POLICY BRIEF 64

Economic Impact of Improved Mustard Varieties: A Case of Giriraj

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Edible oilseeds are the main source of protein and fat. Despite being one of the largest producers of oilseeds, India relies heavily on imports of edible oils to meet its domestic demand. In 2022-23, the country imported 16.5 million tons of edible oils, almost 57% of its domestic demand. Palm oil comprised 59% of the total imports, followed by crude soybean oil (23%), and sunflower oil (17%). Notably, there is a significant geographical concentration of their imports: palm oil is imported from Indonesia and Malaysia, soybean oil from Argentina and Brazil, and sunflower oil from Ukraine, Russia, and Argentina. Such a high dependence on imports and their geographical concentration makes the country highly vulnerable to global supply shocks due to pandemics and geopolitical tensions. Fluctuations in global prices may compel the government to reduce import tariffs and offer incentives to industry and importers. Furthermore, heavy reliance on imports adversely affects the country's foreign reserves, and acts as a disincentive for farmers to expand area under oilseeds[3].

While imports dominate the edible oil market, it is crucial to examine the potential for domestic production of oilseeds. Over the past two decades, the area under oilseeds has increased from 22.8 million hectares in 2000-01 to 30.2 million hectares in 2022-23. Their average yield increased from 810 kg per hectare to 1309 kg per hectare. However, it remains significantly lower (33%) than the global average of 1960 kg per hectare. In India, the primary constraints to oilseed production include their cultivation in arid and semi-arid regions with limited irrigation facilities, susceptibility to insect pests and diseases, lack of incentives, and an unpredictable import policy.

Agricultural research holds significant potential to address these constraints, thereby enhancing the domestic supply of edible oils, reducing the nation's reliance on international markets, and ensuring affordable access for consumers. By focusing on the breeding for high yield, climate-resilience, and pest-resistance varieties, improved cultivation practices, and processing methods, agricultural research can substantially improve the production and quality of edible oils. Evidence indicates that high-quality seeds alone can contribute 15-20% to increased production, with the potential for even greater gains when cultivated using efficient management practices[4].

To illustrate the potential impact of agricultural research on the oilseed sector, we focus on an improved variety of rapeseed-mustard, one of the primary oilseed crops grown in India.

Rapeseed-mustard in India's oilseed complex

Rapeseed-mustard occupies a prominent position in the oilseed complex of India. A prominent member of the Brassicaceae family, rapeseed-mustard is one of the most significant oilseed crops in India, covering approximately 30% of the total area under oilseeds, and accounting for nearly one-third of the total production (Figure 1). This crop serves multiple purposes, including as a source of edible oil for human consumption, protein-rich meals for livestock feed, and raw materials for various industrial applications.

This crop demonstrates adaptability to diverse climatic conditions and is extensively cultivated. However, its production is predominantly concentrated in seven states: Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, West Bengal, Gujarat, and Jharkhand, which collectively account for about 95% of the total production (Figure 2). Besides, it is cultivated in other states, including Assam, Bihar, Chhattisgarh, Jammu & Kashmir, Odisha and Punjab.

Both the area and yield of mustard have increased over time; however, these trends are characterized by significant fluctuations, primarily due to unpredictable extreme climatic conditions and a potential lack of

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[3] Balaji, S.J., Sharma, P., Venkatesh P., and Shreya K. (2022). *Technology and policy options for reducing India's import dependence on edible oils*. Policy Brief 49, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

[4] GoI. (2013). *State of Indian Agriculture 2012-13*. Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.

