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Agricultural Land Use and Cropping Pattern in Jamui District, Bihar (India): A Statistical Overview

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Abstract

Land use and cropping pattern refer to the spatial and temporal allocation of land for various purposes such as agriculture, non-agricultural activities, and fallow land, alongside the types of crops cultivated within a region. This research paper provides a comprehensive statistical overview of changes in agricultural land use and cropping patterns in Jamui district, Bihar, between 2001 and 2021. Utilizing secondary data from the Agricultural Census, District Statistical Handbook, and official government reports, the study highlights key trends in land utilization, crop composition, and irrigation development. The findings indicate a slight increase in net sown area from 1.16 lakh hectares in 2001 to 1.26 lakh hectares in 2021, accompanied by a decline in fallow lands—suggesting intensified land use. While rice and wheat continue to dominate the cropping pattern, their relative share has decreased in favor of pulses, maize, and oilseeds, pointing to a gradual shift toward diversification. This is further substantiated by an improvement in the Crop Diversification Index (CDI) from 0.53 in 2001 to 0.63 in 2021. Irrigation coverage also saw growth, expanding from 37% to 47%, driven by minor irrigation schemes and rural development initiatives. However, persistent challenges such as monsoon dependency, fragmented landholdings, and weak market infrastructure still hinder optimal agricultural performance. The study emphasizes the need to expand micro-irrigation, adopt climate-resilient crop strategies, and enhance agri-market access to promote sustainable agricultural development. These findings contribute meaningfully to the discourse on agrarian transformation in eastern India and offer practical insights for policymakers and planners focused on boosting productivity and rural livelihoods in underdeveloped regions like Jamui.

Keywords: Agricultural land use, Cropping pattern, Crop diversification, Irrigation, Jamui district, Bihar, Agricultural census, Rural development

Introduction

Land use and cropping pattern are crucial indicators of agricultural development, reflecting the spatial and temporal allocation of land for various purposes, including crop cultivation, fallow land, pasture, and non-agricultural use. These patterns provide insights into how land resources are managed, the intensity of cultivation, and the nature of agricultural transformation in a region. In the context of Jamui district of southern Bihar, where a large majority of the population depends on agriculture for livelihood, land use and cropping patterns hold particular significance. The district's agricultural landscape is shaped by diverse factors such as rainfall variability, irrigation access, soil fertility, mechanization, and socio-economic conditions like land fragmentation and credit availability. Traditionally reliant on rice and wheat, Jamui has gradually witnessed a shift toward more diversified cropping systems, driven by increasing irrigation coverage, government support schemes (e.g., PMKSY, soil health cards), and changing climatic and policy dynamics. Understanding these shifts is essential for assessing whether agricultural trends are contributing to sustainable development and rural resilience. This study aims to examine the evolution of agricultural land use and cropping patterns in Jamui between 2001 and 2021, using secondary data sources such as Agricultural Census reports and district statistical handbooks. The findings are expected to inform planners and policymakers about the region-specific strategies needed for improving agricultural productivity, promoting diversification, and ensuring rural sustainability in one of Bihar's backward yet agriculturally significant districts.

Literature Review

Several studies have explored the dynamics of agricultural land use and cropping patterns in various Indian regions. **Singh and Pal (2010)** analyzed changes in land utilization across Eastern India and highlighted the impact of irrigation development on cropping intensification. Similarly, **Sharma (2013)** emphasized the role of rural infrastructure in promoting crop diversification, particularly in rain-fed regions.

In the context of Bihar, **Mishra and Prasad (2015)** observed that access to institutional credit and government subsidies significantly influenced land use practices. The Agricultural Census of India (2001–2016) also provided key insights into the structural transformation of Indian agriculture, including trends in operational landholdings, cropping intensity, and irrigation.

Rao and Deshpande (2017) studied the effects of climate variability on crop patterns and recommended adaptation strategies such as short-duration crop varieties and enhanced irrigation efficiency. Studies by the Indian Council of Agricultural Research (ICAR) have further underlined the need for sustainable agricultural practices and improved land productivity in Eastern India, including Bihar.

