, these resources can be mobilized to secure livelihoods and (iv) it was also found that the least basic amenities are major contributing indicators for livelihood vulnerability in the region. Therefore, by using community participation model, community toilets would be constructed.

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