P. ISSN: 0971-8184 II E. ISSN: 0976-1926
DOI: 10.61949/0976-1926.2025.v38i03.13

Indian Journal of Plant Genetic Resources

RESEARCH ARTICLE

Breaking Barriers in Maize Seed Production: The Success Story of DMRH 1308, DMRH 1301 and LQMH 1 Hybrids

Bhupender Kumar[1*], Sayantan Dey[2], Chhavi Nath[1], Bhadru Dharavath[3], Manish Kakraliya[1], Bahadur Singh Jat[1], Shankar Lal Jat[1], Shyam Bir Singh[1], Sujay Rakshit[1,4] and Hanuman Sahay Jat[1]

Abstract

Hybrid technology has significantly contributed to increasing maize production and productivity in the country. Seed is the basic and key input that determines the farm productivity of any cultivar. However, the private sector contributes significantly to the maize seed supply, but the public sector develops hybrids that contribute to regulating seed prices and quality. For *Kharif* 2025, the DAC Govt. of India, demand for public-bred maize hybrid breeder seeds reached its highest level ever (126 q). The DMRH 1301 (medium duration) and DMRH 1308 (medium duration), released in 2017, and LQMH 1 (short duration) in 2020 through the central varietal release committee from ICAR-IIMR, created a significant impact in terms of acreage. So far a total of 24 different private seed companies have taken up these hybrids by signing 36 MoUs with the institute. In the last four years, DMRH 1308 has consistently topped DAC maize breeder seed demand, with its share ranging from 20.1 to 34.9%. Based solely on DAC breeder seeds supplied till 2024, DMRH 1308 is estimated to cover around 11.57 lakh hectares, DMRH 1301, 4.10 lakh and LQMH 1, 0.70 lakh hectares of land since their release. In farmers' fields, these hybrids yield 6.0 to 10.5 t/ha of grain. Higher female productivity (2.0–3.5 t/ha), longer pollen availability (7–9 days), broader adaptability, tolerance to major diseases and insect pests, and input responsiveness are the main characteristics of these hybrid parental lines, which contribute towards the successful commercial seed production. The majority of hybrid maize seeds are produced in peninsular India, resulting in higher seed costs. It is therefore necessary to establish alternative farmer-led seed production hubs. Our study documented the success story of farmer-led seed production in three different states, especially in new sites in West Bengal. This model can be replicated to popularize other public-bred hybrids.

Keywords: Maize hybrids impact, Flowering synchrony, Hybrid seed production, Alternate seed hubs.

[1]ICAR-Indian Institute of Maize Research, Ludhiana, 141004 India.

[2]State Department of Agriculture, Zonal Adaptive Research Station, Krishnagar, Nadia, West Bengal 741101 India.

[3]Maize Research Centre, ARI Campus, Rajendranagar, Hyderabad, 500 030 India.

[4]ICAR-Indian Institute of Agricultural Biotechnology, Ranchi-834010, India.

***Author for correspondence:**

bhupender.icar@gmail.com

Received: 18/03/2025 **Revised:** 16/06/2025

Accepted: 28/07/2025

How to cite this article: Kumar B, S Dey, C Nath, B Dharavath, M Kakraliya, BS Jat, SL Jat, SB Singh, S Rakshit, HS Jat. (2025). Breaking Barriers in Maize Seed Production: The Success Story of DMRH 1308, DMRH 1301 and LQMH 1 Hybrids. *Indian J. Plant Genet. Resour*. 38(3), 368-375. **DOI:** 10.61949/0976-1926.2025.v38i03.13

