

Sustaining Soybean Acreage in India with Break-Even and Iso-Return Analysis of Crop Dynamics in Madhya Pradesh and Maharashtra

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Abstract

Soybean is a major kharif oilseed crop in India, with Madhya Pradesh and Maharashtra together accounting for about 85% of the country's soybean area. However, soybean acreage has declined in these states in recent years, alongside the expansion of competing crops, particularly maize. This study assessed the economic competitiveness of soybean vis-à-vis maize and paddy in Madhya Pradesh and Maharashtra using secondary data for 2023–24. Break-even price analysis and an iso-return framework were used to estimate the soybean price required to generate returns equivalent to those of competing crops under Cost A2, Cost A2+FL, and Cost C2. The results revealed a considerable competitive disadvantage for soybean relative to maize in both states. At a maize price of ₹2,090/ql, the break-even soybean price under Cost A2 was ₹5,710/ql in Madhya Pradesh and ₹7,065/ql in Maharashtra, compared with the soybean MSP of ₹4,600/ql. Against paddy priced at ₹2,183/ql, the corresponding break-even soybean price in Madhya Pradesh was ₹6,719/ql. In contrast, soybean was relatively competitive with paddy in Maharashtra under the specified price, cost and yield conditions. The analysis also showed that the soybean-to-competing-crop price ratio required for equal returns is not constant but varies with relative prices, yields and production costs. The findings support a cross-commodity approach to soybean price policy, supplemented by region-specific interventions to improve productivity and reduce production costs.

Keywords: soybean, break-even price, iso-return, crop competitiveness, maize, paddy, MSP, price parity

Resource allocation decisions at the farm level involve a rational process in which producers consider expected commodity prices, unit production costs, and yield variability across enterprise options. In Indian agriculture, soybean has long been essential to the rainfed kharif economy, offering a reliable source of vegetable oil and high-protein meal. However, recent trends show a concerning shift away from soybeans toward alternative kharif crops such as maize and paddy in central and western India. Nationally, soybean cultivation decreased from 13.4 million hectares (132.55 lakh ha) in 2023–24 to 12.35 million hectares (123.53 lakh ha) in 2025–26. The most significant decline took place in Madhya Pradesh and Maharashtra. In Madhya Pradesh, soybean area fell from 60.60 lakh ha to 54.54 lakh ha (a 10.00% reduction), while in Maharashtra, it declined by 3.36%, from 51.15 lakh ha to 49.43 lakh ha. Meanwhile, other crops expanded notably. In Madhya Pradesh, paddy area grew by 22.38% (from 34.40 lakh ha to 42.10 lakh ha) and maize by 76.01% (from 15.30 lakh ha to 26.93 lakh ha). In Maharashtra, maize area increased by 58.31%, rising from 9.09 lakh ha to 14.39 lakh ha. The relevant question, therefore, is whether the prevailing soybean price yields returns comparable to those from competing crops. A break-even price

approach offers a useful way to address this question. Boutwell et al. (1975) used iso-return curves to derive soybean/corn and soybean/cotton price relationships that yield equal returns, and demonstrated that break-even price ratios vary with prices, costs and yields. Few studies have focused on the comparative economics of various crops and the selection of alternative crops. Sturm and Smith (1993) conducted a similar investigation in Bolivia, finding that the capital expenditure required and the anticipated profitability, both economic and non-economic, are the attributes of new crops that most significantly influence farmers' initial decisions to adopt or reject them. Mbaye et al. (2014) examined the determinants of smallholders' choices of alternative crops in Kenya, concluding that demographic and socio-economic factors influence crop enterprise decisions. Karelakis and Tsantopoulos (2017) analysed the factors that guide landholders' decisions to adopt alternative crops in Greece, finding that the most critical determinants include scientific support provided to farmers and the development of market demand for the products.

The present study adapts this framework to Indian conditions and evaluates the competitive position of soybean relative to maize and paddy in Madhya Pradesh and Maharashtra. The specific objective was to

evaluate the profitability of soybean relative to competing crops under alternative prices, costs and yields, and to estimate the soybean price required to achieve returns equivalent to those from maize and paddy.