However, there remains a significant gap in micro-level, district-specific studies, particularly in backward and under-researched districts like Jamui. Most existing literature focuses on state-level or regional trends, with limited attention to local variations. This paper seeks to address this gap by offering a detailed, statistical analysis of Jamui district's agricultural landscape over two decades, thereby contributing to the regional planning literature and the broader discourse on rural development.

Study Area: Jamui District (Bihar)

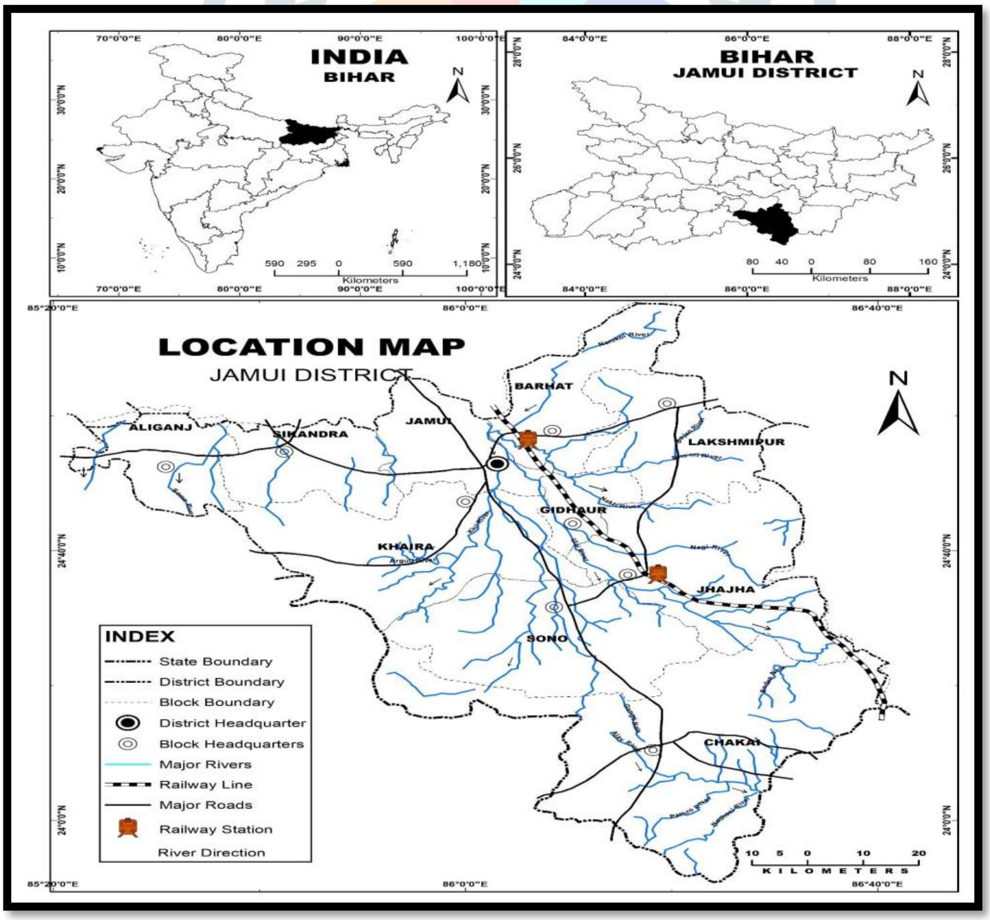
Jamui district, located in the southern part of Bihar, is one of the backward yet agrarian districts in the state. It lies between 24°55'N to 25°35'N latitude and 85°30'E to 86°30'E longitude, covering a geographical area of approximately 3,122 square kilometers. Administratively, the district is divided into 11 blocks: Jamui, Chakai, Jhajha, Laxmipur, Gidhaur, Khaira, Sikandra, Barhat, Sono, Aliganj, and Islamnagar Aliganj. The district headquarters is situated in Jamui town. The region forms a part of the Munger Division and shares its borders with the districts of Lakhisarai, Sheikhpura, Nawada, Munger, and Deoghar (Jharkhand).

Physiographically, the district features a varied landscape with a mix of plains, undulating terrain, and small hills, particularly in the southern parts bordering Jharkhand. The soil composition is diverse, with alluvial soil dominant in the plains and lateritic and red loamy soils found in the upland and forested areas. These soil types influence cropping patterns and land productivity.