Figure 1. Production share of major oilseeds, 2023-24

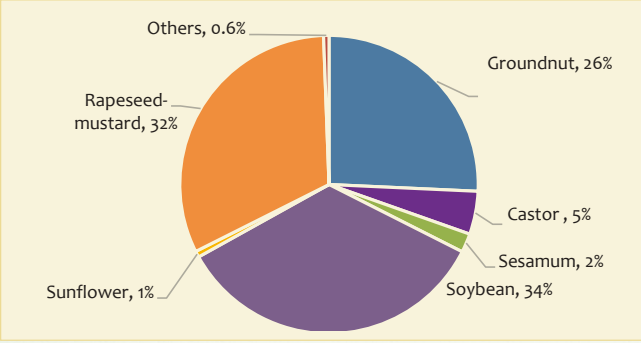
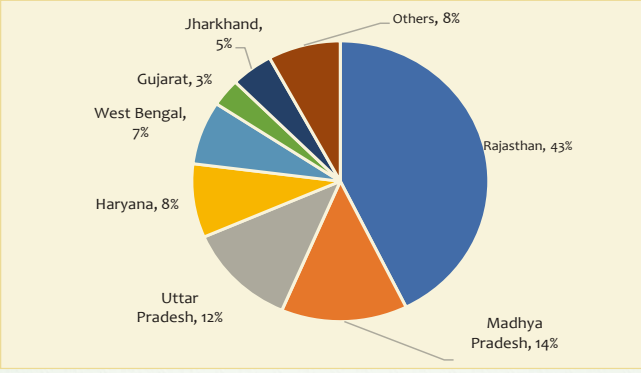
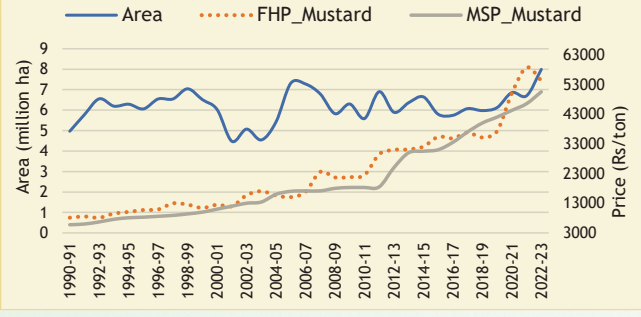


Figure 2. Distribution of mustard area across states of India, 2023-24



adaptive measures. Moreover, the volume of edible oil imports and the associated tariffs significantly affect the variability in farm harvest prices, which subsequently influences farmers' decisions regarding area allocation (Figure 1). Notably, when mustard seed prices are high in the preceding year, farmers are motivated to allocate more area to its cultivation in the subsequent season, anticipating continued high returns[5]. Conversely, when prices are low, farmers may reduce the area under mustard cultivation, or prefer to grow relatively more profitable crops.

Figure 3. Trends in area and one-year lag farm harvest price and minimum support price of mustard in India



Impact of improved rapeseed-mustard varieties

To enhance the domestic production of rapeseed-mustard, one of the most preferred edible oils in India, the national agricultural research system (including institutes under the umbrella of the Indian Council of Agricultural Research (ICAR) and State Agricultural Universities) has evolved several high-yielding varieties (HYVs) over the years. Recently, the ICAR-Indian Institute of Rapeseed Mustard Research (ICAR-IIRMR), Bharatpur, Rajasthan, developed HYVs that are suitable for cultivation in various agroclimatic zones (Table 1). Among these varieties, DRMRIJ-31, popularly called Giriraj, released in 2013-14 has been widely adopted in Haryana, Jammu & Kashmir, Punjab, and parts of Rajasthan, Bihar, Madhya Pradesh, and Uttar Pradesh because of its several traits such as bold seeds, higher yield (2225–2750 kg/ha), and oil content (39–42.6%). It can tolerate cold temperatures and heat stress during flowering and grain filling and is tolerant to diseases such as Alternaria leaf spots, powdery mildew, and white rust. Oil is of superior quality because of its low erucic acid content, rendering it comparatively healthier for consumption, and the resultant oilcake serves as an excellent feed for livestock.

