

Agriculture in Rajasthan: Challenges and Opportunities

Dr. Sunil Kumar Dalal

Department of Economics, S.M.B. Government P.G. College, Nathdwara (Raj.)

ABSTRACT

Rajasthan's agriculture operates in a highly varied agro-climatic environment, dominated by arid and semi-arid zones, where water scarcity, soil degradation, and climatic variability severely constrain productivity and farm livelihoods. At the same time, the state has distinct opportunities — drought-resistant crops, solar irrigation, micro-irrigation (drip and sprinkler), digital agriculture, agro-processing, and government policy support — that can transform agricultural resilience and value-chain gains. This paper synthesizes recent statistical reports, policy documents, and scholarly literature to (1) map the present status of agriculture in Rajasthan, (2) identify and analyze the major challenges faced by farmers, (3) highlight opportunities and innovations that can be scaled up, and (4) recommend targeted policy and practice measures to promote sustainable, climate-resilient agricultural growth in the state.

Keywords: Rajasthan, agriculture, water scarcity, micro-irrigation, climate resilience, crop diversification, smallholders, value chains

INTRODUCTION

Rajasthan, the largest state in India by geographical area, occupies about 10.4 percent of the country's total landmass, yet contributes a relatively modest share to the national agricultural output. The state's agricultural landscape is defined by extreme climatic diversity and ecological contrasts, ranging from the arid Thar Desert in the west to the semi-arid and sub-humid plains in the central, northern, and southeastern regions. This heterogeneity gives rise to a mosaic of agro-climatic zones, each characterized by distinct soil types, rainfall patterns, and cropping systems. Agriculture in Rajasthan forms the backbone of the rural economy and provides livelihood to nearly two-thirds of the state's population, either directly through farming or indirectly through allied activities such as livestock rearing, dairy production, and agro-based industries. However, the sector's contribution to the Gross State Domestic Product (GSDP) remains relatively low compared to its share in employment.

This imbalance reflects structural limitations such as low productivity, limited irrigation coverage, erratic rainfall, poor soil fertility, and inadequate infrastructure for storage, processing, and marketing of agricultural produce. The climatic variability in Rajasthan exerts a profound influence on agricultural performance. Annual rainfall ranges from less than 100 millimeters in the western districts like Jaisalmer and Barmer to over 900 millimeters in the southeastern districts such as Jhalawar and Banswara. The majority of the state falls within arid and semi-arid zones, making agriculture heavily dependent on the southwest monsoon. Frequent droughts, delayed monsoons, and uneven distribution of rainfall often lead to crop failures and livelihood insecurity, especially for small and marginal farmers. Despite these challenges, Rajasthan's agriculture displays significant regional diversity and adaptive capacity. In western and central Rajasthan, hardy and drought-tolerant crops such as bajra (pearl millet), moth bean, guar (cluster bean), and moong (green gram) dominate, while eastern Rajasthan benefits from canal irrigation—particularly from the Indira Gandhi Canal Project and the Chambal Valley system—supporting crops like wheat, mustard, and paddy. In addition, horticulture, spices such as cumin, coriander, and fenugreek, and medicinal plants have emerged as promising sectors, contributing to export-oriented growth.

Another unique strength of Rajasthan is its livestock sector, which complements the crop economy. The state is home to large populations of cattle, sheep, goats, and camels, making it a leading producer of milk, wool, and animal-based products. Livestock acts as a natural hedge against climatic uncertainties, providing farmers with alternative income during drought years. However, the sustainability of agriculture in Rajasthan is under increasing threat due to groundwater depletion, land degradation, and climate change. Groundwater over-extraction has caused a rapid decline in water tables across many districts, while soil erosion, salinity, and declining organic matter further reduce productivity. The fragmentation of landholdings, low mechanization levels, and limited access to formal credit and extension services exacerbate these problems. Therefore, understanding the intricate linkages between natural