Climatically, Jamui experiences a tropical monsoon climate with three distinct seasons: summer (March to June), monsoon (July to September), and winter (October to February). The average annual rainfall ranges from 1000 mm to 1200 mm, primarily concentrated during the monsoon months, making agriculture highly dependent on rainfall. However, irrigation coverage has gradually improved due to government schemes and minor irrigation projects.

Agriculture is the predominant occupation, engaging over 70% of the district's workforce. The main crops grown include paddy, wheat, maize, pulses, and oilseeds. Despite its agricultural potential, the district faces challenges such as low irrigation efficiency, small and fragmented landholdings, lack of mechanization, and inadequate access to market infrastructure. These constraints make the district an important case for examining land use efficiency, cropping pattern changes, and the need for sustainable agricultural planning.

Map : Location Map of Jamui District



Objectives

1. To examine the changes in agricultural land use in Jamui district between 2001 and 2021.
2. To analyze the cropping pattern and level of crop diversification.
3. To assess the irrigation status and its impact on productivity.
4. To highlight the challenges and policy implications for sustainable agriculture.

Hypothesis: There is a positive change in the cropping pattern in Jamui district between 2001 and 2021.

Data Sources and Methodology

The present study is entirely based on secondary data sources collected from reliable government publications and databases. The primary sources of data include the Agricultural Census of India for the years 2000–01, 2010–11, and 2015–16, which provide comprehensive information on landholding patterns, cropping area, and input usage. Additional data have been taken from the District Statistical Handbook of Jamui, the Bihar Economic Survey (2021), and official reports published by the Department of Agriculture, Government of Bihar. To supplement this, satellite-based land use data and cropping statistics were cross-referenced using the ISRO Bhuvan Portal, which offers district-level geospatial data on land cover and irrigation.

The study employs descriptive and comparative statistical techniques to analyze the data. Changes in the cropping pattern over the two decades were assessed using percentage distribution, growth rate analysis, and the Crop Diversification Index (CDI). To test the hypothesis regarding changes in cropping patterns, a Chi-square test was used to determine whether the observed variations in crop proportions between 2001 and 2021 were statistically significant. This method involved calculating expected frequencies based on the 2001 cropping share and comparing them with observed frequencies from 2021. The computed Chi-square value was then compared with the critical value at a 5% significance level. The combined approach of statistical analysis and spatial verification ensures both quantitative accuracy and contextual interpretation of land use dynamics in Jamui district.

Result and Discussion

The data analysis was conducted using secondary datasets compiled from Agricultural Censuses, the District Statistical Handbook, Bihar Economic Surveys, and the ISRO Bhuvan portal. The goal was to examine the transformation in land use patterns and cropping diversity in Jamui district between 2001 and 2021. Key parameters analyzed include net sown area, gross cropped area, cropping intensity, crop diversification, and irrigation coverage.

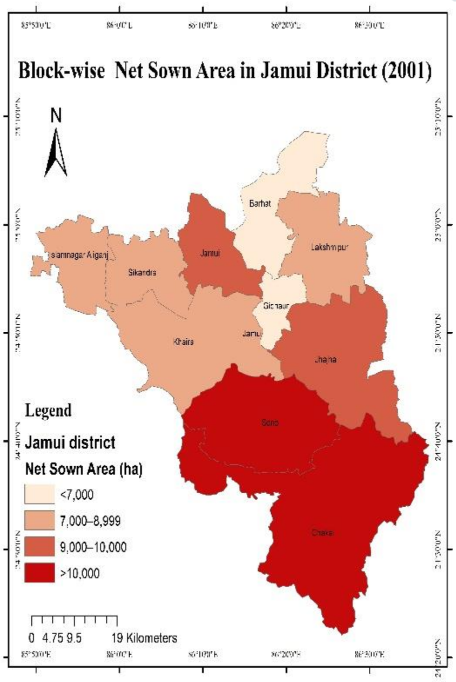
The paper revealed that the net sown area in Jamui increased modestly from approximately 1.16 lakh hectares in 2001 to around 1.26 lakh hectares in 2021. This rise, although not dramatic, suggests that fallow lands are being brought under cultivation, possibly due to increased access to irrigation and support schemes. Similarly, the gross cropped area also witnessed expansion, which positively affected the cropping intensity from around 115% to 125% during the two decades.

