POLICY BRIEF 70

Economic Impacts of Maize Hybrids

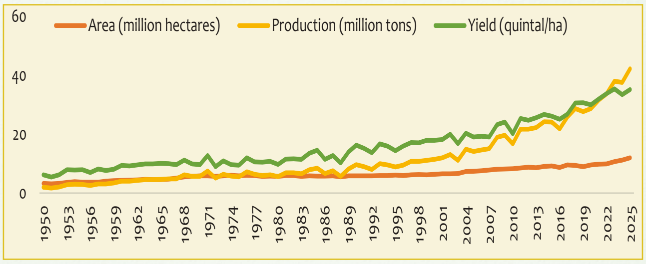
Bhupender Kumar, Kiran Kumara T M, Shankar Lal Jat, and Hanuman Sahay Jat

Maize (*Zea mays* L.), often referred to as the 'queen of cereals,' is one of the most versatile crops and is highly adaptable to diverse agroecological environments. In India, maize has traditionally been grown during the kharif season. However, since 1970s, it has also been grown in rabi and later in spring seasons. Maize is grown in many parts of India for a variety of uses, including feed, ethanol, starch, food, silage, fodder, oil, pharmaceuticals and cosmetics. After rice and wheat, maize is the third most important cereal in India, having the highest yield potential amongst the cereal.

Maize production in the country has been steadily rising, reaching 42.28 million tonnes from a sizable area of 12 million hectares during 2024-25[1] (Figure 1). Madhya Pradesh, Karnataka, Bihar, Maharashtra, Telangana and West Bengal are the top maize-producing states in the country. Over the last decade, maize productivity in the country has improved significantly (32.5%), but there still remains considerable potential for further enhancement. The significant increase in maize production and productivity has been possible due to policy interventions, cultivation of improved maize hybrids, especially single-cross hybrids, adoption of best management practices and effective control of diseases and insect pests.

India has also emerged as one of the major maize exporters in Asia, catering primarily to Southeast Asia and its neighbouring countries.[2] Higher global prices of maize from the U.S., Brazil, and Argentina, along with their longer transport times, have given Indian maize an edge in the Southeast Asian region. Presently, the majority of maize produced in India goes to poultry feed industry (44%), followed by bioethanol production (18%), food (15 %), starch (12%), and animal feed (11%), (Figure 2). With the continued growth in the poultry, biofuel, and starch industries, domestic demand for maize is expected to rise considerably in India. Therefore, targeted interventions are required across the maize value chain, involving the coordinated combined efforts of all concerned stakeholders, to meet the growing domestic demand for maize while addressing productivity enhancement and environmental issues.

Figure 1. Trends in maize yield improvement in India (1950 to 2024)[1]



Bioethanol is primarily produced from agricultural feedstocks such as sugar, starch, and lignocellulosic biomass.[3] In India, during the Ethanol Supply Year (ESY) November 1st 2022 to October 31st 2023, sugarcane molasses accounted for 50% of ethanol production, while sugarcane juice and damaged food grains (primarily broken rice) contributed 25% each. However, the decline in sugar production during 2023–24 has raised concerns about the sustainability of sugarcane juice–based ethanol. Similarly, ethanol from damaged food grains faces challenges related to food security, high procurement cost, groundwater use, and long-term environmental implications.

Against the backdrop, maize is emerging as a key feedstock for ethanol production due to its high starch content, higher yield potential, no effects on food security, less water requirement compared to sugarcane and rice, shorter crop duration, and suitability for cultivation across multiple seasons.[4] For the ESY 2024-25, around 10,020 million litres of ethanol is supplied, with the feedstock allocation estimated at 45.68% from maize, 27.52% from sugarcane (including its derivatives), 22.25% from rice, and 4.54% from damaged food grains[5]. It is estimated that

Bhupender Kumar (Senior Scientist), Shankar Lal Jat (Senior Scientist), and Hanuman Sahay Jat (Director) are affiliated with ICAR-Indian Institute of Maize Research (IIMR), Ludhiana, Punjab. Kiran Kumara T M (Scientist) is affiliated with ICAR-NIAP, New Delhi. Authors express their sincere gratitude to Dr Pratap Singh Birthal, Director, ICAR-NIAP, for his valuable guidance and support throughout this study. The contributions of AICRP partners and collaborating agencies helped in developing and popularising these technologies is greatfully acknowledged.

