

International Journal of Agriculture Extension and Social Development

Volume 8; Issue 6; June 2025; Page No. 120-125

Received: 29-03-2025
Accepted: 03-05-2025

Indexed Journal
Peer Reviewed Journal

Impact of climate change on yield, income and mental health of farmers of Jabalpur district of Madhya Pradesh

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DOI: <https://www.doi.org/10.33545/26180723.2025.v8.i6b.2002>

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Abstract

Climate change, referring to long-term alterations in temperature, precipitation, wind patterns, and other elements of the Earth's climate system is an escalating global issue, particularly impacting agriculture-dependent countries like India. India, being the largest producer and consumer of pulses, has witnessed significant fluctuations in the production and area of lentil crops, largely due to climate anomalies. This study investigates the impact of climate variability, particularly changes in temperature and rainfall, on yield and the income of lentil growers, and its impact on their mental health. The present research was conducted using ex-post facto design, field observations and informal interviews with the lentil growers of the block Panagar of Jabalpur district, Madhya Pradesh. Findings reveals significant alterations in cropping sequences, reduced land area under lentil cultivation, and a corresponding decline in yield and farmer income due to the frequent weather fluctuation, leading to distress situation for the farmers in last few years, ultimately impacting their mental health. The study emphasizes the urgent need for adaptive strategies, enhanced awareness, and policy interventions to mitigate these effects and ensure sustainable lentil production. Further, more research on crop lentil is advised in the study area.

Keywords: Climate change, lentil, Yield and Income, Mental Health and Madhya Pradesh.

Introduction

Climate change has emerged as one of the most pressing global challenges, significantly impacting agriculture, livelihoods, and human well-being, particularly in developing countries like India. In agriculture-centric economies such as India, these climatic shifts have pronounced effects on food production and rural livelihoods. In addition to existing challenges, the impacts of climate change are making smallholder farmers and their agricultural systems more vulnerable ^[1, 2]. While smallholder farmers are struggling to adapt their agricultural systems to climate change impacts, their health is also impacted by climate change. Rising temperatures, erratic rainfall patterns, shifting seasons, and increased frequency of extreme weather events have intensified the vulnerability of rainfed crops such as lentil (*Lens culinaris*), which holds significant nutritional, economic, and agronomic value ^[3,4]. In India, lentil is an important rabi pulse crop, contributing substantially to food security, soil fertility, and farmers' income, especially in the central and eastern regions ^[5].

Among pulses, lentils are vital due to their nutritional value and economic role. India, being the largest producer and consumer of pulses, has witnessed significant fluctuations in the production and area of lentil crops, largely due to climate anomalies. Madhya Pradesh, known as the "Pulse Bowl of India," accounts for a substantial share of the country's lentil production ^[6]. The Jabalpur district, in

particular, is a major lentil-producing area where small and marginal farmers predominantly depend on rainfed agriculture. However, recent years have witnessed fluctuating yields, income instability, and increasing reports of farmer distress, partly attributed to climate-induced risks such as untimely rainfall, heat stress, and drought episodes ^[7,8] (Table 1).

Table 1: Area, Production and Productivity of Crop Lentil from 2013-2023 in Jabalpur District of Madhya Pradesh

Year	Area (Hectare)	Production (Tonnes)	Yield (Tonne/Hectare)
2013 - 2014	23,134.00	16,723.00	0.72
2014 - 2015	22,000.00	18,000.00	0.82
2015 - 2016	20,000.00	25,000.00	1.25
2016 - 2017	22,000.00	29,000.00	1.32
2017 - 2018	23,980.00	36,280.00	1.51
2018 - 2019	6,810.00	6,647.00	0.98
2019 - 2020	5,075.00	4,892.00	0.96
2020 - 2021	5,401.00	6,805.00	1.26
2021 - 2022	4,882.00	9,974.00	2.04
2022 - 2023	4,600.00	7,558.00	1.64

Source: Directorate of Economics and Statistics ^[9]

While several studies have explored the biophysical impacts of climate change on crop production, fewer have holistically examined its socio-economic and psychological consequences on farmers ^[10]. Climate-induced yield losses

directly reduce farm income, amplify indebtedness, and expose smallholder farmers to heightened economic uncertainty, often triggering stress, anxiety, and poor mental health outcomes ^[11,12]. Understanding this interconnected impact pathway is critical for designing effective adaptation strategies and policy interventions that safeguard not just agricultural productivity but also farmer livelihoods and well-being.