Introduction

Maize is an important, versatile crop also known as the 'Queen of cereals' due to its highest yield potential among the cereals. It is a relatively climate-resilient crop and can be grown in tropical, subtropical, and temperate climates from sea level to 3000 metres above sea level. In India, maize cultivation is critical for supporting the nation's burgeoning population and diverse agro-industrial sectors, acting as a crucial element in achieving food, nutritional and industrial security (Kumar *et al.,* 2013). Since the beginning, abiotic and biotic stresses, upscaling of improved PoP at farmers' fields, availability of quality seeds and inputs at affordable prices, coverage under single cross hybrids, controlling post-harvest losses, and market volatility have remained major challenges in maize. During 1950-51, India used to produce 1.73 million tonnes of maize from a 3.16-million-hectare area with a productivity of around 0.55 t/ha. At present (2023–24), nearly 37.67 million tonnes of maize are being produced from a sizable area of 11.24 million hectares of land with a productivity of 3.35 t/ha (Figure 1; MoA & FW, 2024). In India, maize production has increased 22 times, productivity 6.5 times, and area 3.4 times since 1950-51, all

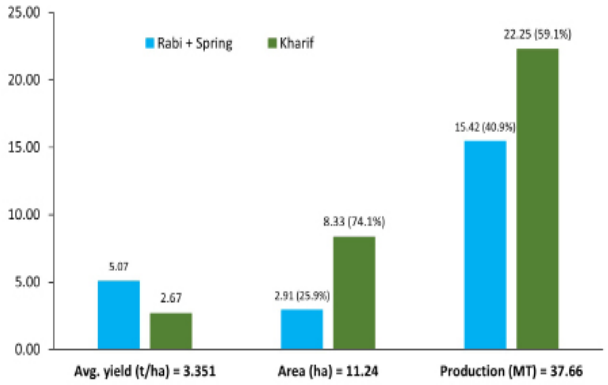

Figure 1: Seasonal-wise area, production, and productivity of maize in India during 2023-24

attributed to hybrid technology. Nearly 2.25 lakh tonnes of hybrid seed will be required to cover 11.24 million hectares (mha) of maize under hybrid/improved cultivars. Notably, *Rabi* and spring cultivation, despite occupying only 25.9% of the total 11.24 million hectares, achieve a higher yield of 5.07 t/ha, which contributes 40.9% (15.42 million MT) to the total 37.66 million MT production. This is possible because almost 100% of the maize acreage in these seasons is under hybrids. Conversely, *Kharif* season cultivation covers 74.1% of the area and accounts for 59.1% (22.25 million MT) of the total production (MoA & FW, 2024).

The significant increase in maize production and productivity has been possible due to policy interventions, cultivation of improved maize hybrids, adoption of best management practices and effective control of diseases and insect pests. In the country, single-cross hybrids have contributed significantly to the increase in maize production and productivity (DMR Vision 2030). The current per day productivity of maize in selected parts of the country is close to 65 kg/day, that of countries like the USA. During *kharif*, Madhya Pradesh has the highest area (2.02 mha) under maize, but Tamil Nadu has the highest *kharif* maize productivity (7.5 t/ha). West Bengal has the highest maize productivity in Rabi (8.0 t/ha) and spring (7.3 t/ha) (2022-23). With high energy value and less anti-nutritional properties like low fibre content, maize is used as food, feed, and fodder as well as a source of thousands of industrial/ processed products (Kumar *et al.,* 2013). About 60% of India's maize consumption goes to feed. A 20% share of maize is consumed as food, with 13% of it consumed directly and 7% in processed form (FICCI Maize Vision 2022; FAO 2023).

High-yielding, stress-tolerant hybrids are needed to meet the escalating demand for maize, driven by population growth and industrial expansion (Duvick, 2005). Additionally, seed production of newly developed maize hybrids plays an important role in improving production and productivity. To cover 11.24 mha of maize under hybrid/improved cultivars in India, nearly 2.25 lakh tonnes of hybrid seed will be needed. Private companies play a significant role in seed supply. The public sector also produces seeds and develops hybrids to control maize seed prices. For *Kharif* 2025, the DAC Govt. of India, demand for public-bred maize hybrid breeder seeds reached its highest level ever (126 q) (https://seednet.gov.in/ SATHI Portal). The DMRH 1301 (for the central western and north east plain zones) and 1308 (for Bihar and the central western zones) released from the ICAR-IIMR Ludhiana for *Rabi* season cultivation in 2017 have had a significant impact on farmers' fields. There should be high genetic purity within the line, a wide range of genetic diversity between the lines, high female productivity (> 3.0 t/ha), pollen availability for a longer period of time, flowering synchrony, broad adaptability, tolerance to major diseases and insect pests, and responsiveness to input. Seed growers and farmers consider all of these factors when producing and adapting hybrids.