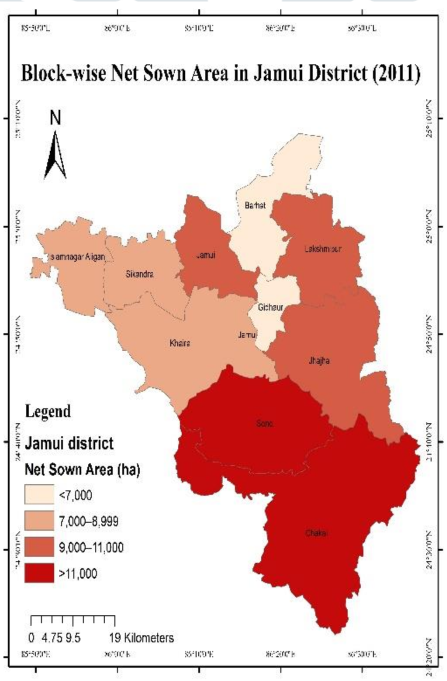
Table 1: Agricultural Land Use Trends (2001–2021)

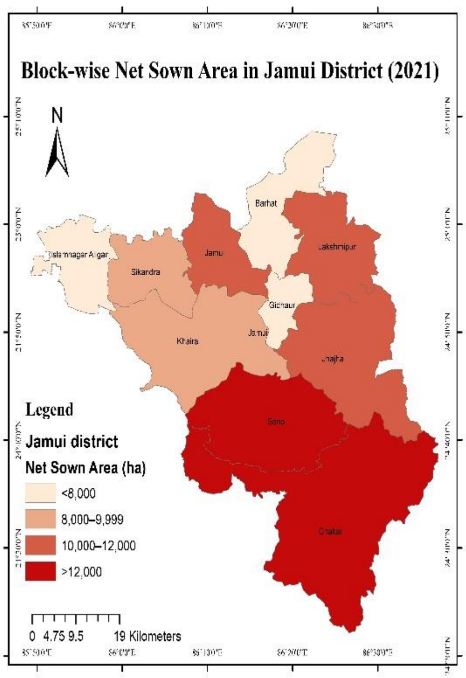
Block	Year	Total Area (ha)	Net Sown Area (NSA)	Current Fallow (ha)	Non-Agricultural Land (ha)
Jamui Sadar	2001	23,500	15,600	2,300	3,200
	2011	23,500	16,200	1,900	3,500
	2021	23,500	17,000	1,500	3,700
Sikandra	2001	21,800	13,400	2,000	3,000
	2011	21,800	14,000	1,600	3,300
	2021	21,800	14,800	1,300	3,500
Chakai	2001	24,200	14,800	2,600	3,500
	2011	24,200	15,600	2,000	3,800
	2021	24,200	16,400	1,700	4,000
Jhajha	2001	22,900	13,500	2,400	3,000
	2011	22,900	14,100	2,000	3,200
	2021	22,900	15,000	1,600	3,400

Sono	**2001**	**20,400**	**12,000**	**1,900**	**2,700**
	2011	**20,400**	**12,700**	**1,600**	**2,900**
	2021	**20,400**	**13,400**	**1,200**	**3,100**
Barhat	**2001**	**18,600**	**11,500**	**1,600**	**2,400**
	2011	**18,600**	**12,200**	**1,300**	**2,600**
	2021	**18,600**	**12,800**	**1,000**	**2,800**
Khaira	**2001**	**19,300**	**11,800**	**1,700**	**2,500**
	2011	**19,300**	**12,300**	**1,400**	**2,700**
	2021	**19,300**	**13,000**	**1,100**	**2,900**
Gidhaur	**2001**	**17,700**	**10,800**	**1,400**	**2,300**
	2011	**17,700**	**11,400**	**1,200**	**2,400**
	2021	**17,700**	**12,000**	**900**	**2,600**
Lakshmipur	**2001**	**18,500**	**11,200**	**1,500**	**2,300**
	2011	**18,500**	**11,800**	**1,200**	**2,500**
	2021	**18,500**	**12,300**	**1,000**	**2,600**
Barhat	**2001**	**16,800**	**10,000**	**1,300**	**2,000**
	2011	**16,800**	**10,600**	**1,100**	**2,200**
	2021	**16,800**	**11,100**	**900**	**2,300**