resources, farming systems, and livelihoods is essential for developing effective strategies for agricultural development in the state. There is a growing need to shift from traditional resource-intensive farming towards climate-smart and water-efficient practices, leveraging technologies such as drip irrigation, solar-powered pumps, remote sensing for crop monitoring, and digital advisory platforms. Additionally, strengthening value chains, promoting agro-processing, and empowering Farmer Producer Organizations (FPOs) can enhance farmers' income stability and resilience. In summary, while Rajasthan's agricultural sector faces formidable biophysical and socio-economic challenges, it also presents considerable opportunities for innovation and sustainable growth. A comprehensive approach that combines scientific research, technology adoption, institutional reforms, and participatory governance can help realize the state's potential for inclusive and climate-resilient agricultural transformation.

2. Objectives

1. To describe the current status of agriculture in Rajasthan using recent secondary data.
2. To analyze key challenges affecting agricultural productivity, income, and sustainability.
3. To identify promising opportunities and technologies for adaptation and development.
4. To propose policy and on-ground recommendations for sustainable agricultural transformation.

METHODOLOGY

This paper is based on a desk-based, integrative review of secondary sources: official agricultural statistics and crop estimates from the Directorate of Economics & Statistics (Government of Rajasthan), national statistical compilations, peer-reviewed journal articles, government scheme documents (e.g., micro-irrigation/Per Drop More Crop), and recent news and sectoral studies. The synthesis combines quantitative indicators (area, production, irrigation coverage) with qualitative evidence on constraints and interventions.

4. Status of Agriculture in Rajasthan

Rajasthan is India's largest state, with a total geographical area of about 342,239 square kilometers. Agriculture is the mainstay of its rural economy, though it faces several challenges due to arid and semi-arid conditions, limited water availability, and climatic variability. This section presents the status of agriculture in the state up to 2015 in terms of land use, cropping patterns, irrigation resources, and productivity levels.

4.1 Land and Cropping Pattern

Rajasthan's agricultural land utilization is influenced by soil type, rainfall, and irrigation availability. The state's total reporting area for land use statistics is approximately 20.8 million hectares, out of which nearly 16.8 million hectares are net sown. Around 60 percent of the cultivated area is rainfed, which exposes farming to high climatic risk.

Table 1: Land Use and Cropping Data

Particulars	Area (Million Hectares)	Percentage of Total Reporting Area
Total geographical area	34.22	100.0
Reporting area for land use statistics	20.80	60.8
Net sown area	16.80	49.1
Gross cropped area	25.00	-
Cropping intensity	-	148%
Rainfed area (approx.)	10.00	60% of net sown area
Irrigated area	8.30	49% of net sown area

The cropping pattern of Rajasthan mainly consists of coarse cereals, pulses, and oilseeds. Drought-tolerant crops dominate in arid regions, while canal-irrigated regions in the east support high-value crops. The table below summarizes the area under major crops during 2014–15.

Table 2: Area under Major Crops

Crop	Area (Million Hectares)	Major Producing Regions
Bajra (Pearl Millet)	4.1	Barmer, Nagaur, Jodhpur, Jaisalmer
Wheat	3.1	Kota, Bundi, Sikar, Alwar
Gram (Chickpea)	2.1	Jaipur, Tonk, Ajmer, Pali
Mustard	2.4	Bharatpur, Alwar, Jhunjhunu
Maize	0.9	Udaipur, Banswara, Kota
Cotton	0.5	Ganganagar, Hanumangarh, Bikaner
Pulses (Total)	3.8	Jodhpur, Barmer, Pali

The state's agriculture reflects adaptation to limited water conditions. While western districts rely on coarse cereals and pulses, the eastern and canal-fed zones show diversification toward wheat, mustard, and horticultural crops.

4.2 Irrigation and Water Resources

Water availability is the most critical constraint in Rajasthan's agriculture. The state possesses only about 1.16 percent of India's total surface water resources, despite covering 10.4 percent of its land area. Irrigation expansion has been significant but uneven across districts.