MATERIALS AND METHODS

Data Base

The study covered Madhya Pradesh and Maharashtra and used secondary data for the 2023–24 agricultural year. Cost of cultivation data for three standardised cost concepts (Cost A2, Cost A2+FL, and Cost C2) were compiled for MP and MH from the Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers Welfare, Government of India. Cost A2 (paid-out expenses), Cost A2+FL (paid-out costs plus imputed value of family labour), and Cost C2 (comprehensive cost including land rent and interest on fixed capital) were compiled for MP and MH from the Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers Welfare, Government of India. Commodity price trends and Minimum Support Prices (MSP) were obtained from official agricultural price notifications.

Analytical Framework

The methodological approach adapts the iso-return framework developed by Boutwell et al. (1975) for regional crop competition. At the planting decision phase, farmers evaluate net returns per hectare (NR) across alternative crop choices given a fixed land resource constraint.

The net return per hectare for soybean (NR_{SB}), maize (NR_m), and paddy (NR_p) above a specific cost threshold is defined as:

$$NR_{SB} = P_{SB} \cdot Y_{SB} - VC_{SB}$$

$$NR_m = P_m \cdot Y_m - VC_m$$

$$NR_p = P_p \cdot Y_p - VC_p$$

where:

- P_{SB}, P_m, P_p = Farmgate/Market prices (₹/qtl) for soybean, maize, and paddy, respectively.
- Y_{SB}, Y_m, Y_p = Yields (qtl/ha) for soybean, maize, and paddy, respectively.

- VC_{SB}, VC_m, VC_p = Production costs per hectare (₹/ha) evaluated at Cost A2, Cost A2+FL, or Cost C2 levels.

To solve for the Break-Even Price (BEP) of soybean (P_{SB}) that yields net returns equal to a competing crop (e.g., maize), the respective net return functions are equated:

$$NR_{SB} = NR_m$$

$$P_{SB} \cdot Y_{SB} - VC_{SB} = P_m \cdot Y_m - VC_m$$

Rearranging the terms yields the break-even price equation for soybean relative to maize:

$$P_{SB} = \frac{P_m \cdot Y_m - VC_m + VC_{SB}}{Y_{SB}}$$

Similarly, the break-even price equation for soybean relative to paddy is expressed as:

$$P_{SB} = \frac{P_p \cdot Y_p - VC_p + VC_{SB}}{Y_{SB}}$$

Asymptotic Behaviour of the Iso-Return Price Ratio

Dividing both sides of the break-even equation by P_m establishes the break-even price ratio (Ratio = P_{SB}/P_m):

$$\frac{P_{SB}}{P_m} = \frac{Y_m}{Y_{SB}} + \frac{VC_{SB} - VC_m}{P_m \cdot Y_{SB}}$$

As the absolute market price level of the competing crop (P_m) increases, the secondary cost-differential term $\left(\frac{VC_{SB} - VC_m}{P_m \cdot Y_{SB}}\right)$ shrinks toward zero. Consequently, the break-even price ratio is non-constant; it varies non-linearly at low price levels and asymptotically approaches the inverse yield ratio $\left(\frac{Y_m}{Y_{SB}}\right)$ as a maximum limit.

RESULTS AND DISCUSSION

Changes in soybean and competing-crop acreage

The area data reveal contrasting trends for soybean and its main competing crops (see Table 1). Soybean cultivated area in Madhya Pradesh decreased by 10.0% from 2023–24 to 2025–26, whereas Maharashtra saw a

smaller decline of 3.36%. Conversely, maize areas grew significantly, with increases of 76.01% in Madhya Pradesh and 58.31% in Maharashtra.

Additionally, paddy cultivation in Madhya Pradesh rose by 22.38%.

Table 1. Area under soybean and selected competing crops in Madhya Pradesh and Maharashtra

State	Crop	2023–24	2024–25	2025–26	% Change (2023–24 to 2025–26)
Madhya Pradesh	Soybean	60.60	58.72	54.54	-10.00
	Rice	34.40	38.30	42.10	+22.38
	Maize	15.30	20.77	26.93	+76.01
Maharashtra	Soybean	51.15	50.72	49.43	-3.36
	Rice	15.25	15.21	14.46	-5.18
	Maize	9.09	11.16	14.39	+58.31
Rajasthan	Soybean	11.26	10.79	9.76	-13.32
	Rice	2.68	3.54	3.50	+30.60
	Maize	8.62	9.70	9.66	+12.06
All India	Soybean	132.55	129.52	123.53	-6.80

The decline in soybean cultivation alongside the expansion of maize indicates growing competition between the two crops. However, changes in area can also be influenced by factors like agro-climatic conditions, irrigation access, market opportunities, and institutional elements. As a result, the observed acreage trends are viewed as contextual indicators rather than direct proof of causation from the estimated break-even prices.