1 Government of India. Division of Economics, Statistics & Evaluation (DES&E), Ministry of Agriculture and Farmers Welfare (MoAFW), Government of India (https://desagri.gov.in/)

2 FASAR & FICCI. (2024). *The Indian Maize Sector: Trends, Challenges & Imperatives for Sustainable Growth.*, Pp 59.

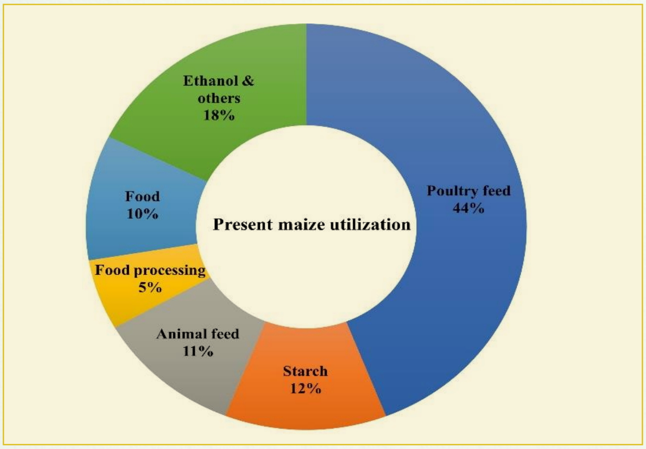
3 Mabee, W.E., McFarlane, P.N., and Saddler, J.N. (2011). Biomass availability for lignocellulosic ethanol production. *Biomass and Bioenergy*, 35(11):4519–4529. https:// doi.org/10.1016/j.biombioe.2011.06.026.

4 Kumar B., Sarkar D., Yankanchi S., Singh R., Mehindiratta S., Pandey P., Nath C., Jha A.K., Kumar K and Jat H.S. (2025). Meta-QTLs and candidate genes mining for starch and climate resilience to improve bioethanol production in maize. *Industrial Crops & Products*, 235: 121753

5 https://www.chinimandi.com/esy-2024-25-around-1002-crore-liters-of-ethanol-supplied-during-nov-24-oct-25/

about 12.7 million tonnes of maize will be required to produce nearly 4840 million litres of ethanol.[6] In practice, during the ongoing ESY 2024–25 (up to end-July), maize has already contributed about 43% of total ethanol production, surpassing sugarcane, whose share declined to 38%, despite its status as the traditional primary feedstock. This growing reliance on maize has not only reinforced its role in India's ethanol economy but also led to higher maize prices, encouraging more farmers to shift towards cultivating this as a profitable crop. The demand is projected to rise further to achieve the E30 target (30% ethanol blending in petrol) of the Government of India by 2030. Additionally, the Government of India is also planning to blend diesel by 5 % isobutanol by 2030. Therefore, continuous efforts are needed to improve maize production and productivity in the country.

Figure 2. Utilization pattern of maize in India



Hybrid maize technology: The catalyst behind productivity gains

The exploitation of heterosis through the commercial cultivation of maize single-cross hybrids has been one of the main successes in maize breeding. Despite its success, wider adoption across all regions of the country remains crucial to sustain productivity and enhance genetic potential under diverse ecologies. However, suboptimal crop management practices and the high incidence of biotic and abiotic stresses often limit farmers to realizing only half of the potential yield. Thus, achieving maximum production requires greater coverage under stress-resistant single-cross hybrids, coupled with the adoption of improved portfolios of agronomical practices. Currently, nearly 70 % of Indian's maize area is under single-cross hybrids,[7] which could potentially be extended to 90-100% with a greater emphasis on climate-resilient varieties.

The maize seed sector in India is predominantly led by the private sector (65-70%), while the public sector contributes 25–30%[8]. Despite this strong presence, farmers continue to face challenges in accessing good-quality seeds at the right time and at affordable prices, which remains a bottleneck. The majority of hybrid maize seed production is concentrated in the peninsular regions of Andhra Pradesh and Telangana, leading to increased seed costs due to transportation to northern, western and eastern parts of the country.

