

# Challenges and opportunities

## in rainfed agriculture

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*Rainfed agriculture sustains billions of people worldwide, particularly in arid and semiarid regions. Variable rainfall is a key issue leading to frequent crop failures. Droughts and other extreme events are expected to intensify further due to global climate change affecting rainfed agriculture. Shallow depth, limited water-holding capacity, poor organic matter content further exacerbate the moisture deficiency coupled with frequent pest outbreak making it difficult for crops to thrive. Early warning systems, drought-tolerant crop varieties, agroforestry, agri-horti systems, improved water management practices and precision agriculture technologies play a key role for protecting rainfed farming. Climate-resilient agriculture practices, technological advancements, policy support, and market diversification can help farmers build resilience and improve their livelihoods. Addressing the challenges and seizing the opportunities requires a concerted effort from governments, farmers, researchers, and civil society organizations.*

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**R**AINFED agriculture, where crops rely solely on natural rainfall for their water needs, sustains billions of people worldwide. It is particularly prevalent in arid and semiarid regions of the developing countries, where it forms the backbone of rural economies. However, this vital agricultural system faces numerous challenges, exacerbated by climate change and other factors. Rainfed agriculture in India occupies 51% of the net sown area (70.77 m ha). Majority of land holdings out of 46 million is under unirrigated (40%) and partly irrigated (13%). Among the several field crops, 39% of rice, 83% of nutri-cereals (other than rice and wheat), 81% of pulses, 72% of oilseeds and 66% of cotton is rainfed. More importantly, 2/3<sup>rd</sup> of livestock is dependent on drylands. This article explores the key challenges confronting rainfed agriculture and the promising opportunities that exist for its sustainable development. By understanding these issues, we can work towards building more resilient and productive rainfed agricultural systems that can meet the growing demands for food and livelihoods.

### Challenges in rainfed agriculture

Rainfed agriculture in India supports the livelihoods of millions of small and marginal farmers. However, this system is highly vulnerable to a range of environmental, infrastructural, and socio-economic challenges. Climate

variability, particularly in the form of irregular monsoons, droughts, and extreme weather events, has increasingly jeopardized rainfed agriculture in India.

### Crop related issues

Crop production in dry farming regions faces numerous challenges, largely due to reliance on rainfed conditions and limited resources of smallholder farmers. Variable rainfall is a key issue, with inconsistent patterns leading to frequent crop failures. Rain often falls intensely over a few days, causing runoff and soil erosion. The distribution of rainfall during the growing season is crucial, as uneven rain leads to water shortages at critical crop stages. Monsoon irregularities further complicate farming, with delayed onset or early withdrawal reducing yields and prolonged dry spells causing drought stress. High temperature, low humidity, and hot winds increase moisture loss and contribute to soil erosion, creating unstable and low-productivity conditions for farmers in these regions.

### Drought

It is one of the most severe challenges, especially in states like Maharashtra, Rajasthan, Karnataka, and parts of Madhya Pradesh, where drought frequency is on the rise. According to the Intergovernmental Panel on Climate Change (IPCC), these droughts are expected to



Bajra farmer

intensify further due to global climate change. India has already witnessed shifts in monsoon patterns, leading to delayed rains, long dry spells, and shorter, intense bursts of rainfall that fail to provide consistent water for crops. This uncertainty in monsoon timing and intensity has had a direct impact on rainfed agriculture, with farmers struggling to adapt. Extreme weather events, such as cyclones in coastal regions like Odisha and Andhra Pradesh, and flooding in parts of Bihar and Assam, have also increased. These events can destroy standing crops, damage infrastructure, and erode soil, making it more difficult for farmers to recover between growing seasons.

#### **Soil-related issues**

It is another significant issue in India's rainfed areas. In regions like Bundelkhand, where rainfed farming is predominant, high soil erosion rates have been reported. The erosion rate can exceed 10 tonnes of topsoil per hectare annually, which strips the soil of essential nutrients and decreases its fertility. In places where continuous cropping is practiced without replenishing the soil with organic matter or fertilizers, nutrient depletion can lead to a reduction in soil fertility by as much as 50%. This makes the land less productive over time, forcing farmers to rely on additional inputs, which many cannot afford. Furthermore, in areas like Gujarat and Rajasthan, where irrigation is used in rainfed fields, salinity build-up has become a concern. The rise in salinity levels, often by 1-2% per year, threatens the sustainability of farming, as it turns once-productive land into barren fields.

Soil constraints in dryland regions significantly impact crop production, varying across different soil types such as black soils, red soils, and alluvial soils. Among these, alluvial soils face fewer challenges compared to red and black soils. One major issue is inadequate soil moisture availability. Low rainfall and poor organic matter content further exacerbate the moisture deficiency, making it difficult for crops to thrive during dry spells. In addition to moisture limitations, dryland soils generally have very low organic matter content, often less than 1%, due to high temperatures and the minimal addition of organic manure. This lack of organic matter negatively affects the soil's physical properties, such as its ability to retain moisture, further stressing crops in dry conditions. Poor soil fertility is another concern,

with most dryland soils suffering from deficiencies in essential nutrients like nitrogen and zinc.