Against this backdrop, the present study aims to assess the impact of climate change on the yield, income, and mental health of lentil growers in Jabalpur district of Madhya Pradesh. Specifically, it seeks to (i) quantify the extent of climate-related yield variations; (ii) analyze the income implications for lentil farmers; and (iii) evaluate the psychological stress and mental health conditions linked to climate-induced agrarian distress. By integrating biophysical, economic, and psychological dimensions, this research intends to provide a comprehensive understanding of how climate change affects vulnerable farming communities and inform targeted policy responses in the region.

Methodology

The present study was conducted in Panagar block of Jabalpur district (Madhya Pradesh), with the objective of assessing impact of Climate Change on yield, income and mental health of Lentil Growers of Jabalpur District of Madhya Pradesh. Using three-stage sampling for the study, first selection of block on the basis of decrease in area under lentil was done, followed by selection of villages and farmers. Out of the seven block under district Jabalpur, block panagar was chosen as the research area, as this block has witnessed a vast decrease in area under lentil crop in past few years ^[13] (Department of Farmer Welfare and Agriculture Development, Jabalpur). On the basis of larger

area affected under lentil cultivation, 08 villages were selected randomly out of 227 villages of block Panagar. Further, a list of lentil growing farmers of each selected villages was prepared with the help of RAO's, out of which 120 lentil growers were selected by using proportionate random sampling method.

Dependent variables considered for the research were yield, income and mental health, while only two weather parameters viz. rainfall and temperature were included. As, according to Rao (2010), there are seven parameters of climate change, viz., temperature, rainfall, relative humidity, wind speed, sunshine hours, evaporation and number of rainy days. But, among these climatic factors, rainfall and temperature are the major weather variables that influence crop production ^[14, 15]. Therefore, considered only two parameters for the study. Weather data for the study was procured from Metrological Department, JNKVV, Jabalpur (M.P.) for the analysis purpose. Initially, the study was conducted during 2014-16, to access the impact of climate change on area, yield and income of crop lentil. Further, Using a narrative literature review supported by direct interaction and informal interviews with the farmers during 2014-16, 2018-19 and 2019-20 mental and health impacts of climate change on farmers was assessed.

While, qualitative data were collected by personally interviewing the respondents with the help of pre-tested structural schedule and by field observations. Ex-post facto design was used in the investigation, which gives information after occurring of the events. The analysis involved frequency distributions, percentage analysis, t-tests, and relative/absolute changes to determine climate impact, while software SPSS was used for finding the correlation between the dependent and independent variables.

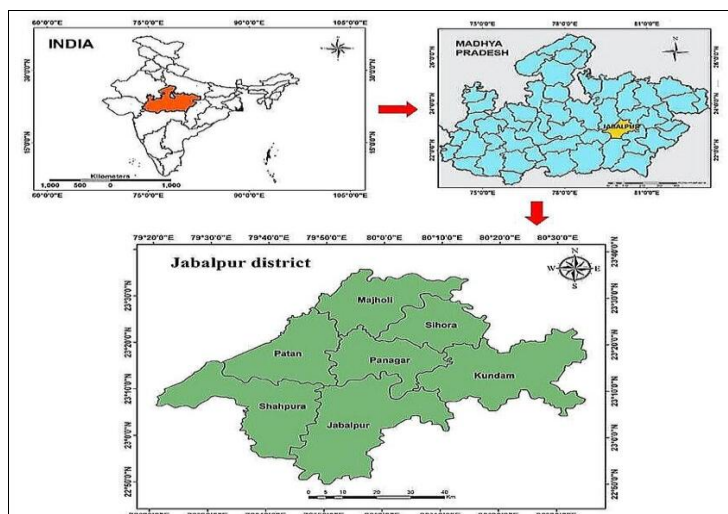


Fig 1: Location of district Jabalpur, Madhya Pradesh, India ^[16]