Furthermore, approximately 70% of the maize in India is cultivated under rainfed conditions, while only 30% is grown under irrigated conditions. In irrigated maize, long-duration hybrids are predominant, which require more time, irrigation and are generally prone to major abiotic stresses. Most of these are from the private sector and are sold to farmers at prices ranging from Rs 300 to 1000 per Kg. The short to medium duration hybrids are more preferred for sustainable intensification in rainfed and major agri-food systems of the country due to their lesser duration and better adaptability under abiotic and biotic stresses conditions. On the other hand, long-duration hybrids, while potentially offering higher yields under ideal conditions, may be more susceptible to yield losses under various abiotic stresses such as drought, water logging, heat and cold and biotic such as charcoal rot, post flowering stalk rot and banded leaf and sheath blight diseases.

Recognizing these challenges and considering all factors, the ICAR-Indian Institute of Maize Research (IIMR) developed and released two medium-duration field corn hybrids viz., DMRH 1301 and DMRH 1308, in 2017-18. Of these, DMRH 1301 was recommended for rabi cultivation in the Central Western Zone (CWZ) and North Eastern Plain Zone (NEPZ), while DMRH 1308 was recommended for the Central Western Zone (CWZ) 2017-18 and later for Bihar state in 2020. Together, these two zones representant nearly 50% of India's total maize area. From 2021-22 onwards, DMRH 1308 was also included in the packages of practices for commercial cultivation in West Bengal by the state agriculture department. To date, IIMR has released 29 hybrids, among which DMRH 1308 and DMRH 1301 have become more popular at the national level. Alone, these two hybrids have been licensed to over 25 private seed companies through the signing of 33 MoUs in last four years. These hybrids have consistently received the highest DAC maize breeder seed indents over the past four years, accounting for up to 39% of the total indent. The characteristic features of these hybrids are provided in Table 1.

Economic benefits

Assessing the economic impacts of hybrid maize technologies is important because it provides insights into how they contribute to farmers' income, productivity, and resource-use efficiency. To date, no comprehensive economic impact studies have been conducted on maize in India. Therefore, this study represents the first attempt to analyse the economic impacts of two maize hybrids-DMRH 1301 and DMRH 1308-which have been in high demand for the past seven years. Economic surplus model was employed to quantify the economic benefits resulting from the adoption of maize hybrids. The adoption of maize hybrids directly benefits producers due to an increase in production, represented by an upward shift in the supply curve, and indirectly to consumers by reducing output prices. Assuming linear demand and supply curves, the incremental changes in producer surplus (ΔPS) and consumer surplus (ΔCS) in the closed-economy framework were computed as -

6 NAAS (2024). *Maize for Bioethanol Production in India: Prospects and Strategy*. Strategy Paper No. 19, National Academy of Agricultural Sciences, New Delhi: 20 pp

7 ICAR-Indian Institute of Maize Research. (2019). Newly released high yielding single cross maize hybrids for different ecologies of India. *Indian Journal of Agricultural Sciences,* 89 (2):371–75.

8 ICAR-Indian Institute of Maize Research. (2024). *ICAR-Indian Institute of Maize Research at a Glance*, Pp 38.

Table 1 Features of Maize Hybrids DMRH 1301 and DMRH 1308

Particulars	DMRH 1301	DMRH 1308
Type of corn	Field corn (Yellow maize)	Field corn (Yellow maize)
Year of release	2017	2017
Domain area	Rajasthan, Madhya Pradesh, Gujarat, Chhattisgarh, Bihar, West Bengal, Odisha, and Jharkhand	Rajasthan, Madhya Pradesh, Gujarat, Chhattisgarh, Bihar, and West Bengal
Maturity group	Medium (125-145 days)	Medium (125-140 days)
Season	*Rabi*	*Rabi*
100 kernels weight (gm)	25-30	28-30
Yield (t/ha)	9-10	9.5-10
Other useful traits	Moderately resistant to *Turcicum* leaf blight and charcoal rot diseases, medium ears placement and semi-dent.	Moderately resistant to *Turcicum* leaf blight and charcoal rot diseases, medium ears placement, short to medium height, and semi-dent.

$$\Delta PS = P_0 Q_0 (K - Z)(1 + 0.5\varepsilon_d Z)$$

$$\Delta CS = Z P_0 Q_0 (1 + 0.5\varepsilon_d Z)$$

Where, P_0 is the pre-adoption price of the crop, Q_0 is the pre-adoption level of its production, ε_d is the price elasticity of its demand, K is a supply shift parameter, and z is the relative change in its price, which can be computed as

$$Z = \frac{K\varepsilon_s}{\varepsilon_s + \varepsilon_d}$$

Where, ε_s and ε_d are the absolute values of the price elasticity of the supply and demand, respectively. The total economic surplus can be computed as

$$\Delta TS = P_0 Q_0 K(1 + 0.5\varepsilon_d Z)$$

The values of parameters used to estimate the economic surplus are taken from surveys or published literature (Table 2).