#### **Pest and disease problems**

Exacerbated by climate change, pests have also become more frequent in Indian rainfed regions. Warmer temperatures and erratic rainfall have created favourable conditions for pests such as the fall armyworm, which has ravaged maize crops across Karnataka and Maharashtra. In some regions, pest and disease outbreaks have increased by 20-30%, causing substantial economic losses for rainfed farmers, who often lack access to modern pest management techniques. These outbreaks can reduce crop yields by up to 20%, leading to a cycle of poverty and indebtedness, as farmers are unable to recover the value of their crops.



Pest outbreak

#### **Infrastructure needs**

One of the most pressing issues in India's rainfed agricultural scenario is the lack of adequate infrastructure. Over 80% of rainfed farmers do not have access to reliable irrigation systems, leaving them vulnerable to the uncertainties of rainfall. For example, in drought-prone regions like Marathwada in Maharashtra, farmers have no choice but to wait for monsoon rains, as groundwater levels are severely depleted. Even when irrigation systems are available, the infrastructure is often poorly maintained, and farmers face challenges in accessing water during critical stages of crop growth. Moreover, more than half of the farmers in rainfed areas struggle with limited access to markets. In regions like Odisha and Madhya Pradesh, poor road connectivity and lack of cold storage facilities force farmers to sell their

produce at low prices. The lack of access to organized markets means that middlemen often exploit farmers, reducing their profits. Additionally, post-harvest losses are significant, with poor storage facilities resulting in up to 30% of crop production being wasted in some regions.

To ensure the long-term viability of rainfed agriculture in India, greater investment is essential in rural infrastructure, farmer education, and implementation of climate-resilient technologies. With the appropriate support, India's rainfed farming communities can enhance their resilience to climate change and improve their livelihoods, ensuring food security for millions.

### **Socio-economic issues**

Socio-economic constraints in dryland farming stem from the poor economic conditions of the farmers. They face limited access to inputs, delayed availability of credit, and have a low risk-bearing capacity. As a result, dryland farmers adopt low-input agriculture, leading to poor yields.

### **Opportunities in rainfed agriculture**

- Rainfed agriculture in India, despite its challenges, holds tremendous potential for sustainable development and improved livelihoods, especially for the millions of small and marginal farmers who depend on it. With over half of the country's arable land being rainfed, innovative strategies can transform this sector into a more resilient and productive system. By adopting climate-resilient agriculture, leveraging technological advancements, and creating policy and market support, India's rainfed farmers can better cope with the growing impacts of climate variability and enhance their economic prospects.
- Climate resilient agriculture offers a range of practices that can help Indian rainfed farmers increase their resilience to climate-related challenges. One such practice is agroforestry, which involves integrating trees with crops providing multiple benefits such as fruits, fodder, timber, improving soil quality and ecosystem services. In states like Rajasthan and Madhya Pradesh, agroforestry has already shown success in improving land productivity while offering additional income from timber and fruit trees. Another effective practice is conservation agriculture, which involves minimizing soil disturbance, maintaining crop cover, and practicing crop rotation. This practice helps improve soil quality and is suitable for rainfed cropping systems of Telangana and Karnataka.
- India's rich biodiversity also presents an opportunity for drought-tolerant crop varieties, which can be vital for many areas frequently impacted by drought. Research institutions, including ICRISAT and state agricultural universities, are working to develop and promote drought-tolerant varieties of crops like upland rice, pulses and oilseeds, which are predominantly cultivated in rainfed areas. Pulses fix on an average 25 kg N per ha which is sufficient for growing rainfed pulse crops.
- Improved water management techniques, such as drip irrigation and rainwater harvesting, are essential for improving water-use efficiency. Projects like the Rajasthan Government's *Mukhya Mantra Jal Swavlamban Abhiyan* have demonstrated the value of these methods by increasing water availability and enhancing crop yields in rainfed areas.
- The use of precision agriculture technologies, such as GPS-based field mapping and soil sensors, can help farmers optimize input-use and improve yields in rainfed regions where resource management is critical.
- Initiatives like natural farming to be validated with precision agriculture practices, use of minimal chemical inputs and efficient use of water resources in appropriate rainfed production systems.
- Remote sensing and satellite imagery are also proving to be powerful tools for monitoring crop health, soil moisture, and weather patterns, allowing farmers to make timely, data-driven decisions. For example, platforms like the Indian Space Research Organisation's (ISRO) Bhuvan app provides farmers with real-time satellite data on weather and agricultural conditions.
- Early warning systems for weather events are critical in India's rainfed areas, which are prone to droughts, floods, and cyclones. By providing farmers with advance notice of impending extreme weather, these systems allow them to take preventive measures, such as adjusting planting schedules or protecting their crops. The Ministry of Earth Sciences' IMD Agro-Meteorological Advisory Services, which issues weather forecasts and advisories to farmers, is an important step toward mitigating weather-related risks in agriculture.
- Horticulture holds great potential for improving nutrition, income, and livelihoods, particularly in India's rainfed areas, which cover 60% of the net sown land. These regions face challenges like poverty, resource dependence, and climate risks, but hardy fruit crops with deep root systems offer resilience by utilizing deeper soil moisture. Conservation of natural resources, especially rainfall, is crucial for boosting productivity. Horticulture aids in diversification, better land use, risk reduction, and economic returns, contributing 28% to agricultural GDP. As demand for horticulture grows, rainfed areas present opportunities for sustainable development through increased productivity and cost-effective farming systems.
- Agroforestry plays an important role in the sustainability of rainfed areas, since high risk is involved with arable farming due to aberrant weather situations and other abiotic and biotic stresses resulting in uneconomic yields. Agroforestry is increasingly viewed as a system that provides ecosystem services, environmental benefits and economic commodities as part of multifunctional working landscapes.