Cost of cultivation and relative cost position

A comprehensive analysis of the empirical cost structures presented in Table 2 reveals fundamental cost-push pressures and regional disparities that elucidate the shifting comparative advantage among kharif crops in central India. In Madhya Pradesh, out-

of-pocket operational costs (Cost A2) for soybean increased rapidly by 20.40% between 2021–22 and 2023–24, ascending from ₹24,888/ha to ₹29,964/ha. During the same period, competing enterprises within the state experienced remarkably stable operational costs. Cost A2 for maize grew modestly by 2.92%, rising from ₹31,696/ha to ₹32,622/ha, while paddy Cost A2 increased by a modest 4.51%, moving from ₹35,201/ha to ₹36,787/ha. At the comprehensive Cost C2 level which accounts for land rent and fixed capital interest soybean costs expanded by 17.97% to reach ₹48,801/ha. This increase significantly outpaced the modest cost growth rates of 6.09% for maize (₹53,445/ha) and 5.81% for paddy (₹67,407/ha), demonstrating a sharp rise in soybean expenses that substantially squeezed its profit margins relative to competing staples.

Table 2: Cost of Cultivation Across Cost Concepts in MP and MH (₹/ha)

State	Crop	Cost Concept	2021–22	2022–23	2023–24	% Change (2021–22 to 2023–24)
MP	Soybean	Cost A2	24,888	26,035	29,964	+20.40
		Cost A2+FL	29,512	30,769	34,528	+17.00
		Cost C2	41,368	43,804	48,801	+17.97
	Maize	Cost A2	31,696	32,295	32,622	+2.92
		Cost A2+FL	37,890	38,599	39,060	+3.09
		Cost C2	50,377	51,974	53,445	+6.09
	Paddy	Cost A2	35,201	36,104	36,787	+4.51
		Cost A2+FL	44,943	46,257	46,988	+4.55
		Cost C2	63,707	66,053	67,407	+5.81
MH	Soybean	Cost A2	49,130	54,342	52,483	+6.82
		Cost A2+FL	53,717	59,931	58,379	+8.68
		Cost C2	69,905	76,396	75,396	+7.85
	Maize	Cost A2	57,282	61,693	63,195	+10.32
		Cost A2+FL	66,969	73,238	75,929	+13.38
		Cost C2	92,343	99,966	100,434	+8.76
	Paddy	Cost A2	67,567	69,085	65,884	-2.49
		Cost A2+FL	81,713	84,500	87,282	+6.82
		Cost C2	93,349	96,267	101,998	+9.27

Maharashtra's agricultural costs are notably higher than Madhya Pradesh's due to structural factors. In 2023–24, soybean Cost A2 in Maharashtra was ₹52,483/ha, which is 75.15% more than Madhya Pradesh's ₹29,964/ha. This cost gap persists across all categories, with the total comprehensive cost (Cost C2) at ₹75,396/ha in Maharashtra compared to ₹48,801/ha in Madhya Pradesh. Elevated agricultural wages, intensive land preparation, and higher land rental rates in Maharashtra increase the baseline break-even price, making soybean cultivation more capital-intensive in the state.

Analyzing the difference between Cost A2 and Cost A2+FL reveals the importance of unpaid family labor across different enterprises and regions. In 2023–24, family labor added an estimated value of ₹4,564/ha to soybean cultivation in Madhya Pradesh, while paddy required a higher ₹10,201/ha because of labor-intensive tasks like nursery development, manual transplanting, and water management. In Maharashtra, family labor's contribution was ₹5,896/ha for soybean, ₹12,734/ha for maize, and ₹21,398/ha for paddy. The significant family labor involvement in paddy provides smallholders with an economic buffer against direct

cash expenses, making paddy a more attractive venture with lower liquidity risk despite its higher overall cost.

Finally, when accounting for fixed capital depreciation, interest on investment, and land rental values, the total comprehensive cost (Cost C2) for cereal alternatives in Maharashtra exceeds six-figure thresholds per hectare. By 2023–24, Cost C2 was recorded at ₹1,00,434 per hectare for maize and ₹1,01,998 per hectare for paddy. While maize entails substantial total resource commitments in Maharashtra evidenced by an 8.76% increase in Cost C2 from ₹92,343 per hectare to ₹1,00,434 per hectare its superior per-hectare yield potential enables farmers to more effectively absorb these fixed capital overheads than soybean.