Results and Discussion

General Profile of farmers

In the present study, it was depicted that, among 120 lentil growers, majority of farmers (50%) were in the middle age group, with more than half having higher education and 52.40% possessing marginal to small landholdings, while a maximum (62.50%) no. of famers having small to medium irrigated landholdings. It was also found that, most farmers had marginal land under lentil cultivation and medium

experience in lentil farming, though over fifty per cent lacked farm power and had few implements, 40% were in the low annual income category, 48% showed low social participation, 60% had low extension participation, 47% demonstrated medium use of information sources. Additionally, more than 50% of farmers had low to medium income, limited farm power, and extension exposure. Also, awareness and knowledge about climate change were moderate. (Table 2)

Table 2: Distribution of respondents according to their General profile

Particular	Categories	No. of respondents	Percentage
Age	Young (up to 35 years)	26	21.65
	Middle (36 to 55 years)	60	50.00
	Old (above 55 years)	34	28.35
Education	Illiterate	03	2.50
	Primary education	23	19.20
	Middle education	31	25.80
	Higher secondary education	34	28.30
	College education	29	24.20
Size of land holding	Marginal land holding (Up to 1 ha.)	28	23.35
	Small land holding (1.1 to 2 ha)	35	29.15
	Medium land holding (2.1 to 4 ha)	45	37.50
	Large land holding (Above 4 ha)	12	10.00
Land Under Irrigation	Marginal land holding (Up to 1 ha.)	34	28.35
	Small land holding (1.1 to 2 ha)	35	29.15
	Medium land holding (2.1 to 4 ha)	40	33.35
	Large land holding (Above 4 ha)	11	9.15
Area Under Lentil	Marginal land holding (Up to 1 ha.)	93	77.50
	Small land holding (1.1 to 2 ha)	15	12.50
	Medium land holding (2.1 to 4 ha)	08	6.67
	Large land holding (Above 4 ha)	04	3.33
Experience of lentil growing	Low (0-20) years	49	40.83
	Medium (21-40) years	59	49.17
	High (41-60) years	12	10.00
Farm Power	No farm power (0 score)	61	50.82
	Low (1-5 score)	6	5.00
	Medium (6-10 score)	43	35.83
	High (11 and above score)	10	8.35
Implements	Low (1-5 score)	66	54.96
	Medium (6-10 score)	38	31.65
	High (score 11 and above)	16	13.39
Annual Income	Up to Rs.24,000	10	8.35
	Low (Rs.24,001 to 1,00,000)	55	45.85
	Medium (Rs.1,00,001 to 2,00,000)	35	29.15
	High (above Rs.2,00,000)	20	16.65
Social Participation	No participation	40	33.63
	Low participation (1 to 5 score)	58	48.37
	Medium participation (6-10 score)	12	10.00
	High participation (11 and above score)	0	0.00
Extension Participation	No participation	22	18.35
	Low participation (1 to 7 score)	72	60.00
	Medium participation (8-14 score)	21	17.55
	High participation (15-21 score)	5	4.10
	Medium (19-30 score)	61	50.82
	High (31-42 score)	38	31.65
Knowledge Level	Low (12 - 23)	33	27.53
	Medium (24 - 35)	62	51.67
	High (36 - 48)	25	20.80

Change in temperature and rainfall

It was observed with the help of secondary data, that there has been increase in both minimum and maximum temperature by 2°C and 0.90°C respectively in district Jabalpur in span of 7 years from 2013- 2020. The present study shows that there was a difference of 5.35 °C between the minimum temperatures as required by lentil crop and the actual average temperature for the years 2014-15 and 2015-16, followed by 3.53 °C between the optimum temperature and negligible change noticed in maximum temperature differed. Thus, it can be concluded that due to the vast difference of 5.35 °C between the minimum temperatures as required by lentil crop and the actual average temperature, there was a greater impact seen on area, adoption, cropping pattern and yield of lentil.