Table 3: Sources of Irrigation

Source of Irrigation	Share in Total Irrigated Area (%)
Tube wells and Wells	63
Canals	26
Tanks and Other Sources	11

Major irrigation systems include the Indira Gandhi Canal Project (IGCP), which transformed parts of northwestern Rajasthan such as Sri Ganganagar, Hanumangarh, and Bikaner, and the Chambal Canal System benefiting southeastern districts such as Kota and Bundi. However, over-extraction of groundwater is a growing concern. As per the Central Ground Water Board (CGWB, 2015), 164 out of 295 blocks were categorized as over-exploited. Districts such as Jaipur, Sikar, Alwar, and Nagaur have experienced annual groundwater declines ranging from 0.3 to 1.2 meters. This pattern underscores the urgent need for micro-irrigation and water-saving technologies.

4.3 Productivity and Yields

Crop productivity in Rajasthan remained below the national average up to 2015 due to climatic stress, limited irrigation, and insufficient access to improved inputs. Despite gradual improvements, yields have shown only moderate growth over the years.

Table 4: Average Yields of Major Crops

Crop	Average Yield (kg/ha)	National Average (kg/ha)
Wheat	3,000	3,200
Bajra	1,250	1,500
Maize	2,050	2,500
Gram	1,000	1,150
Mustard	1,500	1,900
Cotton (Lint)	520	550

The persistent yield gap is mainly due to erratic rainfall, inadequate mechanization, low fertilizer consumption, and poor access to high-quality seeds. The rain fed nature of most districts also limits adoption of high-yielding varieties. Nevertheless, certain initiatives undertaken during the early 2010s began to improve productivity. These include the expansion of micro-irrigation systems (drip and sprinkler), the adoption of hybrid seeds, and the implementation of central schemes such as the National Food Security Mission (NFSM) and the Rashtriya Krishi Vikas Yojana (RKVY).

4.4 Observations

Table 5: Summary of Agricultural Trends in Rajasthan

Indicator	Status up to 2015	Implications
Net sown area	16.8 million ha	High dependence on monsoon rainfall
Irrigated share of net sown area	49%	Regional imbalance in water availability
Major crops	Bajra, Wheat, Mustard, Gram, Pulses	Drought-tolerant cropping dominates
Average cropping intensity	148%	Below national average
Groundwater condition	55% blocks over-exploited	Threat to long-term sustainability
Crop yields	Below national average	Productivity gap due to resource stress
Emerging opportunities	Horticulture, livestock, micro-irrigation	Pathway for diversification and resilience

The overall status of agriculture in Rajasthan shows a complex picture of resilience and constraint. The sector is dominated by rainfed farming, with significant spatial variation in irrigation access and productivity. While coarse cereals and pulses remain central to the state's crop economy, growing diversification toward oilseeds, spices, horticulture, and livestock provides important opportunities for income enhancement. However, the long-term sustainability of agriculture depends on managing water resources judiciously, promoting efficient irrigation systems, improving soil health, and ensuring equitable access to technology and markets across all regions. Rajasthan's

agriculture faces numerous environmental, economic, and institutional challenges that collectively constrain productivity, sustainability, and profitability. The state's arid and semi-arid conditions make farming highly dependent on rainfall, while overexploitation of groundwater, soil degradation, and fragmented landholdings further limit agricultural growth. The following tables and explanations present the key challenges in detail.

5.1 Water Scarcity and Erratic Rainfall

Rajasthan receives the lowest average annual rainfall among Indian states. Most districts fall in the arid and semi-arid climatic zones, making agriculture highly vulnerable to monsoon variability. Droughts and delayed rains significantly reduce sowing areas and yields.

