An assessment of farm households' vulnerability to climate change in Samastipur, Bihar

Abstract:

Climate change is a serious threat to the agrarian economy of Bihar due to persistent droughts, floods, irregular rainfall, *etc*. The present study was conducted during 2023–24 in Samastipur district of Bihar to anlyze the socio-economic vulnerability of farm households. In Samastipur two blocks were selected randomly and in each blocks, clusters of village were also selcted randomly and from each clusters and 20-20 respondents were selected purposively from all three category of farmers i.e. cropping only, cropping + livestock and cropping + livestock, total 120 farm housholds were selected. For socio-economics status frequency and percentage method was used. For socio-economic vulnerability index IPCC approach used. Findings indicated that majority of farmers belongs to middle age group, medium family income and marginal land holding size. Most of the farmes (66.67%) belong to moderate vulnerability group (0.147-0.345) followed by low (<0.147) and high (>0.345) vulnerability group that is 16.67% and 16.67% respectively. The study suggested focused policy efforts to improve the current socio-economic status of farm households by understanding the importance of closely associated variables affecting the degree of vulnerability to cope with climate change.

Introduction:

Global climate changes are posing unique challenges and become a researchable issue to be present day agriculture. Climate constitutes complex inter-related factors such as cloudiness, evaporation, temperature, rainfall, wind speed and sun shine, etc. which play a vital role. Change in one factor that triggers changes in other factors.

Indian regions are characterized with a high populace mainly dependent on livelihoods sensitive to climate variations and witness to frequent fluctuations in agricultural production and income (Bizikova *et al.,* 2013; Brown *et al*., 2007). High dependence on climate-sensitive sectors, limited infrastructure, volatile markets, poor socio-economic and low biophysical status of the habitat makes the rural poor most vulnerable to climate change (Banerjee, 2014; Safriel and Adeel, 2005; Singh *et al*., 2017). Climate change is considered one of the most important

challenges for Bihar. Bihar is an agricultural sector occupies a prominent place in the structural changes of the economy with a significant contribution to the state's income and rural employment. Bihar, located in the country's most fertile northern plains, is blessed with some of the finest fertile alluvial soils deposited by the mighty river Ganga and its tributaries. This makes it a state with huge potential and can make India a food-secure nation. The eastern state's weather also supports a diverse variety of crops. And maybe this is the reason why agriculture has become Bihar's economic backbone for the past several decades. The sector engages 77 per cent of the state's workforce and contributes to around 24.8 per cent of the state domestic product (SDP).

Methodology:

The present study was conducted during 2023–24 in Samastipur district of Bihar to anlyze the socio-economic vulnerability in 120 purposively selected farm households. For socio-economics status frequency and percentage method was used. For socio-economic vulnerability index IPCC approach used.

Analytical Framework

Suitable statistical tools will be applied in order to get meaningful results. IPCC Vulnerability Framework will be used for development of Socio-economic Vulnerability Index (SeVI) at farm household level.

Detailed Computation Process for SeVI

a) Data ranges and scales used will be different among the indicators and in order to compare and perform arithmetical operations on them, they will be normalized (Go´mezLimo´n and Sanchez-Fernandez, 2010) during their integration into aggregate vulnerability index within a dimensionless range (0–1).

b) Normalization of all the indicators and then averaging these resultant normalized values.

$$\boldsymbol{Zi} = (\boldsymbol{Xi} - \boldsymbol{Xmin}) \div (\boldsymbol{Xmax} - \boldsymbol{Xm\ in})$$ (When the indicator is positively related to the index)

$$\boldsymbol{Zi} = (\boldsymbol{Xmax} - \boldsymbol{Xi}) \div (\boldsymbol{Xmax} - \boldsymbol{Xmin})$$ (When the indicator is negatively related to the index)

where,

Z_i is the normalized value of w.r.t. the indicator X

X_i is the value of indicator in original units

X_{min} is the minimum value of the indicator in original units

X_{max} is the maximum value of the indicator in original units (unless specified on a priori basis)

c) Three indices for sensitivity, exposure and adaptive capacity will be constructed by

obtaining aweighted mean of the indicators identified.

d) These three indices will be averaged to obtain the SeVI for regional as well as household level

e) Exposure, sensitivity and adaptive capacity indices will be calculated separately by using theirrespective indicators along with their respective calculated weights to the indicators Principal Component analysis (PCA) used.

f) Exposure, sensitivity and adaptive capacity indices will be calculated separately by using theirrespective indicators along with their respective calculated weights.

$$SeVI = (Exposure + Sensitivity) - Adaptive\ Capacity$$

Indicators selection:

List 1 : Exposure Indicators

Sl. No.	Exposure Indicators	Relationship with component
1.	Trend in *kharif* rainfall (Coefficient of trend)	+
2.	Trend in *rabi* rainfall (Coefficient of trend)	+
3.	Trend in *summer* rainfall (Coefficient of trend)	+
4.	Trend in *kharif* temperature (Coefficient of trend)	+
5.	Trend in *rabi* temperature (Coefficient of trend)	+
6.	Trend in *summer* temperature (Coefficient of trend)	+
7.	Trend in *kharif* relative humidity (Coefficient of trend)	+
8.	Trend in *rabi* relative humidity (Coefficient of trend)	+
9.	Trend in *summer* relative humidity (Coefficient of trend)	+
10.	Nearest possible water resource (KM.)	+
11.	Inclusion of village in drought/flood declared areas (1-Yes / 0-No)	+
12.	No. of drought/flood in last 10 years (Number)	+

Note: Selection of the variables: 1-9: Ahsan *et al*. (2010); Sendhil *et al*. (2015); Sendhil *et al*. (2016); Sendhil *et al*. (2018); Ayanlade (2018); Balaganesh *et al*. (2020), 10-12: Authors inclusion based on expert opinion.