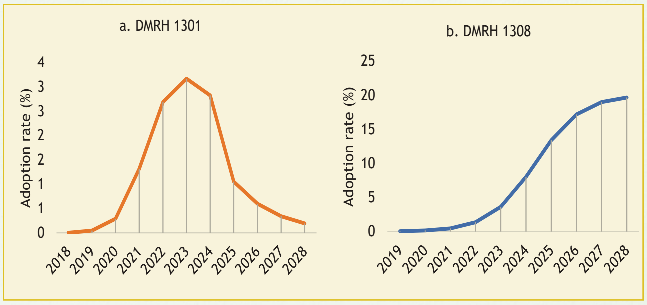
There has been an increase in the area of both the hybrids since their release. Based on seed demand for these hybrids, it is estimated that DMRH 1301 has occupied 1.05% of the total maize area in 2024-25 with its peak adoption of 3.2% in 2023. However, another hybrid DMRH1308 is replacing the DMRH 1301 with an estimated area of 5.72 lakh ha in 2024-25. By 2028, its estimated adoption rate is projected to increase to 20% (Figure 3). The yield advantage of maize hybrids was estimated using both AICRP data and farm surveys. Both DMRH 1301 and DMRH 1308 have 11% and 12% higher yield advantage over comparable hybrids, respectively. Additionally, the cost of cultivation is also marginally lower due to irrigation savings.

The adoption of maize hybrids resulted in significant economic benefits for both producers and consumers. The total estimated economic surplus resulting from the adoption of DMRH1301 amounted to Rs 12,404 million during 2018-2024, with producer and consumer surplus at Rs 5,380 million and Rs 7,024 million, respectively (Table 3).

Table 2. Parameters used in estimating economic surplus model

Parameter	Description	DMRH1301	DMRH1308	Source
Q_o	Production in domain area (000' tons) T.E.2020-21	11868	11722	Government of India[1]
P_o	Farm harvest price of maize (Rs/ton) T.E.2020-21	22353	22755	Government of India[9]
E(Y)	Yield gain (%)	11	12	AICRP reports and Farmer's fields data
E(Y)	Change in variable cost (%)	2	2	Farmer's fields data
A_{max}	Maximum adoption (%)	3.2	20	Expert opinion
EGR	Exogenous output growth rate (%)	8	8	Authors estimation
ε_s	Supply elasticity	0.25	0.25	Kumar and Mittal (2022)[10]
ε_d	Demand elasticity	-0.19	-0.19	Kumar et al. (2011)[11]
þ	Probability of success	1	1	Expert opinion
1-δ	Depreciation rate (%)	0	0	Expert opinion
DR	Discount rate (%)	5	5	Birthal et al. (2012)[12]

Figure 3. Adoption curve of maize hybrids: (a) DMRH 1301 and (b) DMRH 1308



The projected economic benefits for the extended period from 2018-2028 are significantly higher. The estimated producer surplus is expected to reach Rs 6,972 million,

9 MoFW. (2025). *Farm harvest prices (FHP) 2023-24*. DES&E, Ministry of Agriculture and Farmers Welfare, Government of India

10 Kumar, P., and Mittal S. (2022). *Agricultural price policy for ensuring food security in India.* NABARD Research and Policy Series No. 1/2022. National Bank for Agricultural and Rural Development, Mumbai.

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

12 Birthal, P., Nigam, S., Narayanan, A. and Kareem, K. (2012). Potential economic benefits from adoption of improved drought-tolerant groundnut in India. *Agricultural Economics Research Review*, 20(1):1-14

while the consumer surplus is anticipated to increase to Rs 9,103 million. Consequently, the total economic surplus by 2028 is projected to be approximately Rs 16,075 million. On the other hand, the adoption of DMRH1308 leads to the largest estimated economic benefits during the period 2019-2024, resulting in a total economic surplus of Rs 17,972 million, which translates into Rs 2,995 million per annum. The producers could harvest a surplus of Rs 7,795 million, whereas consumers benefited more with Rs 10,117 million. The projected economic benefits suggest that for the period 2019-2029, total economic surplus is expected to reach Rs 1,48,129 million, assuming a peak adoption level of 20% in the domain area.