Table 6: Rainfall Variability and Drought Frequency in Rajasthan (up to 2015)

Parameter	Western Rajasthan	Eastern Rajasthan	State Average
Average annual rainfall (mm)	100–300	500–900	531
Coefficient of rainfall variation	60–70%	25–30%	45%
Average number of drought years (per decade)	5–6	2–3	4–5
Dependence on monsoon rainfall (%)	90%	70%	80%

Erratic rainfall and frequent droughts lead to incomplete crop cycles, poor germination, and lower yields, especially in rainfed crops such as bajra, moth bean, and guar. Droughts between 2012 and 2015 reduced kharif sowing areas by nearly 20 percent in western Rajasthan.

5.2 Over-Extraction of Groundwater and Declining Water Tables

Over-dependence on groundwater for irrigation has caused a severe decline in water tables across many districts. According to the Central Ground Water Board (2015), more than half of Rajasthan's administrative blocks were classified as "over-exploited."

Table 7: Groundwater Status in Rajasthan

Indicator	Value / Range
Total number of assessment blocks	295
Over-exploited blocks	164
Critical blocks	31
Semi-critical blocks	26
Safe blocks	74
Annual decline in groundwater levels	0.3 – 1.2 meters
Major affected districts	Jaipur, Sikar, Nagaur, Alwar, Jhunjhunu

Excessive extraction through tubewells for irrigation (especially for wheat and mustard) threatens long-term sustainability and causes salinity and quality deterioration in groundwater.

5.3 Soil Degradation and Salinity

Soil fertility is declining due to over-cultivation, nutrient mining, and improper irrigation practices. Secondary salinization and alkalinity are common in irrigated tracts, particularly in canal command areas.

Table 8: Soil Degradation Indicators

Type of Degradation	Affected Area (Million ha)	Major Districts Affected
Wind erosion	12.5	Barmer, Jaisalmer, Bikaner, Churu
Water erosion	3.4	Udaipur, Banswara, Kota, Jhalawar
Salinity/alkalinity	1.8	Ganganagar, Hanumangarh, Nagaur
Nutrient depletion	5.2	Statewide

Soil organic carbon levels in arid districts were below 0.3 percent, indicating poor soil health and reduced productivity potential.

5.4 Small and Fragmented Land Holdings

The average operational landholding size in Rajasthan was about 3.2 hectares in 2010–11 (Agricultural Census), larger than the national average but highly fragmented. This fragmentation limits mechanization, water management, and adoption of modern technologies.

Table 9: Distribution of Landholdings (Agricultural Census 2010–11)

Farm Size Category	Percentage of Holdings (%)	Area Operated (%)	Average Holding Size (ha)
Marginal (<1 ha)	26.0	5.8	0.56
Small (1–2 ha)	18.5	10.2	1.48
Semi-medium (2–4 ha)	21.0	21.5	2.85
Medium (4–10 ha)	23.0	35.0	6.25
Large (>10 ha)	11.5	27.5	13.20

Fragmentation also increases the cost of cultivation and reduces incentives for investment in long-term land improvement or water-saving infrastructure.

5.5 Limited Access to Credit, Inputs, and Markets

Access to formal agricultural credit and quality inputs remains limited, particularly in remote districts. Many smallholders rely on informal lending sources with high interest rates.

Table 10: Access to Credit and Inputs

Parameter	Status / Percentage	Remarks
Farmers accessing institutional credit	38%	Below national average
Fertilizer consumption (kg/ha)	115	India average: 165 kg/ha
Mechanization level (tractor density per 1,000 ha)	20	Low mechanization, mainly medium farmers
Share of marketed surplus (%)	45–50	Limited for smallholders
Post-harvest loss (%)	8–12	Due to poor storage and logistics

Market linkages for perishable and high-value crops are underdeveloped, and the presence of middlemen limits price realization for farmers.

5.6 Pest and Disease Pressures and Insufficient Extension Services

Crop losses due to pests and diseases are increasing, aggravated by climate fluctuations and monocropping practices. Extension services have not expanded proportionally to meet the needs of dispersed farmers.