Table 1. Recent varieties of mustard developed by ICAR-IIRMR

Variety	DRMRIJ 31	DRMR 150-35	DRMR 1165-40	DRMRIC 16-38	DRMR 2017-15	DRMR 2018-19
Year of release	2013	2020	2020	2021	2021	2024
Plant height (cm)	180-210	171-180	177-196	188-197	191-204	168-181
Maturity (days)	137-153	86-140	133-151	120-149	120-150	106-149
Seed type	Bold	Medium	Medium	Medium	Medium	Medium
1000 seed weight (gm)	5.6	4.7	4.9	4.1	4.1	4.4
Average yield (kg/ha)	2500	1820	2400	1750	1780	1859
Oil content (%)	39-42.6	37.7-42.8	40-42.5	37.6-40.9	40.7	37.8

Source: Annual Reports of AICRP-RM[6]

Figure 4 also demonstrates the superior performance of Giriraj compared to other widely cultivated varieties, such as Varuna, Kranti, and Rohini, as well as the national average yield. Over the nine-year period from to 2015-16 to 2023-24, Giriraj consistently showed higher performance, with an estimated average yield exceeding that of other popular varieties by approximately 300 kg per hectare. Compared to the national average, Giriraj's yield was approximately 700 kg per hectare higher.

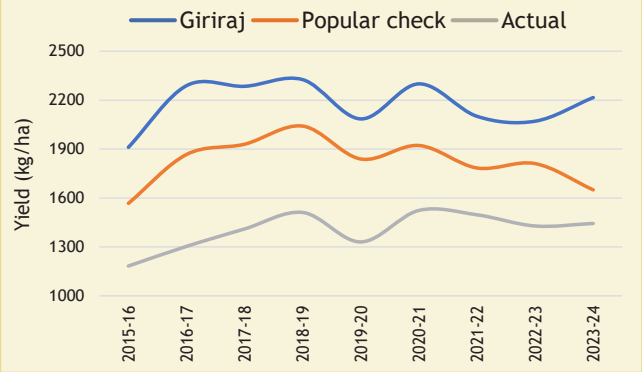
Based on estimates derived from data on breeder seed supply and farm surveys[7], the variety Giriraj has spread to cover about 15% of the total mustard area in 2023-24. Projections indicate an increase in its adoption rate to 17% by 2030 under business-as-usual (BAU) scenario (Figure 5). With significant promotional efforts, it can occupy 20% of the total mustard area.

[5] Devi, G. and Jadav, K.S. (2019). Price and non-price factors: A way for selecting mustard as a livelihood crop in Gujarat. *Pantnagar Journal of Research* 17(1): 40-46.

[6] IIRMR. (various years). Annual Reports of All-India Coordinated Research Project (AICRP), ICAR-Indian Institute of Rapeseed Mustard Research, Bharatpur, Rajasthan.

[7] Farm surveys were conducted in rapeseed-mustard growing states of Rajasthan, Madhya Pradesh, Uttar Pradesh and Bihar in January 2025.

Figure 4. Trends in yield of Giriraj vis-a-via other popular varieties



To quantify the economic impact of Giriraj, we employ the economic surplus model, a well-established approach for impact evaluation. The analysis considers the distribution of benefits between producers and consumers in a closed economy setting, wherein benefits of technological change can be distributed between producers and consumers. Producers benefit from an increase in production, represented by an upward shift in the supply curve, whereas consumers benefit from lower output prices, indicated by a downward shift in the demand curve. The following equations provide the economic benefits, taking into account the shifts in supply and demand curves resulting from the adoption of Giriraj.

$$\Delta CS_t = P_o Q_o Z_t (1 + 0.5 Z_t \eta)$$

$$\Delta PS_t = P_o Q_o (K_t - Z_t) (1 + 0.5 Z_t \eta)$$

$$\Delta TS_t = \Delta CS + \Delta PS = P_o Q_o K_t (1 + 0.5 Z_t \eta)$$

where ΔCS_t is the change in consumer surplus in year t, ΔPS_t is the change in producer surplus in year t, ΔTS_t is the change in total surplus, P_o is the initial price, Q_o is the initial level of production, Z_t is the reduction in price as a result of an increase in supply due to adoption of Giriraj, η is the absolute value of demand elasticity, ε is the supply elasticity, and K_t is the proportionate supply shift in year t due to the adoption of the variety.