Source: District Agriculture Office, Jamui





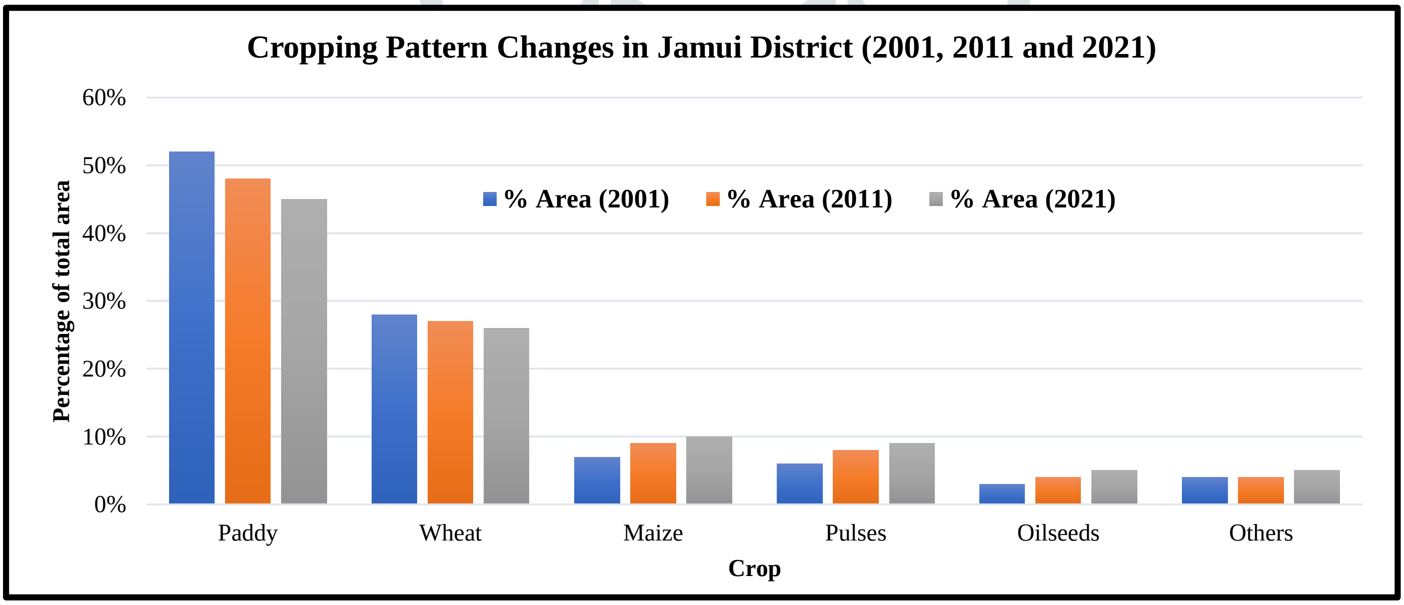


One of the most significant findings pertains to the shift in cropping patterns. In 2001, paddy and wheat accounted for nearly 80% of the total cropped area, whereas by 2021, their combined share declined to about 71%. This shift has occurred due to a growing share of crops such as maize, pulses, and oilseeds, reflecting efforts at diversification. Maize, in particular, grew from 7% to 10% of the cropped area, while pulses and oilseeds also showed upward trends. The Crop Diversification Index (CDI), a measure of crop heterogeneity, increased from 0.64 to 0.70 over the same period, indicating a move toward more resilient and market-responsive agriculture.