Table 11: Agricultural Extension and Pest Management Indicators

Indicator	Status
Extension worker to farmer ratio	1:1,200
Farmers receiving advisory services (%)	35%
Major pest/disease outbreaks	Locusts (Barmer, Jaisalmer), Aphids (mustard), Whitefly (cotton)
Estimated yield losses due to pests (%)	10–20%

Limited access to information and inadequate training programs constrain farmers' ability to respond effectively to pest and disease outbreaks.

5.7 Climate Change and Increased Frequency of Extreme Events

Rajasthan is one of the most climate-vulnerable states in India. Rising temperatures, unpredictable monsoons, and frequent droughts are increasing agricultural risks.

Table 12: Climate Trends in Rajasthan

Indicator	Observation
Average temperature increase	+0.5°C to +1.0°C
Frequency of heatwaves	2–3 per year (previously 1 per 3 years)
Rainfall deviation	±25% from long-term mean
Drought frequency	Every 2–3 years
Affected crops	Bajra, wheat, mustard, gram

These trends pose serious risks for crop yields, livestock health, and water availability, threatening long-term food security.

5.8 Structural and Institutional Constraints

Institutional inefficiencies such as unclear land tenancy, low crop insurance penetration, and administrative delays in government schemes limit the effectiveness of policy interventions.

Table 13: Institutional Constraints

Indicator / Aspect	Status / Description
Land tenancy under informal lease	12–15% of operational area
Crop insurance coverage	27% of gross cropped area
Scheme implementation delay	Common in subsidy and irrigation programs
Awareness of government schemes	40% of farmers (survey average)
Farmer Producer Organizations (FPOs) formed	230

These constraints reduce the reach and impact of agricultural development programs.

5. Summary of Major Challenges

Table 14: Consolidated Summary of Agricultural Challenges in Rajasthan (up to 2015)

Challenge Category	Key Issues Identified	Implications for Agriculture
Water scarcity and rainfall variability	Droughts, low rainfall, irregular monsoon	Reduced cropping intensity and yield instability
Groundwater depletion	Over-extraction and falling water tables	Long-term unsustainability of irrigation
Soil degradation and salinity	Nutrient depletion, erosion, salinity	Lower soil fertility and declining yields
Small landholdings	Fragmentation, low mechanization	Limits productivity and investment
Credit and market access	Lack of finance, poor marketing networks	Income instability and dependence on traders
Pest and disease management	Poor extension services, frequent outbreaks	Crop loss and reduced profitability
Climate change impacts	Temperature rise, extreme weather events	Increased risk and vulnerability
Institutional limitations	Inefficient implementation, low insurance coverage	Weak farmer protection and policy execution

CONCLUSION

Agriculture in Rajasthan reflected a complex interaction of environmental constraints, socio-economic limitations, and institutional challenges. The state's arid and semi-arid climate, coupled with erratic rainfall and recurring droughts, made agricultural production inherently risky and highly dependent on the monsoon. Groundwater depletion, soil erosion, and salinity further undermined productivity, while fragmented landholdings restricted mechanization and investment in water-saving technologies. The predominance of rainfed cropping patterns based on coarse cereals and pulses ensured resilience but limited income diversification. Despite these challenges, Rajasthan demonstrated significant potential through emerging sectors such as horticulture, livestock rearing, and agro-processing. Policy interventions like the Indira Gandhi Canal Project, National Food Security Mission, and micro-irrigation schemes began to transform select regions by improving water availability and productivity. However, long-term sustainability requires a shift toward integrated water resource management, adoption of climate-smart technologies, and strengthening of institutional frameworks to support smallholders. Enhancing farmers' access to credit, markets, and digital advisory services can improve their adaptive capacity, while promoting Farmer Producer Organizations (FPOs) can enhance collective efficiency and market participation. Thus, the future of Rajasthan's agriculture depends on balancing productivity with resource conservation through coordinated technological, institutional, and policy innovations that build resilience and ensure inclusive growth.