Break-even soybean price vis-à-vis Competitive crops

The iso-return analysis revealed a substantial gap between the prevailing soybean MSP and the price required to match maize returns. At the maize MSP of ₹2,090/ql, the break-even soybean price under Cost A2 was ₹5,710/ql in Madhya Pradesh and ₹7,065/ql in Maharashtra (Table 3).

Table 3: Break-even price of soybean at alternative prices of competitive crops, 2023–24

State	Cost concept	Maize price (₹/ql)	Break-even soybean price (₹/ql)	Paddy price (₹/ql)	Break-even soybean price (₹/ql)
Madhya Pradesh	A2	2,090	5,710	2,183	6,719
	A2+FL	2,090	5,555	2,183	6,254
	C2	2,090	5,546	2,183	5,746
Maharashtra	A2	2,090	7,065	2,183	2,076
	A2+FL	2,090	6,625	2,183	1,079
	C2	2,090	6,144	2,183	1,227

In 2023–24, the soybean MSP was ₹4,600 per quintal. The Cost A2 break-even price surpassed this MSP by ₹1,110 per quintal in Madhya Pradesh and by ₹2,465 per quintal in Maharashtra. The wider margin in Maharashtra suggests that maize holds a comparatively stronger competitive edge given the current regional yield and cost dynamics. Additionally, the iso-return analysis indicates that as maize prices rise, the break-even soybean price also increases. For instance, in Madhya Pradesh, the Cost A2 break-even soybean price rose from ₹5,109 per quintal at a maize price of ₹1,870 per quintal to ₹6,557 per quintal at a maize price of ₹2,400 per quintal. Similarly, in Maharashtra, the figures increased from ₹6,322 to ₹8,113 per quintal over the same maize price range. The soybean–paddy relationship showed notable differences between the two states. In Madhya Pradesh, with a paddy MSP of ₹2,183 per quintal, the break-even soybean price under Cost A2 was ₹6,719 per quintal

₹2,119 above the soybean MSP. Under Cost A2+FL and Cost C2, the break-even prices were ₹6,254 and ₹5,746 per quintal, respectively. Conversely, in Maharashtra, the break-even soybean price at a paddy price of ₹2,183 per quintal was only ₹2,076 under Cost A2, and ₹1,079 and ₹1,227 per quintal under Cost A2+FL and Cost C2, respectively. This indicates that, considering the 2023–24 price, cost, and yield conditions, soybean was economically competitive with paddy in Maharashtra. This regional difference highlights the need to include state-specific production conditions when analyzing crop competitiveness. Using a single national soybean-to-paddy price ratio would overlook the significant economic differences seen between the two states. The Cost A2 iso-return price ratios offer additional evidence indicating that the competitive relationship is not static. In Madhya Pradesh, at the 2023–24 Minimum Support Prices (MSPs) of ₹2,183 per quintal for paddy and ₹2,090 per quintal for maize, the break-even ratios of soybean to

paddy and soybean to maize were 3.07 and 2.73, respectively. In Maharashtra, the respective ratios were 0.95 for soybean to paddy and 3.38 for soybean to maize.

The result aligns conceptually with Boutwell et al. (1975), demonstrating that the soybean/corn break-even price ratio changes with the price level and nears an asymptotic value linked to relative yields. Therefore, relying solely on a fixed price ratio with a competing crop for soybean price policy may not accurately capture evolving economic conditions. The

parity price should be updated whenever there are changes in crop prices, yields, or production costs.

The price-ratio analysis

Empirical tracking further shows that the break-even price ratio ($P_{\text{SB}} / P_{\text{C}}$) is non-linear. When commodity prices are low, cost differences significantly influence the ratio; as prices increase, the ratio approaches the yield differential of the crops. Since yield gaps and cost structures differ between MP and MH, a single nationwide pricing policy cannot effectively prevent regional shifts in acreage.