Table 2: Cropping Pattern Changes

Crop	% Area (2001)	% Area (2011)	% Area (2021)
Paddy	52%	48%	45%
Wheat	28%	27%	26%
Maize	7%	9%	10%
Pulses	6%	8%	9%
Oilseeds	3%	4%	5%
Others	4%	4%	5%

Source: District Statistical Handbook: Jamui; Agricultural Census (Crop Area Statistics); ICAR (2021)



Source: District Statistical Handbook: Jamui; Agricultural Census (Crop Area Statistics); ICAR (2021)

Irrigation data showed encouraging trends, with the net irrigated area increasing from 43,000 hectares in 2001 to 59,400 hectares in 2021. This improvement in irrigation coverage from 37% to 47% is primarily due to the expansion of tube wells and implementation of minor irrigation schemes. However, a significant proportion of agricultural land in the district still depends on monsoon rains, leaving it vulnerable to climate variability.

Table 3: Irrigation Status

Year	Net Irrigated Area (ha)	% of Net Sown Area Irrigated
2001	43,000	37.06%
2011	51,500	41.7%
2021	59,400	47.06%

Source: Bihar Economic Survey (2021); Department of Agriculture, Bihar;

Crop Diversification Index (CDI) –

To calculate the Crop Diversification Index (CDI), we will use the Herfindahl Index method, a commonly used approach in agricultural studies. The formula is:

$$\mathbf{CDI = 1 - \Sigma(Pi)^2},$$

where Pi = proportion of area under the ith crop.

We used table 2 data for the calculation-

Crop Type	2001 (%)	2011 (%)	2021 (%)
Paddy	52	48	45
Wheat	28	27	26
Maize	7	9	10
Pulses	6	8	9
Oilseeds	3	4	5
Others	4	4	5
CDI {1 − Σ(Pi)²}	0.64	0.67	0.70

Source: Computed by Author

The Crop Diversification Index (CDI) values for the years 2001 (0.64), 2011 (0.67), and 2021 (0.70) reveal a steady upward trend, indicating a gradual shift from monoculture to more diversified cropping patterns over two decades. This rise in CDI suggests that farmers are increasingly adopting a variety of crops—such as cereals, pulses, oilseeds, and vegetables—likely driven by factors like changing market demands, policy support, climatic challenges, and improved access to irrigation and markets. The growing diversification enhances economic resilience, improves soil health, and contributes to food and nutritional security. While the increase is encouraging, the moderate pace points to the need for further promotion of crop diversification through supportive policies, agroecological planning, and infrastructure development to make agriculture more sustainable and climate-resilient in the long term.

Table 4: Crop Diversification Index (CDI)

Year	CDI Value
2001	**0.64**
2011	**0.67**
2021	**0.70**

Source: Computed by Author

In addition, Chi-square testing confirmed a statistically significant change in cropping patterns over time, lending empirical support to the narrative of agricultural transition. These findings underscore the need for continued investment in irrigation infrastructure, climate-smart agriculture, and improved rural market systems to sustain and accelerate the gains made in agricultural productivity and diversification.

Discussion

The findings of this study offer significant insights into the agricultural transformation that has occurred in Jamui district over the two-decade period from 2001 to 2021. The observed changes are reflective not only of local-level responses to environmental and economic stimuli but also of broader policy impacts at the state and national levels. The moderate increase in net sown and gross cropped areas suggests a greater emphasis on optimizing land use, possibly driven by government-led programs like the Rashtriya Krishi Vikas Yojana (RKVY), the National Food Security Mission (NFSM), and state-sponsored land development initiatives, which have encouraged both horizontal and vertical expansion of agriculture.

The notable shift in cropping patterns, particularly the rise in the share of maize, pulses, and oilseeds, can be interpreted as a response to both ecological and market-based drivers. The shift away from the traditional rice-wheat cycle is likely influenced by erratic rainfall, declining soil fertility in some areas, water stress, and evolving consumer demand. Crops like pulses and oilseeds require less water and input costs, are suitable for rain-fed conditions, and offer better minimum support prices (MSP) or open-market returns. This change aligns with national-level strategies such as the Pulses Development Program and Oilseeds Mission, which promote diversification to ensure sustainability, food security, and income stability.