List 2 : Sensitivity Indicators

Sl. No.	Sensitivity Indicators	Relationship with component
1.	Household type (Kutcha=1; Semi Pucca=2; Pucca=3)	-
2.	Depending on natural resources (1-Yes / 0-No)	+
3.	Total consumption expenditure on food (Rupees/month)	+
4.	Easy access to electricity (1-Yes / 0-No)	-
5.	Family members with chronic illness (Number)	+
6.	Nature of roads (Paved=1/Not paved=0)	-
7.	Loss of family member due to drought/flood(Number)	+
8.	Loss of livestock due to drought/flood (Number)	+
9.	Total operational holdings (acre)	+
10.	Family size (Number)	+
11.	Easy access to the drinking water resources (Yes/No)	+

Note: Selection of the variables: 1-9: Ahsan *et al*. (2010); Sendhil *et al*. (2015); Sendhil *et al*. (2016); Sendhil *et al*. (2018); Ayanlade (2018); Balaganesh *et al*. (2020), 10-11: Authors inclusion based on expert opinion.

List 3: **Adaptive Capacity Indicators**

Sl. No.	Adaptive Capacity Indicators	Relationship with component
1.	Sources of climate variability related information (Frequency)	+
2.	Easy access to credit (1-Yes / 0-No)	+

3.	Enjoying group credit facility (1-Yes / 0-No)	+
4.	Applied for any gov. crop insurance scheme (1-Yes / 0-No)	+
5.	Average farm size (acre)	+
6.	Average herd size (acre)	+
7.	Total milk production in (lit/month)	+
8.	Yearly gross income (Rupees)	+
9.	Farming experience (No. of years)	+
10.	Trainings attended (Number)	+
11.	Social participation (1-Yes / 0-No)	+
12.	Educational level of the household head (Illiterate=0; Read and write=1; Primary=2; Middle=3; High School=4; Higher Secondary=5; Graduate and above=6)	+

Note: Selection of the variables: 1-9: Ahsan *et al*. (2010); Sendhil *et al*. (2015); Sendhil *et al*. (2016); Sendhil *et al*. (2018); Ayanlade (2018); Balaganesh *et al*. (2020), 10-12: Authors inclusion based on expert opinion.

Result and Discussion:

The table.1 presents data on the distribution of individuals across different age groups. In the "Young" age group, which includes individuals aged 35 and below, there are 28 individuals, accounting for 23.33% of the total population. The "Middle" age group, covering ages 36 to 50, has the highest frequency with 85 individuals, making up 70.83% of the total. Finally, the "Old" age group, consisting of individuals above 50 years, has only 7 individuals, representing just 5.83% of the total. This distribution shows a clear concentration of individuals in the middle-aged category, with a smaller proportion in both the younger and older categories.

Table.1. Distribution of respondents on the basis of age

Age Group	Frequency	Percentage
Young upto 35	28	23.33

Middle (36-50)	85	70.83
Old (Above 50)	7	5.83

The table.2 shows the gender distribution of a given population. The "Male" group has 106 individuals, comprising 88.33% of the total, while the "Female" group consists of 14 individuals, accounting for 11.67% of the total. This indicates a significant majority of males in the population, with females representing a much smaller proportion.

Table.2. Distribution of respondents on the basis of gender

Gender Group	Frequency	Percentage
Male	106	88.33
Female	14	11.67

The table.3 presents the marital status distribution of the population. Among the individuals surveyed, 113 are married, making up 94.17% of the total, while 7 individuals are unmarried, representing 5.83%. This shows a dominant trend of married individuals, with a small proportion of unmarried individuals in the population.

Table.3. Distribution of respondents on the basis of marital status

Marital Status	Frequency	Percentage
Married	113	94.17
Unmarried	7	5.83

The table.4 provides the caste category distribution within the population. The "General" category includes 16 individuals, accounting for 13.33% of the total. The "Other Backward Classes" category has the highest frequency with 57 individuals, representing 47.50% of the population. The "Extremely Backward Class" category follows closely with 37 individuals, comprising 30.83% of the total. Lastly, the "Scheduled Castes/Scheduled Tribes" category

consists of 10 individuals, making up 8.33% of the population. This distribution shows a significant concentration in the Other Backward Classes and Extremely Backward Class categories, with smaller proportions in the General and Scheduled Castes/Scheduled Tribes categories.