Figure 1: Price ratio over cost A2 in Madhya Pradesh

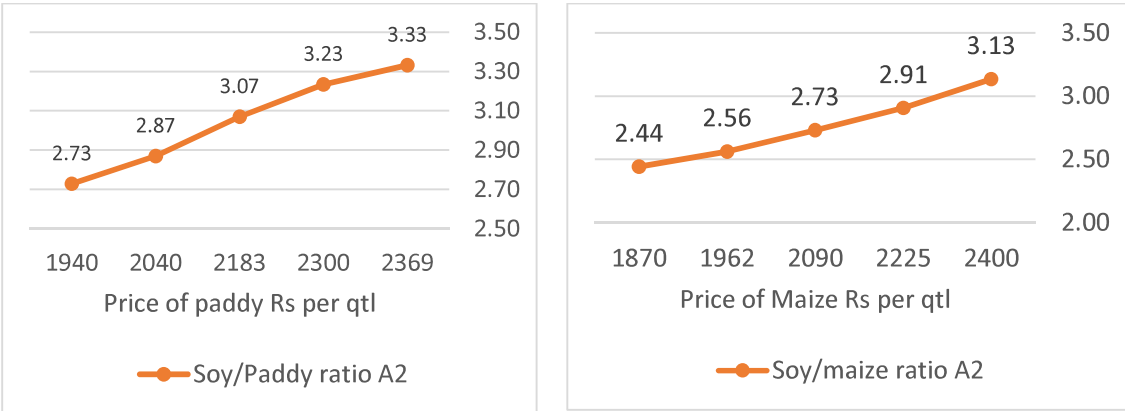
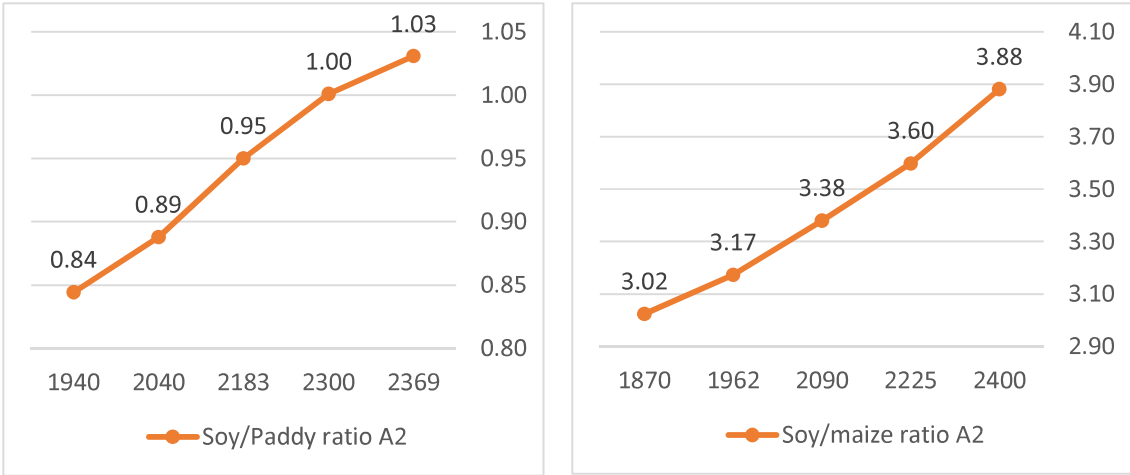


Figure 2: Price ratio over cost A2 in Maharashtra



Conclusion

The study assessed the competitive strength of soybean relative to maize and paddy in Madhya Pradesh and Maharashtra through break-even and iso-return analyses. Findings indicate that soybean faced a significant economic challenge compared to maize under the 2023–24 price, yield, and cost scenarios.

Specifically, at a maize price of ₹2,090 per quintal, soybean needed to reach ₹5,710 per quintal in Madhya Pradesh and ₹7,065 per quintal in Maharashtra (Cost A2) to match maize returns, which is higher than the soybean MSP of ₹4,600 per quintal.

In Madhya Pradesh, the soybean–paddy relationship was highly unfavorable to soybean, requiring a price of

₹6,719 per quintal at a paddy price of ₹2,183 per quintal under Cost A2. Conversely, in Maharashtra, soybean stayed competitive with paddy under the same pricing conditions, highlighting the influence of regional cost and yield differences.

The findings indicate that evaluating soybean competitiveness requires more than just nominal output prices or a set soybean-to-competing-crop price ratio. Break-even prices fluctuate depending on crop prices, yields, and production costs. Consequently, soybean price policies could be improved by adopting a flexible cross-commodity parity framework that accounts for the returns from key competing crops in major soybean-producing areas. Simultaneously, price intervention must be supplemented with measures that enhance productivity and reduce costs. Technological interventions tailored to specific regions, along with improvements in yield stability, efficient utilization of inputs, and enhanced market realization, can mitigate the economic disparity between soybeans and competing crops. This integrated strategy would support the preservation of soybean cultivation and bolster domestic oilseed production.

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