GreenariA
Go Green, Learn Green
An Agricultural Monthly e-Magazine
Volume 03, Issue 05, 2025
ISSN: 2584-153X
Article ID: G-25-0518

CLIMATE-SMART PULSES: THE FUTURE OF SUSTAINABLE AGRICULTURE IN INDIA

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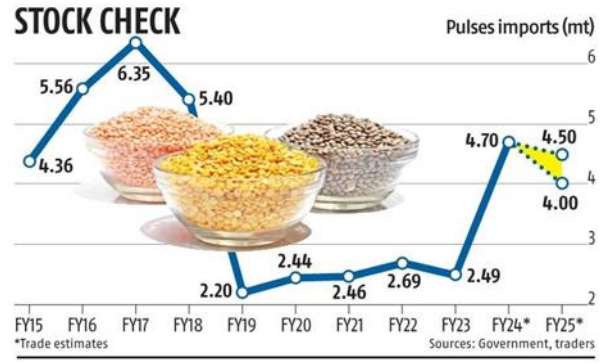
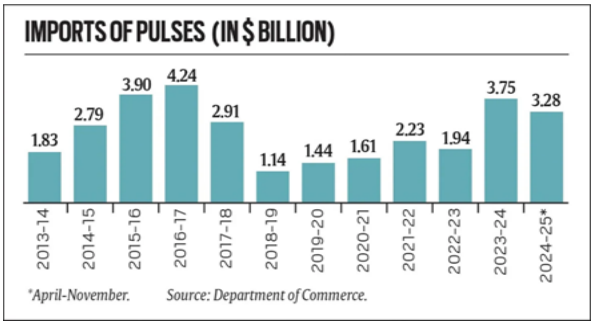
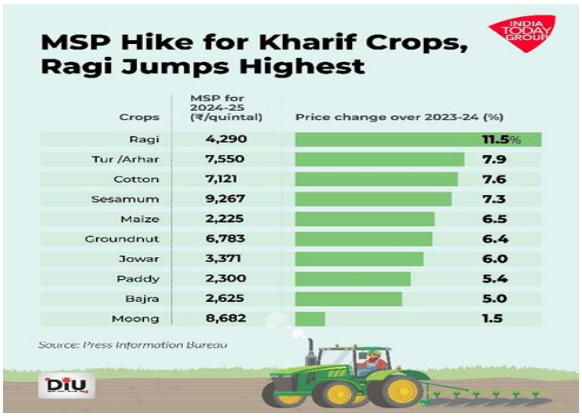
Introduction

India, is a nation largely reliant on plant-based diets to over 1.4 billion people, making protein nutrition an ongoing public health and agricultural challenge. Pulses-legumes such as chickpeas, lentils, pigeon peas, mung beans, and urad are integral to Indian cuisine and culture, but more importantly, they are a cornerstone of protein nutrition for hundreds of millions. Unlike meat or dairy, pulses are accessible to the poor, environmentally sustainable, and agronomically versatile. Together with cereals, pulses account for more than 80% of the dietary protein intake in India, contributing significantly to the daily protein needs of the population. This unique combination provides complementary amino acids and offers a complete protein profile, especially critical in vegetarian diets. In India, pulse farmers are on the verge of being affected by climate change. From prolonged dry spells and intense heat waves to unpredictable monsoons and depleted soils, these conditions are making pulse cultivation increasingly volatile. Yet pulses developed in India being low-input, nitrogen-fixing, and hardy are uniquely positioned against climate-induced agricultural risks. Beyond their dietary value, pulses enrich the soil by fixing atmospheric nitrogen, reducing dependence on synthetic fertilizers. This makes them crucial to sustainable agriculture and climate-resilient farming systems. However, despite India being the largest global producer and consumer of pulses, it remains a net importer due to a chronic gap between demand and supply. With over 60% of pulse cultivation dependent on rainfall and practiced by small and marginal farmers, the sector is highly exposed to climatic stress. Crop losses due to higher temperature, moisture stress, or unseasonal rains are becoming routine. However, recent innovations in climate-resilient pulse varieties and adaptive agronomic practices offer a strategic path forward.





