



Research Article

ECONOMIC IMPACT ASSESSMENT OF CLIMATE CHANGE ON RAINFED AGRICULTURE AND FOOD SECURITY IN CENTRAL INDIA

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Abstract- Climate change is one of the most formidable development challenges faced by humanity today; its consequences are global and intergenerational. Vulnerability to climate change and natural disasters has a strong linkage with poverty and has the potential to create multiple stresses over any regional growth trajectory. There is need to mitigate these adverse effects of climate change through the adoption of sustainable land management practices such as zero tillage appropriate use of fertilizers, improved water management. Adverse climate effects which are most negative threaten crop productivity, hence the need to adopt measures that are sustainable and emit less GHGs in crop production enterprise and policy provisions strengthened to address the challenges. In this backdrop the present paper attempts (I) To evaluate the impact of drought on the yield of crops. (II) To identify the extent of awareness and assess coping mechanism followed by the farmers to climate change. (III) To identify the factors influencing in decision making on the coping mechanism to mitigate the impact of climate change.

Keywords- Climate change, Natural disasters, Policy provisions, Coping mechanisms.

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Introduction

Based on both primary and secondary data attempts to assess the impact of drought on the productivity of principal crops in rainfed situation along with farmer's perception and factors influencing adoption of the coping mechanism to mitigate impact of climate change in Central India. The study results revealed that climate sensitivity of rainfed agriculture is increasingly magnified and weakening agricultural productivity over time. Rainfed farmers were highly vulnerable to climate change and adopted coping mechanisms viz., shifting cropping pattern, mix/intercropping drought tolerant crops, technological mitigation, integrated farming system etc. Climate change is a global problem hence it should be addressed by all countries with a shared perspective free from narrow and myopic consideration. Thus study suggests efficient management of natural resources in rainfed areas to overcome the effects of climate changes. To overcome the loss of yield due to climate weather information by meteorological department must disseminate well in advance so that farmers adopt suitable coping mechanisms to overcome the problems of climate change on crop yield.

Materials and Methods

Damoh district of Madhya Pradesh was selected purposively to examine the impact of climate change. A multistage random sampling design was employed for the selection of the sample respondents [1]. Five villages namely Sitanagar, Athai, Barpati, Aamchopra and Imlai were selected from Damoh block and 100 farmers were selected randomly. These selected farmers were further categorized into 3 groups based on their farm size viz. small (Up to 2 ha.) medium (2.01 to 4 ha.) and large (above 4 ha.). The required information to fulfill stated objectives were collected by survey method using pre-tested interview schedule and personal interview of the respondents. The data pertains to the agricultural year 2013-14.

Time series secondary data on area, production and yield of major crops, rainfall from 2003-04 to 2013-14 were obtained from District Agricultural Statistics, Damoh. Compound growth rate, coefficient of variation, average, percentage and logit model were employed to analyze the factors influencing the adoption of coping mechanism among sample farmers.

Results and Discussion

Impact of climate change of Agriculture

The impact of climate change on agriculture will be severally felt in India. It has been projected that under the scenario of a 2.5°C to 4.9°C temperature rise, rice yields will drop by 32 to 40% and wheat yields by 41-52%. This would cause GDP to fall by 1.8 to 3.4%.

Growth and Instability in Rainfed crops

Table-1 Growth and instability in production, area and yields of major rainfed crops in Damoh district (M.P.)

S. No	Crop	Compound Growth Rate (%)			Yield Instability Index (%)
		Area	Production	Yield	
1.	Paddy	0.434***	8.002*	19.411***	53.145
2.	Jowar	-19.604***	-17.688***	2.380***	14.353
3.	Black gram	5.092***	7.312	2.116***	36.569
4.	Soybean	11.440***	11.911	0.423	41.850
5.	Sesame	-1.962***	-1.227**	0.753***	22.685
6.	Green gram	1.604	4.942	3.056***	31.376
7.	Wheat	3.564***	20.771*	16.615***	50.019
8.	Chickpea	-1.884***	-1.555***	0.335**	26.995

9	Pea	10.452***	9.515	-0.849	20.696
10	Red gram	30.187	33.710	2.706***	38.968
11	Mustard	1.935	3.042**	1.084***	13.656
12	Linseed	-19.990	-21.464	-1.833*	20.464

***Significant at 1% level, ** Significant at 5%, * Significant at 10% level

Drought and its impact on crops yield

Table-2 Impact of drought on crop yield in Damoh District (Kg./ha.)

S.No.	Crop	Average yield	Yield in drought years	Total yield loss	Percent loss of normal yield
1.	Paddy	1028	418	610	146
2.	Jowar	761	620	141	23
3.	Urd	448	325	123	38
4.	Soybean	935	394	541	137
5.	Til	304	237	67	28
6.	Green gram	376	313	63	20
7.	Wheat	2675	1236	1439	116
8.	Chickpea	969	535	434	81
9.	Pea	736	471	265	56
10.	Redgram	791	595	196	33
11.	Mustard	542	402	140	35
12.	Linseed	550	344	206	60

*Average of 2004 to 2014

In Damoh district out of 11 years (2003-04 to 2013-14) there were four drought years which occurred during the year 2004-05, 2006-07, 2007-08 and 2012-13. The major effect of the drought reflected in the crop yield due to inadequate, poor and erratic distributed rainfall. In selected crops, yield reduction was very high in the range of 20% in Chickpea to 146 % in Rice since it is a sensitive crop to drought. Moderate deviation in rainfall resulted high reduction in the crop yields in Damoh district of Madhya Pradesh. Climatic variation such as occurrence of drought has high level of impact on the yield of rainfed crops.