The distribution of benefits due to the adoption of maize hybrids suggests that consumers received 57% of the total gain, whereas producers received the remaining 43% of the benefits. Consumers gain from potentially lower prices owing to an increase in supply. Similarly, producers benefit from increased yields, leading to higher profits. This indicates that adoption of maize hybrids has not only ensured a stable market supply, also contributed to broader economic welfare across the maize value chain.

Table 3. Estimates of economic surplus from adoption of maize hybrids in domain area

(Rs in million)

Particulars	DMRH1301		DMRH1308	
	2018-2024	2018-2028	2019-2024	2019-2029
Consumer surplus	7,024	9,103	10,177	83,884
Producer surplus	5,380	6,972	7,795	64,246
Total economic surplus	12,404	16,075	17,972	1,48,129
Economic surplus per annum	1,772	1,461	2,995	13,466

Policy implications

Strengthening seed production system and replacement rate: Seed quality has a greater impact on hybrid performance, and access to good-quality seeds at the right time and affordable prices continues to be a major concern for farmers. Currently, more than 95% maize seed production and processing is concentrated in peninsular India, primarily in Telangana and Andhra Pradesh. This needs to be diversified beyond the peninsular regions to reduce the seed costs. Policy interventions are required to develop new seed production hubs, seed processing, storage and transportation infrastructure for availing good quality seed to the farmers at the right time and affordable prices. Some of the potential strategies include i) developing a dedicated National Public–Private Partnership framework for the seed sector, ii) revising IPR guidelines to promote transparency, fairness and farmer access, iii) establishing neutral platforms for dialogue and collaborative project development, and iv) policy reforms involving seed price regulation and quality control. Further, to enhance the SRR, it is essential to strengthen seed production and distribution networks, ensure timely availability of good-quality hybrid seed, and promote field demonstrations to build farmer confidence in the technology.

Invest in research and development (R&D): Nearly 70% of maize in India is grown under rainfed conditions, where both biotic and abiotic stresses significantly constrain its productivity. To address these challenges, greater investment is required in developing climate-resilient high-yielding hybrids with desirable plant ideotype/architecture (narrow and semi-erect leaves), and in bridging yield gaps by upscaling site-specific improved packages of practices. Since maize is going to be used as a major feedstock for bioethanol production, R&D efforts must also focus on developing high-starch, high-yielding hybrids with improved ethanol recovery efficiency. This calls for the integration of novel breeding tools such as Double haploid (DH), Gene editing, Genomic selection, Speed breeding, etc. with conventional maize breeding programme for enhancing the breeding efficiency and reduce varietal development cycles to cater the present needs. The demonstrated economic advantages reinforce the need to invest in breeding strategies that combine high productivity with greater stability, thereby supporting long-term gains for farmers and strengthening the maize value chain.

Promote mechanized maize cultivation: The majority of maize growers are marginal to small farmers, and therefore, affordable mechanized maize cultivation needs to be strengthened for timely and efficient crop operations. There is a need to develop plant type suited well for mechanized maize and high-density planting. Also need to harness the role of custom hiring centres (CHCs) and cooperative societies for ensuring the timely availability of machines to the small landholders at affordable prices.

Towards a sustainable maize production system: In the present scenario of maize 'Farm to Fuel', there is an urgent need to scale up proven technologies to build a resilient and sustainable maize production ecosystem in India. Beyond the use of good-quality seeds, the focus must shift towards mainstreaming sustainable agricultural practices that enhance resource-use efficiency and improve crop productivity. With the expansion of spring maize cultivation, promoting drip irrigation (both surface and subsurface) under zero-tillage systems is crucial for improving water productivity and conserving groundwater resources. Shifting from sole reliance on chemical pest control towards eco-friendly alternatives, such as ecosystem engineering, biological control, and integrated pest and disease management, needs to be promoted. Collectively, these interventions can transform maize into a remunerative crop for India's food, feed, and fuel security, while ensuring sustainability, farmer profitability, and competitiveness in global markets.

November 2025

ICAR – NATIONAL INSTITUTE OF AGRICULTURAL ECONOMICS AND POLICY RESEARCH
(Indian Council of Agricultural Research)
P.B. No. 11305, Dev Prakash Shastri Marg, Pusa, New Delhi-110 012, INDIA
Phone : 91-11-25847628, 25848731, Fax : 91-11-25842684 E-mail : director-niap@icar.org.in
https://www.niap.res.in