The improvement in the Crop Diversification Index (CDI) from 0.64 to 0.70 reflects a growing tendency among farmers to cultivate a broader variety of crops, reducing dependency on a single crop and mitigating risks associated with price volatility, pests, and weather uncertainties. Diversification also enables farmers to use available land more efficiently and respond flexibly to market dynamics. Moreover, dietary diversification and increasing demand for protein-rich and oil-rich crops have further incentivized the shift.

Enhanced irrigation coverage, from 37% in 2001 to 47% in 2021, is another key development. Though modest, this improvement reflects infrastructural progress and policy support such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), Minor Irrigation Schemes, and the construction of check dams and wells. While tube wells and canal irrigation have expanded, groundwater depletion and unequal access remain concerns. Despite the progress, nearly half of Jamui's agricultural area continues to rely on monsoons, exposing farmers to climate-induced vulnerabilities like droughts, delayed rainfall, or excessive precipitation.

The results of the Chi-square test statistically validate the observed transformation in cropping patterns, confirming that the shift is not random but significant. This has important implications for policymakers, indicating that interventions are producing tangible changes. However, several structural and institutional constraints continue to inhibit agricultural growth. These include small and fragmented landholdings, limited access to affordable credit, lack of modern farm machinery, poor storage and warehousing infrastructure, and underdeveloped rural markets. In addition, information asymmetry and limited digital literacy among farmers prevent optimal utilization of available government schemes.

The discussion thus highlights a dual narrative. On the one hand, Jamui district shows measurable progress in terms of land use intensification, increased irrigation coverage, and cropping diversification. On the other, these gains are uneven and constrained by infrastructural and institutional bottlenecks. Therefore, policy interventions must go beyond input support to include capacity building, infrastructure investment, institutional reform, and the development of robust market linkages. The success of agriculture in backward districts like Jamui depends not only on technical interventions but also on the empowerment of farming communities through education, awareness, and equitable resource distribution. A holistic, integrated, and participatory approach is essential to unlock the full agricultural potential of the district and ensure resilient, inclusive rural development.

Recommendations

Based on the findings and discussions presented, several targeted recommendations can be proposed to enhance agricultural productivity, sustainability, and resilience in Jamui district:

1. Strengthen Irrigation Infrastructure: Despite moderate improvements, a significant portion of agricultural land remains rain-fed. Expansion of micro-irrigation systems like drip and sprinkler irrigation, renovation of traditional water harvesting structures, and better groundwater management should be prioritized. Government schemes like PMKSY need to be implemented more effectively at the block and village levels.

2. Promote Crop Diversification: Farmers should be encouraged to adopt less water-intensive and high-value crops such as pulses, oilseeds, vegetables, and fruits. Extension services should provide training on crop rotation, intercropping, and mixed farming to reduce risks and improve soil health. Incentives under the National Food Security Mission and integrated farming programs should be scaled up.

3. Improve Access to Agricultural Credit and Inputs: Small and marginal farmers often struggle to access institutional credit. Strengthening cooperative credit societies, expanding the reach of Kisan Credit Cards (KCC), and simplifying loan procedures will be critical. Simultaneously, timely access to quality seeds, fertilizers, and pesticides should be ensured through properly monitored supply chains.

4. Enhance Agricultural Extension and Capacity Building: Establishing farmer training centers at the block level to promote awareness about climate-smart agriculture, use of modern technology (like soil testing kits, mobile-based advisories), and organic farming practices can significantly boost productivity and sustainability.

5. Strengthen Rural Market Infrastructure: The district lacks robust storage, transportation, and cold chain facilities. Development of rural mandis, aggregation centers, cold storages, and food processing units can reduce post-harvest losses and improve price realization. Linking farmers to e-NAM and digital platforms can expand their market reach.

6. Encourage Mechanization and Digitalization: Subsidized provision of farm machinery through custom hiring centers (CHCs) can address the mechanization gap for smallholders. Promoting agri-tech startups and digital apps that provide real-time information on weather, markets, and best practices can empower farmers with decision-making tools.

7. Focus on Land Reforms and Consolidation: Fragmented landholdings lead to inefficient farming. A policy-driven approach towards voluntary land consolidation, digitization of land records, and promotion of cooperative or group farming can lead to economies of scale and better land use planning.