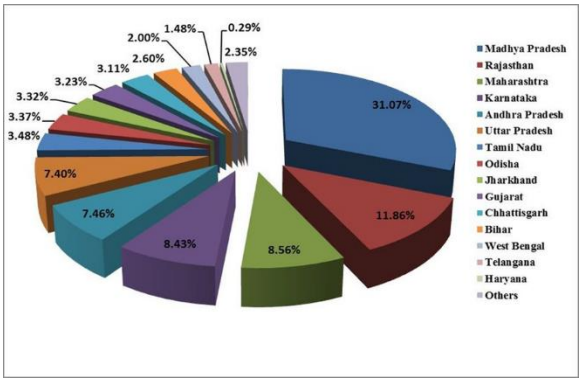


MINIMUM SUPPORT PRICES FOR KHARIF MARKETING SEASON (IN Rs)

Crops	2022-23	2023-24	Increase (%)
Moong	7,755	8,558	10.35
Sesamum	7,830	8,635	10.28
Cotton (Long Staple)	6,380	7,020	10.03
Groundnut	5,850	6,377	9.01
Cotton (Medium Staple)	6,080	6,620	8.88
Jowar-Maldandi	2,990	3,225	7.86
Ragi	3,578	3,846	7.49
Jowar-Hybrid	2,970	3,180	7.07
Paddy-Common	2,040	2,183	7.01
Soybean (Yellow)	4,300	4,600	6.98
Paddy-Grade A	2,060	2,203	6.94
Maize	1,962	2,090	6.52
Bajra	2,350	2,500	6.38
Nigerseed	7,287	7,734	6.13
Tur/Arhar	6,600	7,000	6.06
Sunflower Seed	6,400	6,760	5.63
Urad	6,600	6,950	5.30

Current Status of Pulse Production and Consumption in India

As of 2023-24, India produces around 24.5 to 26 million metric tonnes (MMT) of pulses annually, covering about 25% of global production and 38% of the cultivation area. Chickpea alone accounts for roughly 45% of domestic output, followed by pigeon pea (15%), lentils (10%), and mung and urad beans (20%). These crops are cultivated predominantly in states like Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, and Karnataka, which together contribute more than 60% of total pulse production.



Despite this, India's domestic requirement stands at around 30–32 MMT per year. According to WHO dietary guidelines, the recommended daily intake of pulses is 60 grams per person. India, with its burgeoning population, should ideally ensure over 30 MMT annually to meet these nutrition targets. However, per capita availability in 2023 was only about 45 grams per day, signaling a significant shortfall. This shortfall is met through imports, which have steadily increased in recent years. In 2023–24 alone, India imported over 4.7 MMT of pulses, primarily from Canada (lentils), Myanmar, Mozambique, and Tanzania. While imports help plug immediate gaps, they also raise the prices of pulses in exporting countries, impacting global food security and making pulses unaffordable for the poor in those nations.

Climate Change: The Hidden Crisis for Pulses

Understanding the Climatic Threats

Pulses are extremely vulnerable to climatic variability. While they are generally resilient crops requiring less water and able to grow in marginal soils, extreme weather events are posing unprecedented risks. Between 1960 and 2020, India's average temperature has risen by approximately 0.7°C, and projections indicate further warming of 1.5–2°C by 2050. This warming shortens the Rabi growing season, affecting crops like chickpea, lentils, and peas that require cool conditions. Rabi pulses like chickpea and lentil are particularly susceptible to rising winter temperatures. Heat waves during the flowering and pod-setting stages, especially from February to March, have caused significant flower drop, shortened crop duration, and reduced soil moisture—all of which lower yields. According to a 2023 report from the Indian Meteorological Department, India experience 88 heatwave days, affecting agriculture in more than 12 states. The damage was particularly visible in states like Uttar Pradesh, Bihar, and Madhya Pradesh. Kharif pulses, dependent on monsoonal rainfall, face their own challenges. Irregular rains, long dry spells followed by flooding, and increased incidence of pests due to humidity have led many farmers to abandon pulse cultivation in favor of more stable crops like rice or cotton. February-March heatwaves have increased flower drop in pulses, reducing yields by up to 30%. Erratic monsoons and late-onset rainfall have affected Kharif pulses such as

pigeon pea and moong bean. Too much rain during the sowing phase or water stagnation during flowering leads to poor pod formation and pest outbreaks. In 2023, for instance, delayed monsoons in central India reduced pigeon pea sowing by nearly 15% compared to the five-year average.