Farmer's Perception

The farmer's perception on the impact of climate change on the crops grown in rainfed condition such as yield reduction (80%) and reduction in net revenue (86%) over the years. About 65% and 69% of the sample respondents reported heavy pest and disease outbreak and degradation of land (58 to 73%) for cultivation respectively. Fast evaporation of soil moisture was expressed by two third respondents while 79% expressed change in climatic and precipitation pattern. The results indicated that sample respondent have satisfactory level of perception on the climate change.

Table-3 Farmers perception on the impact of climate change (In Per cent)

Factors	Size Group			Overall N=100
	Small N=48	Medium N=30	Large N=22	
1. Reduction in farm income	96	83	78	86
2. Reduction in crop yield	92	77	71	80
3. Crop failure	98	90	68	85
4. Outbreak of pest & disease	69	67	65	67
5. Poor & erratic rainfall	99	92	89	93
6. Degradation and unsuitability of land for cultivation	73	67	58	66
7. Change in climatic & rainfall pattern	83	80	74	79
8. Evaporation of soil moisture	78	64	42	66

More than 80% of sample respondents reported reduction in rainfall and its impact on crop yield rate and net farm income have positive relationship followed by pests and diseases (67%) and changes in temperature and seasonal pattern. About two-third (66%) of the respondents expressed that soil lost its vigour due to erosion and lack of organic manures factors. Results inferred that farmers have

knowledge regarding continuously occurring of yield loss and also know the reasons for yield reduction.

Coping mechanisms

Table-4 Coping mechanism adopted by respondents to mitigate the impact of Climate change (In percent)

Coping mechanism	Size Group			Overall N=100
	Small (N=48)	Medium (N=30)	Large (N=22)	
1. Change in cropping pattern	58	42	24	41
2. Mixed/Intercropping	92	76	54	74
3. Drought resistant crops	24	48	21	31
4. Crop insurance	4	16	14	11
5. Integrated/Mixed farming system	88	70	46	68
6. Reduced consumption expenditure	46	38	06	30
7. Selling of land & livestock	24	7	3	10
8. Borrowing	80	52	16	49
9. Shifting the profession	66	44	20	43

To mitigate the impact of climate change the farmers in the district have to adopt strategies to sustain their life.

About three-fourth (74%) of the sample respondents was adopted mixed/intercropping followed by integrated/mixed farming system change in cropping pattern to the extent of 68%. About 43% of sample farmers have adopted change in profession followed by reduction in consumption expenditure borrowing (30%) and about one-tenth of the respondents adopted crop insurance as a coping mechanisms [3].

Factors determining the adoption of coping mechanism

The logit regression was performed to identify the factors that influenced the awareness of farmers about climate change.

Size of holding (X_1), education (X_6), experience (X_8) net farm income (X_3), net worth (X_7) contact with extension personals (X_9) and social participation (X_{10}) were the significant factors influencing the adoption of coping mechanisms for the impact of climate change.

Table-5 Factors influencing adoption of coping mechanisms

Variables	Size Group			Overall
	Small	Medium	Large	
Regression coefficient (b)				
Size of holding (X_1)	0.02	-0.19	-0.39	-0.28**
Family size(X_2)	-0.04	-0.09	0.07	-0.07
Farm income(X_3)	0.14	0.18	0.09	0.12***
Household age(X_4)	-0.30	-0.25	0.17	-0.26
Gender(X_5)	0.16	0.08	0.13	0.14
Education(X_6)	0.06	0.10	0.12	0.09***
Net worth(X_7)	0.11	0.17**	0.23*	0.15*
Farming experience(X_8)	0.17**	0.28***	0.12***	0.19***
Contact with extension personals(X_9)	0.11	0.16	0.15	0.13
Social participation(X_{10})	0.05	0.07	0.10	0.08**

***Significant at 1% probability level **Significant at 5% level *Significant at 10% probability level

Factors such as age, family size, gender does not have significant impact on the adoption of coping mechanisms for climate change.

Policy Implication

The results of the study indicate that capacity of M.P. state to cope with climate is severely limited due to facing resource constraints. To overcome the loss of yield due to climate the meteorological department must disseminate weather information to farmer well in advance through weather station located in different parts of the state.

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Author Contributions

All authors contributed equally to the work. P.K. Awasthi designed experiments and wrote the manuscript, Apoorwa Tomar collected and analyzed data and N.K. Raghuwanshi gave technical support and conceptual advice. All authors discussed the results and implications and commented on the manuscript at all stages.

Abbreviations

ha. = hectare, c= Celsius, GDP= Gross Domestic Product, N= Numbers, M.P.= Madhya Pradesh

Conflict of Interest: None declared

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