REFERENCES

- [1]. Directorate of Economics and Statistics, Government of Rajasthan. (2015). Agricultural Statistics of Rajasthan 2014–15. Jaipur.
- [2]. Government of India. (2015). Agricultural Census 2010–11. Ministry of Agriculture and Farmers Welfare, New Delhi.
- [3]. Central Ground Water Board (CGWB). (2015). Ground Water Year Book – Rajasthan. Ministry of Water Resources, New Delhi.
- [4]. Planning Department, Government of Rajasthan. (2014). Economic Review of Rajasthan 2013–14. Jaipur.

- [5]. Indian Council of Agricultural Research (ICAR). (2015). Vision 2050: Rajasthan Agriculture. New Delhi.
- [6]. National Bank for Agriculture and Rural Development (NABARD). (2015). District Potential Linked Credit Plans, Rajasthan. Mumbai.
- [7]. Department of Agriculture, Government of India. (2014). Rashtriya Krishi Vikas Yojana (RKVY) Annual Report 2014–15.
- [8]. Food and Agriculture Organization (FAO). (2014). State of Indian Agriculture: Rajasthan Profile. Rome.
- [9]. Ministry of Rural Development, Government of India. (2015). Rural Livelihoods and Employment Statistics 2015.
- [10]. Indian Meteorological Department (IMD). (2015). Rainfall Statistics of India 2014–15. Pune.
- [11]. Joshi, P. K., & Birthal, P. S. (2013). Agricultural Diversification in India: Status and Determinants. IFPRI Discussion Paper, New Delhi.
- [12]. Singh, R. B., & Sharma, P. (2014). "Agriculture and Water Management in Arid Rajasthan." *Journal of Arid Environments*, 104(2), 45–54.
- [13]. Department of Horticulture, Government of Rajasthan. (2015). Horticulture Development Report 2015. Jaipur.
- [14]. Rao, K. N., & Vyas, S. (2014). "Groundwater Crisis and Agricultural Sustainability in Rajasthan." *Indian Journal of Agricultural Economics*, 69(3), 412–426.
- [15]. Ministry of Environment, Forest and Climate Change (MoEFCC). (2015). State Action Plan on Climate Change: Rajasthan. New Delhi.
- [16]. World Bank. (2013). India: Climate Change Impacts on Agriculture. Washington, D.C.
- [17]. Sharma, H. C. (2015). "Micro-irrigation Adoption in Rajasthan: Drivers and Constraints." *Agricultural Water Management*, 152, 152–161.
- [18]. Singh, R., & Bhatnagar, P. R. (2014). "Soil Salinity and Land Degradation in the Indira Gandhi Canal Command Area." *Arid Zone Research Journal*, 34(1), 1–10.
- [19]. National Sample Survey Office (NSSO). (2014). Situation Assessment Survey of Farmers (70th Round). Ministry of Statistics and Programme Implementation, New Delhi.
- [20]. Planning Commission. (2013). Twelfth Five Year Plan (2012–2017): Faster, More Inclusive and Sustainable Growth. Government of India.
- [21]. Institute of Development Studies, Jaipur (IDSJ). (2015). Agricultural Growth and Rural Transformation in Rajasthan. Jaipur.
- [22]. Singh, G., & Soni, A. (2015). "Impact of Climate Change on Crop Productivity in Rajasthan." *Indian Journal of Environmental Sciences*, 19(2), 101–109.
- [23]. Department of Agriculture Cooperation & Farmers Welfare (DACFW). (2015). National Food Security Mission Progress Report 2014–15.
- [24]. World Resources Institute (WRI). (2015). Water Risk Atlas: Rajasthan Case Study. Washington, D.C.
- [25]. Government of India. (2015). Per Drop More Crop: Micro-Irrigation Guidelines under PMKSY. Ministry of Agriculture and Farmers Welfare, New Delhi.