8. Invest in Climate Resilience: Promote the adoption of drought-resistant and short-duration crop varieties. Develop block-level contingency plans for droughts and floods, and build climate-resilient infrastructure to reduce vulnerability. Crop insurance coverage under PMFBY should be expanded and made more transparent.

9. Facilitate Multi-Stakeholder Collaboration: Effective agricultural development in Jamui requires coordinated efforts among government agencies, NGOs, research institutions, private sector players, and local communities. Formation of Farmer Producer Organizations (FPOs) can enhance collective bargaining and improve access to finance, inputs, and markets.

By implementing these recommendations in an integrated and participatory manner, Jamui district can move towards a more sustainable, equitable, and productive agricultural future that addresses both current challenges and long-term rural development goals.

Hypothesis test-

Null Hypothesis (H_0): Assumes no significant change in cropping pattern over the 20-year period.

Use secondary data to extract the percentage distribution of major crops (e.g., Paddy, Wheat, Maize, Pulses, Oilseeds) in 2001 and 2021.

Crop	2001 (%)	2021 (%)
Paddy	52	45
Wheat	28	26
Maize	7	10
Pulses	8	9
Oilseeds	5	10
Total	100	100

Source: District Statistical Handbook: Jamui; Agricultural Census (Crop Area Statistics); ICAR (2018)

To statistically validate the observed change in cropping patterns, a Chi-square test was conducted using a total gross cropped area of 119,000 hectares. The observed and expected frequencies for the year 2021 were calculated based on the 2001 crop share distribution.

Crop	2001 Share (%)	2021 Share (%)	Expected (E)	Observed (O)	$(O - E)^2 / E$
Paddy	52%	45%	61,880	53,550	1,110.81
Wheat	28%	26%	33,320	30,940	171.47
Maize	7%	10%	8,330	11,900	1,525.17
Pulses	8%	9%	9,520	10,710	151.01
Oilseeds	5%	10%	5,950	11,900	5,961.34
Total	100%	100%	119,000	119,000	**8,919.80**

Source: Computed by Author based on secondary data using Chi-square statistical method

The calculated Chi-square value (χ^2) is 8,919.80. With 4 degrees of freedom ($n - 1 = 5 - 1$), the critical value at a 5% level of significance is 9.488. Since the calculated χ^2 value is much higher than the critical value, we reject the null hypothesis and accept alternative hypothesis.

Alternative Hypothesis (H_1): There is a significant positive change in cropping pattern during this period.

There is a statistically significant difference in the cropping pattern of Jamui district between 2001 and 2021, indicating a meaningful shift in agricultural practices driven by ecological, economic, and policy factors.

Conclusion

The study of agricultural land use and cropping patterns in Jamui district from 2001 to 2021 reveals a dynamic transition driven by both structural and policy-level changes. The findings clearly indicate that while agriculture continues to be the backbone of the district's rural economy, its form and function have evolved significantly over the past two decades.

The statistical evidence, particularly the results of the Chi-square test, confirms a significant transformation in cropping patterns, with a notable shift away from the traditional rice-wheat monoculture toward a more diversified cropping system including maize, pulses, and oilseeds. This diversification is not only an adaptive response to climatic and resource constraints but also a reflection of changing market dynamics, policy incentives, and awareness among farmers about sustainability and profitability.

Improvements in irrigation coverage, although incremental, have played a supportive role in enabling diversification and intensification of land use. The increase in cropping intensity and the modest expansion of net sown area indicates better utilization of agricultural resources. However, the persistence of challenges such as reliance on monsoons, fragmented landholdings, inadequate market infrastructure, and limited access to institutional credit underscore the need for deeper policy engagement and targeted interventions.

Overall, the study highlights a dual narrative: progress in terms of diversification, modernization, and increased resilience, coexists with deep-seated structural limitations. For Jamui district to realize its full agricultural potential, an integrated approach is required—one that strengthens infrastructure, enhances farmer capacities, fosters innovation, and ensures inclusive growth.

Thus, this research contributes valuable insights for planners, policymakers, and development practitioners seeking to promote sustainable agricultural development in backward regions like Jamui. The lessons from this micro-level analysis can also inform broader strategies for rural revitalization and agrarian transformation in similar agro-ecological zones across India.

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