The parameters used to estimate the economic surplus owing to the introduction of Giriraj are listed in Table 2.

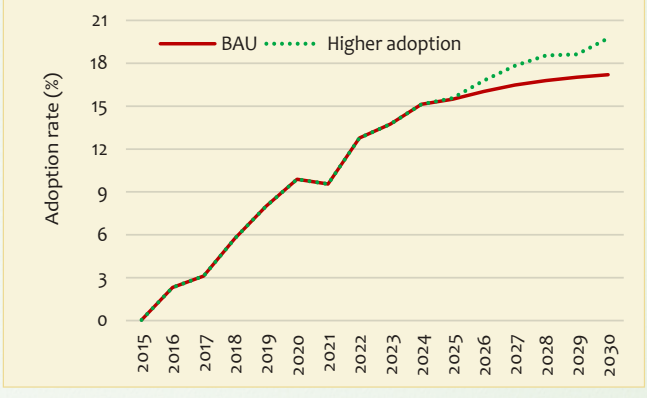
The adoption rate of a technology and its yield advantage relative to other technologies are critical parameters for estimating its economic impact. There has been a rapid expansion of the area under Giriraj since its release for field cultivation. When estimating the long-term impact of crop varieties, it is important to account for their typical lifecycle. Generally, a crop variety typically remains in the seed supply chain for approximately 15 years, after which genetic deterioration is expected to occur, leading to lower yield and even an increase in its proneness to insect pests and diseases.

Table 2. Parameters used for estimating economic surplus due to Giriraj

Parameter	Value	Source
Production in target states[1]	5.47 million tons	Division of Economics, Statistics & Evaluation (DES&E), Ministry of Agriculture and Farmers Welfare (MoAFW), Government of India (https://desagri.gov.in/)
Average farm harvest prices (FHP) of mustard during 2021 to 2023	Rs 53000/ ton	Farm harvest prices (FHP): DES&E, Ministry of Agriculture and Farmers Welfare, Government of India
Yield gain	19%	Frontline demonstration (FLD) data from AICRP-RM, and verified from field survey
Increase in variable cost	2%	FLD data from AICRP-RM, and field survey
Adoption level	15%	Estimated using breeder seed indent received at IIRMR and verified from field survey in target states
Supply elasticity	0.508	Kumar and Mittal (2011)[2]
Demand elasticity	0.297	Kumar and Mittal (2011)
Study period	2015-2024	

The yield advantage of Giriraj has been thoroughly evaluated using comprehensive data from controlled field trials and extensive farm surveys. These assessments have demonstrated that Giriraj has a 19% higher yield. While the yield advantage of Giriraj is significant, its adoption is associated with a marginal increase in cultivation costs, approximately 2% higher than other varieties due to higher expenses for seeds and other inputs.

Figure 5. Adoption rate of Giriraj (%)

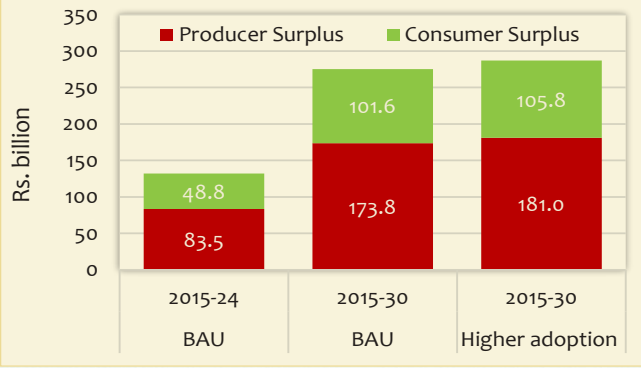


[8] Target states include Rajasthan, Haryana, Madhya Pradesh, Uttar Pradesh, Bihar, and Punjab, which together share 78% area and 84% production of mustard.