Though, lentil has a tolerance of extreme environmental

conditions such as drought and hot temperatures and can be grown in semi-arid regions without irrigation, but very high temperature and rainfall at flowering and pod set stage, affects its reproductive performance and reduces yield, resulting into shift in area of lentil. Further, lentil is a drought resistant crop, but for good yield, if irrigation available, it requires at branching and pod- filling stage, thus requires approximately 135 mm of water in its whole life [17]. But, heavy rainfall at critical stages like flowering and maturity shows severe impact on lentil yield.

Changing climate is expected to have impact on area, cropping pattern, production and productivity causing decline in yield, directly resulting into increases of prices of the most important crops [18]. In past few years, we have witnessed hike in the price of pulses, which is the result of low and poor yield, due to variation in climate.

Table 3: Ideal weather requirement of lentil crop vs. actual weather

S. No.	Categories	Temperature requirement of lentil crop (°C)	Average temperature of 2014-15 and 2015-16 (°C)	Difference in temperature (°C)
1.	Minimum temperature	18	12.65	-5.35
2.	Maximum temperature	28-30	28.30	Negligible change
3.	Optimum temperature	24	20.47	-3.53

Impact of climate change on Yield and Income of lentil growers

Lentil can be grown on wide range of soil types and soil pH although there is evidence that, in comparison with other Legume crops (e.g. chickpea, fababean and pea) it is more sensitive to water logging and soil pH<6.5^[18]. Though, the soil and condition of block Panager is favourable for lentil crop, but due to adverse change in climate, i.e. continuous increase in maximum temperature and decrease in minimum temperature, along with uneven distribution of rainfall, reduction in yield of lentil was witnessed during the study period. (Table 2), which has directly impacted the area covered under lentil crop,

It was revealed in the research that, there were seven consecutive frost in the year 2014-15, which resulted into low (71.63%) or nil (17.50%) of yield. Along with temperature, uneven distribution of rainfall is also one the reason which has its adverse impact on crop growth. The finding is supported by IPCC (2007), Chapagain *et al.* (2009), Dubey *et al.* (2012), Bhan *et al.* (2014) and Amin *et al.* (2015)^[19, 20, 17, 15, 21]. It was also found that, out of total farmer growing lentil majority (71.6%) of respondent has reduced area under lentil cultivation or has stopped cultivating lentil due to the adverse impact of climate change i.e. occurrence of frost or rainfall at critical periods, followed by (66.6%) farmers shifting area due to low or no yield and due to impact of *Rhizoctonia solani* (35%) and (27.5%) witnessed heavy loss in lentil cultivation. As a resultant of poor yield in the year 2014-15, 54 lentil growers (45.00%), quit growing lentil and shifted to growing rabi vegetables. Therefore, approximately half of the lentil growers, due to adverse impact of climate change on lentil crop shifted their cropping pattern.

Table 4: Distribution of respondents according to Impact of climate change on yield

S. No.	Yield (q)	(2014-15)		(2015-16)	
		f	%	f	%
1.	Nil	21	17.50	05	7.66
2.	Low (1-10)	86	71.63	40	61.53
3.	Medium (11-20)	10	8.32	12	18.18
4.	High (21-30)	3	2.55	09	13.63
	Total	120	100	*66	100
	Yield (q/ha)	2.004		4.59	

***Note:** As the respondents for the year 2014-15 and 2015-16 were same and 54 lentil growers quit lentil growing due to adverse impact of climate change. Therefore, in the year 2015-16, data of yield for only 66 farmers was considered.

Previous studies have revealed that lentil cultivation is highly sensitive to temperature and rainfall variations. Several researchers have identified declining trends in productivity, shifts in cropping calendar, and increased pest incidences linked to climate factors. Notably, Dubey *et al.* (2011) and Dhuppar *et al.* (2012) found yield reductions in

lentils due to temperature rises and erratic rainfall. Other studies highlighted that socio-economic variables such as land holding size, education, and market orientation influence farmers' adaptability^[18, 22].