Table.4. Distribution of respondents on the basis of caste

Caste Category	Frequency	Percentage
General	16	13.33
Other backward classes	57	47.50
Extremely Backward Class	37	30.83
Scheduled castes/ scheduled tribes	10	8.33

The table.5 outlines the educational attainment levels of the population. Among the individuals surveyed, 4 are illiterate, representing 3.33% of the total. The "Functionally Literate" category includes 7 individuals, or 5.83%. A significant portion of the population has completed middle school, with 23 individuals, making up 19.17%. The "Secondary School" category includes 25 individuals, accounting for 20.83%. In the "Higher Secondary" category, there are 34 individuals, which represents 28.83% of the total. Only 6 individuals, or 5.00%, have completed "Graduate and Above" education, indicating a relatively low proportion with higher education. The "Primay Education" category includes 21 individuals, making up 17.50% of the population. This distribution shows that the majority of individuals have attained education up to the Higher secondary levels.

Table.5. Distribution of respondents on the basis of education

Education	Frequency	Percentage
Illiterate	4	3.33
Functionally literate	7	5.83

Primary Education	21	17.50
Middle school	23	19.17
Secondary school	25	20.83
Higher Secondary	34	28.33
Graduate and Above	6	5.00

The table.6 shows the distribution of individuals based on their landholding sizes. A majority, 93 individuals or 77.50% of the population, are classified as "Marginal Farmers" with land holdings of up to 2.5 acres. The "Small Farmers" category, which includes those with land holdings between 2.51 and 5 acres, consists of 22 individuals, representing 18.33% of the total. Only 5 individuals, or 4.17%, are classified as "Medium Farmers" with land holdings between 5.01 and 10 acres. Interestingly, there are no "Large Farmers" with land holdings greater than 10.01 acres, as indicated by the 0% in that category. This distribution highlights a predominance of marginal farmers, with very few individuals holding medium-sized land parcels and no one possessing large land holdings.

Table.6. Distribution of respondents on the basis of land holding

Land Holding	Frequency	Percentage
Marginal farmers (Up to 2.5 acres)	93	77.50
Small farmers (2.51 to 5 acres)	22	18.33
Medium farmers (5.01 to 10 acres)	5	4.17
Large farmers (> 10.01 acres)	0	0.00

The table.7 shows the distribution of family sizes within the population. The majority of individuals, 76 or 63.33%, belong to small families with up to 4 members. The "Medium Family Size" category, which includes families with 5 to 6 members, consists of 27 individuals, making up 22.50% of the total. The "Large Family Size" category, with families of 7 or more members,

includes 17 individuals, representing 14.17%. This indicates that most families are small, while a smaller proportion falls into the medium and large family categories.

Table.7. Distribution of respondents on the basis of family size

Family Size	Frequency	Percentage
Small family size (up to 4 members)	76	63.33
Medium family size (5 to 6 members)	27	22.50
Large family size (7 and above)	17	14.17

The table.8 presents the distribution of annual income among individuals. A significant majority, 85 individuals or 70.83%, fall into the "Medium" income category, earning between 88,663 and 109,721. The "High" income category, for those earning above 109,722, consists of 12 individuals, making up 10.00% of the total. Meanwhile, 23 individuals, or 19.17%, fall into the "Low" income category, earning up to 88,662. This shows that most individuals have a medium farm income, with fewer people in the low and high-income brackets.

Table.8. Distribution of respondents on the basis of annual income

Farm Income	Frequency	Percentage
Low (up to 88,662)	23	19.17
Medium (88,663 - 109,721)	85	70.83
High (above 109,722)	12	10.00

The table.9 categorizes individuals based on their vulnerability levels. The majority, 80 individuals or 66.67%, fall into the "Moderate" vulnerability group, with scores between 0.147 and 0.345. The "Low" vulnerability group, with scores below 0.147, includes 20 individuals, representing 16.67% of the population. Meanwhile, 20 individuals, or 16.67%, belong to the "High" vulnerability group, with scores greater than 0.345. The mean vulnerability score is

0.246, with a standard deviation of 0.098, indicating that most individuals have moderate vulnerability, with fewer in the low and high categories.

Table.9. Distribution of respondents on the basis of vulnerability

Vulnerability Group	Frequency	Percentage
Low (<0.147)	20	16.67
Moderate (0.147-0.345)	80	66.67
High (>0.345)	20	16.67
Mean = 0.246	**SD = 0.098**	

Conclusion:

The agrarian economy of Bihar is under threat from climate change, characterized by frequent droughts, floods, and inconsistent rainfall. Socio-economic status was analyzed using frequency and percentage methods, while vulnerability was measured using the IPCC framework. Results showed that most farmers of farmers belongs to middle age group, medium family income and marginal land holding size. Most of the farmes (66.67%) belong to moderate vulnerability group (0.147-0.345) followed by low (<0.147) and high (>0.345) vulnerability group that is 16.67% and 16.67% respectively. The study suggested focused policy efforts to improve the current socio-economic status of farm households by understanding the importance of closely associated variables affecting the degree of vulnerability to cope with climate change.

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