Agroforestry

### Policy support for rainfed agriculture

Policy support plays a crucial role in enabling rainfed farmers to adopt sustainable and climate-resilient practices. Increased investment in agricultural research and development is essential for developing new technologies and practices that can benefit rainfed farmers. Institutions like the Indian Council of Agricultural Research (ICAR) and state agriculture universities are critical in driving research that focuses on improving rainfed crop varieties, soil health, and water management. Furthermore, subsidies and incentives for rainfed farmers can encourage the adoption of sustainable practices. The government's Soil Health Card Scheme, which provides farmers with information on the nutrient status of their soil, is an example of a policy designed to improve soil management and fertility



Crop intensification

Access to credit and insurance is another area where policy support can significantly benefit rainfed farmers. Initiatives like the *Pradhan Mantri Fasal Bhima Yojana* (PMFBY), which provides crop insurance against weather-related risks, can help farmers manage the financial risks associated with rainfed agriculture. Similarly, improving access to credit through institutions like NABARD (National Bank for Agriculture and Rural Development) allows farmers to invest in better seeds, irrigation systems, and other technologies that can improve their productivity. Market Diversification offers significant opportunities for rainfed farmers to increase their profitability. One promising avenue is the production of value-added products from rainfed crops. For example, the processing of millets, pulses,

and oilseeds into flour, snacks, or health products can increase their market value and open up new income streams for farmers. In states like Karnataka and Tamil Nadu, the promotion of millet-based products is gaining traction, driven by increasing consumer demand for nutritious, organic foods. Additionally, organic and sustainable agriculture practices, which are often inherent in rainfed farming, can attract premium prices in domestic and international markets. The growing trend toward organic farming, supported by schemes like the *Paramparagat Kristi Vikas Yojana* (PKVY), is creating new opportunities for rainfed farmers to tap into niche markets. Expanding access to export markets can provide rainfed farmers with new opportunities to sell their produce at better prices. India is a leading exporter of rainfed crops like spices, oilseeds, and pulses, and with better market linkages, rainfed farmers can significantly increase their earnings. Government initiatives like the *Agriculture Export Policy* aim to strengthen the infrastructure and regulatory framework to facilitate easier access to global markets for smallholder farmers.

By embracing these opportunities, rainfed agriculture in India can become a more resilient and sustainable sector, contributing not only to the nation's food security but also to rural development and climate change mitigation. With the right blend of technology, policy support, and market access, rainfed farmers can enhance their livelihoods and play a crucial role in the country's agricultural future

### SUMMARY

Rainfed agriculture, despite its challenges, is a vital component of the global food system. By understanding the key challenges and opportunities, we can work towards building more resilient and productive rainfed agricultural systems. The main challenges facing rainfed agriculture include climate variability, soil degradation, pest and disease outbreaks, and lack of infrastructure. Climate change is exacerbating these challenges, making it more difficult for farmers to adapt and thrive. However, there are also significant opportunities for sustainable development in rainfed agriculture. Climate-resilient agriculture practices, technological advancements, policy support, and market diversification can help farmers build resilience and improve their livelihoods. Addressing the challenges and seizing the opportunities requires a concerted effort from governments, farmers, researchers, and civil society organizations. By working together, we can create a sustainable future for rainfed agriculture that benefits both current and future generations. As we look ahead, we must ask ourselves: What can we do to ensure that rainfed agriculture remains a viable and sustainable source of food and livelihoods in the face of climate change and other challenges? The answer lies in our collective commitment to innovation, collaboration, and a sustainable future.

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