[9] Kumar, P., Kumar, A., Shinoj, P. and Raju, S.S. (2011). Estimation of demand elasticity for food commodities in India. *Agricultural Economics Research Review* 24(1): 1-14.

The adoption of Giriraj between 2015 and 2024 has yielded a significant economic impact, resulting in a surplus of Rs 132 billion, which translates to Rs 13.2 billion annually (Figure 6). The economic benefits are anticipated to continue increasing, with projections suggesting a potential surplus of Rs 275 billion by 2030, or Rs 17.2 billion per year, assuming an adoption rate of 17% while maintaining other parameters constant. When the adoption rate rise to 20%, the benefits could be even more substantial, albeit marginally.

Figure 6. Economic surplus from Giriraj



The adoption of Giriraj yields significant benefits for both producers and consumers. Producers capture the majority of these benefits, accounting for 63% of total economic gains. This substantial share likely translates into increased income for farmers, potentially enhancing their livelihood. Conversely, consumers receive the remaining 37% of the benefits from adopting Giriraj. It is noteworthy that both producers and consumers benefit from adoption of the improved mustard variety. The increased adoption of Giriraj may contribute to a more stable market supply, potentially reducing price volatility and ensuring consistent availability of edible oils.

Policy implications

The improved mustard varieties offer numerous advantages, including more stable economic returns for farmers, and a reduction in imports of edible oils. To facilitate the dissemination of high-yielding variety (HYV) seeds, policymakers should consider the following measures:

Strengthen seed supply chain: A robust seed supply system is crucial to harness the production potential of improved varieties. The seed replacement rate (SRR) for mustard is 68% but varies significantly across major mustard-growing states. It is as high as 80% in Rajasthan to as low as 13% in Jharkhand. Madhya Pradesh which accounts for 14% share in rapeseed-mustard area has SRR of 40%. Except in Rajasthan the SRR is significantly lower than the optimal 80-85%. To improve SRR, it is essential to strengthen the seed supply chain, particularly in states with significant untapped potential. Strategies may include establishing more seed production, storage and transportation facilities, and implementing awareness programs to educate farmers about the benefits of SRR.

Target rice fallows: Rice fallows present a massive opportunity for expanding oilseed cultivation, particularly in eastern India. Of the total 11.59 million hectares of rice fallows in the country, approximately 75% lie in the eastern states of Odisha, Chhattisgarh, West Bengal, Assam, Jharkhand, and Bihar (8.54 million hectares). This vast expanse of unutilized land offers immense potential for increasing oilseed production, specifically through the cultivation of medium-duration mustard varieties. For example, in Odisha, the realizable yield of Giriraj is 860 kg per hectare, more than double the state average of 340 kg per hectare. Notably, Giriraj can grow on residual moisture after rice harvest and has remarkable adaptability to terminal heat stress, which is common in eastern India.

Market and price support: Multiple factors, including import dynamics, fluctuating tariff rates, and volatility in farm harvest prices, affect farmers' decision-making processes regarding acreage allocation under oilseeds. Despite government interventions aimed at stabilizing prices and supporting farmers through minimum support prices and procurement initiatives, the price volatility persists because of inconsistent import policies and tariff structures. To address these challenges, a comprehensive and sustainable trade policy is crucial. A well-designed trade policy can help reduce price volatility, and foster long-term growth and stability in the production of oilseeds.

Invest in research: Sustained investment in research is essential to develop high seed and oil yielding varieties that are resistant to diseases and pests, and tolerant to climatic aberrations, including low and high temperatures. Beyond production, the research should also aim to improve the processing efficiency.

April 2025

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