Thus, from the present study it can be concluded that, in comparison to the standard yield of lentil i.e 18 to 20 q/ha (source: "Agronomy-Rabi Crops"), the average yield in both the years is very low which is the adverse effect of climate change, i.e. sudden decrease or increase in temperature and high rainfall during pod filling or maturity stage. Due to the low yield farmers were not able to fetch good market price for the crop.

Moreover, the income of lentil growers has shown a declining trend. Reduction in yield, poor market prices, increased cost of cultivation, and crop failure due to weather extremes have collectively affected the profitability. About 75% of growers reported a decline in their annual income due to these challenges. Yields declined significantly with temperature anomalies and erratic rainfall, especially during flowering and pod-setting stages.

Impact of climate change on Mental health of the farmers

Smallholder farmers are facing growing challenges as climate change heightens the risks to their agricultural practices and personal well-being. While they attempt to adjust their farming systems, their health is also increasingly threatened by climate-related impacts. The health impacts of climate change on smallholder farmers can grouped in to four categories: (i) communicable diseases, (ii) non-communicable diseases, (iii) mental health, and (iv) occupational health, safety, and other health issues. Without controlling increasing temperature, the health impacts of [A] communicable diseases, [B] non-communicable diseases, [C] mental health, and [D] occupational health, safety, and other health issues of climate change on smallholder farmers will all worsen with time^[23].

The present study focused towards only impact of climate change on mental health of the farmers. It was illustrated from the study that, significant mental health implications among lentil growers affected by extreme climatic events during the 2014-2016 rabi season was witnessed. A total of seven frost events, combined with sustained low temperatures and excessive rainfall during the reproductive stage of lentil cultivation, led to substantial crop damage across the study area. Approximately 18% of the farmers experienced complete crop failure, reporting zero yield due to severe frost damage and waterlogging conditions, while the remaining 72% reported very low yield. This resulted into low or nil income from the lentil crop, ultimately creating distress condition for the farmers, 83% of the zero-yield farmers reported symptoms of moderate to severe psychological distress, including anxiety, sleeplessness, irritability, and hopelessness. 62% of farmers with partial yield showed signs of mild to moderate psychological stress.

Common stressors reported included fear of indebtedness, food insecurity, and uncertainty about the viability of future rabi cropping. Due to the above reasons, shift in area under lentil crop was seen.

Further, when farmers other than lentil growers were interviewed, it was concluded that, repeated crop failures or low yields result in heightened anxiety and persistent worry about livelihood, loan repayment, and food security. Many farmers experience symptoms of depression, including a deep sense of hopelessness, loss of interest in daily activities, agriculture and emotional numbness. Sleeplessness is also commonly reported, often accompanied by irritability and mood swings. The mental strain frequently leads to social withdrawal, with affected farmers avoiding community events and peer interactions due to shame or fear of judgment. In some cases, the burden of financial and emotional stress leads to substance abuse, such as excessive alcohol or tobacco use, as a coping mechanism. In severe cases, the continued stress and trauma associated with crop loss and economic instability can result in suicidal thoughts or actions. These mental health challenges are often left unaddressed due to the stigma surrounding psychological issues, a lack of awareness, and limited access to mental health services in rural areas. repeated crop failures or low yields result in heightened anxiety and persistent worry about livelihood, loan repayment, and food security.

Conclusion

The study concludes that climate change has significantly influenced the yield and income of lentil growers. Temperature and rainfall variability directly impacted crop yield and farmers' livelihood. Adaptation measures including climate-smart agriculture, technological interventions, and policy support are crucial to mitigate these effects and ensure sustainable lentil production in climate-sensitive regions. It was also concluded that, repeated crop failures or low yields result in heightened anxiety and persistent worry about livelihood, loan repayment, and food security. Many farmers experience symptoms of depression, including a deep sense of hopelessness. Further, the psychological toll of climate change on farmers, particularly smallholder and marginal farmers, underscores the urgent need for integrated support systems that include not just agronomic and financial assistance but also timely psychological intervention and counseling.

Acknowledgement / Funding: Not applicable

Author Contributions: All authors equally contributed.

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that-Written informed consent was obtained from all participants prior to publish / enrolment.

Conflict of Interest: Authors have no conflict of interest.

Ethical approval: Not applicable

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