Emerging Climate-Resilient Varieties

To mitigate these effects, Indian agricultural research bodies like ICAR and IIPR have developed several climate-resilient pulse varieties:

- **Pusa Arhar 16**: A short-duration, drought-tolerant pigeon pea that matures in 120 days instead of the usual 170.
- **JG 14 (Chickpea)**: Heat-tolerant and early-maturing, ideal for dry regions of Madhya Pradesh and Maharashtra.
- **IPL 316 (Lentil)**: Resistant to high temperatures and suitable for late sowing conditions.
- **IPM 02-03 (Mung bean)**: Tolerant to moisture stress with high seed yield and early maturity.

Biological and Agronomic Barriers to Productivity

India's pulse yields are among the lowest in the world. The national average yield hovers around 800–900 kg/ha, compared to 1,700 kg/ha in Canada or 2,000 kg/ha in Ethiopia. Several biological and economic constraints contribute to this yield gap:

1. **Seed Quality:** Only about 25% of farmers use certified seeds. The rest rely on low-quality farm-saved seeds, reducing genetic potential.
2. **Pests and Diseases:** Pod borer, Fusarium wilt, powdery mildew, and root rot are widespread. Losses from pests alone can range from 20% to 40% annually.
3. **Fertilizer Use:** Pulses receive only 30–40% of the recommended fertilizer doses, primarily due to cost and lack of awareness.
4. **Lack of Credit and Inputs:** Around 80% of pulse farmers are smallholders with limited access to institutional credit, crop insurance, and market infrastructure.

Innovations: Toward Sustainable and High-Yielding Pulse Varieties

To address the yield and resilience issues, Indian agricultural research institutions, especially the Indian Council of Agricultural Research (ICAR), have developed over 100 new pulse varieties in recent years. Precision farming techniques, such as laser leveling, drip irrigation, and soil testing kits, are slowly gaining traction. Rhizobium bio-inoculation has shown promising results by improving nitrogen fixation, enhancing soil fertility, and boosting yields by 10–20%. Biotechnological tools such as CRISPR and TALENs offer exciting possibilities for pulse improvement. These gene-editing tools can target specific traits like drought resistance or disease immunity without introducing foreign genes, thus avoiding the controversies associated with GM crops. Additionally, marker-assisted selection and TILLING (Targeting Induced Local Lesions in Genomes) are helping breeders develop new varieties faster and more accurately.

Indicator	**Value (2023–24)**
Total Pulse Production	24.5–26 MMT
Domestic Requirement	30–32 MMT
Imports	4.7 MMT
Import Value	USD 3.7 Billion
Average Yield (India)	850 kg/ha
Average Yield (Canada)	1,700 kg/ha
Area Under Cultivation	~28 million hectares
Major Producing States	MP, Maharashtra, UP, Rajasthan
MSP for Tur (2024–25)	₹7,000/quintal
MSP for Masoor (2023–24)	₹6,000/quintal

Government Initiatives: MSP, Procurement, and Incentives

To counter the production deficit and incentivize domestic cultivation, the Indian government introduced Minimum Support Prices (MSPs) for major pulses. These MSPs have been revised regularly to reflect input costs and encourage farmers. In the 2024–25 Kharif season, the MSP for Tur (pigeon pea) was increased by ₹550 per quintal, reaching ₹7,000/quintal. Similarly, Masoor (lentil) received a ₹500 per quintal hike for the Rabi 2023–24 season. In addition to MSPs, procurement under schemes like PM-AASHA (Pradhan Mantri Annadata Aay Sanrakshan Abhiyan) and National Food Security Mission (NFSM)-Pulses has expanded. The government procured nearly 5 million tonnes of pulses during the recent Rabi and Kharif seasons. These schemes not only assure prices for farmers but also reduce distress sales and market volatility. Financial allocations under the Rashtriya Krishi Vikas Yojana (RKVY) and National Agricultural Market (eNAM) have helped improve market linkages. Despite these positive interventions, challenges remain in implementing these schemes uniformly across all regions, especially in backward and tribal districts.

Conclusion

Pulses are more than protein, they are climate warriors. Investing in climate-resilient varieties and adaptive agronomy is not just an agricultural imperative but a nutritional one. As India faces a hotter, more erratic climate, climate-smart pulses offer a low-cost, high-impact solution to secure food, soil, and livelihoods. By scaling up innovations and ensuring inclusive policy support, India can transform its pulse sector into a resilient pillar of sustainable development. With the right investments and institutional support, pulses can secure not only the plates of India’s poor but also its future against malnutrition, climate change, and agricultural distress. In doing so, India will not only feed its population but also lead the global charge toward sustainable, equitable food systems.