Since most hybrid maize seeds are produced in peninsular India, transportation expenses contribute to higher seed costs. To minimize seed costs, alternative farmer-led seed production sites should be established in West Bengal, Bihar, Rajasthan, Madhya Pradesh, and Jharkhand. Important requirements for seed production at a specific location include availability of isolations, farmers' willingness, trained manpower, fertile soil, well-developed irrigation systems, mechanized cultivation, transportation, processing, and storage facilities (DSR, 2016). A lack of genetic purity and environmental factors hamper the widespread adoption of superior hybrids (Singh *et al.,* 2023). Nevertheless, estimating hybrids' impact and documenting their successful seed production can help other breeders design strategies for successful seed production and popularize their hybrids. The purpose of this study was to estimate the impact of selected maize hybrids developed and released from the ICAR-IIMR Ludhiana between 2017-2020, explore their seed production methodologies, and examine their adaptation based on the breeder seeds supplied into the seed chain. We also discussed the challenges and future prospects of strengthening maize seed production in the country through alternative seed hubs.

Materials and Methods

Materials

The selection of parental inbred lines is a foundational step in hybrid maize breeding. The two medium duration field corn hybrids, viz., DMRH 1301 and DMRH 1308, released in Aug. 2017 and notified on 24th January, 2018 [S.O.399(E) S.N.17] (Figure 2) (Kumar *et al.,* 2019) for *rabi* season cultivation, have the BML 6 as a common female and IML 418-1 and HKI 163, respectively, as male parents. The DMRH 1301 was recommended for North Eastern Plain Zone (NEPZ) comprising the states of Eastern UP, Bihar, Jharkhand, West Bengal and Odisha and Central and Western Zone (CWZ)

Figure 2: Photos of Hybrid DMRH 1308 (A), DMRH 1301 (B), LQMH 1 (C) and their ongoing seed production (D-F) from West Bengal, Andhra Pradesh and Telangana

comprising the states of Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh. Similarly, DMRH 1308 recommended for Bihar [S.O.3482 (E) S.N.50, 7th October, 2020], and Central Western Zone (CWZ) [S.O.399(E) S.N.19, Jan., 24, 2018] comprising the states of Rajasthan, Gujarat, Chhattisgarh and Madhya Pradesh. DMRH 1308 has also been included in the packages and practice of West Bengal for commercial cultivation. Besides, LQMH 1 (S.O. 3482 (E) S.N.38, 07.10.2020) (Figure 2), is the short duration biofortified hybrid released in 2020 (Kumar *et al.,* 2021) for *Kharif* season cultivation in Northern Hill Zone (NHZ) comprising the states of J&K, Himachal Pradesh, Uttarakhand (Hill region), and Northern Eastern Hill region (Meghalaya, Sikkim, Assam, Tripura, Nagaland, Manipur, Arunachal Pradesh). IML 343-1 is the female line and HKI 163 is the male line of this hybrid. The above-given parental lines and hybrids were the basic materials for large-scale seed production and commercial cultivation. Over the last 7 to 8 years, large-scale seed production has been undertaken for them in three states such as West Bengal, Andhra Pradesh, and Telangana.

Standardization of Seed Production

ICAR-IIMR, in collaboration with the state department of agriculture, West Bengal state seed corporation, and farmers groups in Nadia District, West Bengal, sowed the first batch of seed for DMRH 1301 from 3 to 5th November 2018. The female and male were planted in the ratio of 3:1 and 4:1 at four sites separated by >1000 m from each other. Three and four represent female lines, while one represents male lines. In total, 10 hectares of land were considered for sowing, with 2.5 hectares at each site. For both ratios, females and males were sown on the same date, while in another set, males, e.g., IML 418-1, were sown 5 days after females (BML 6) sowing. Since 2021-22, DMRH 1308 has been included in the package and practices of West Bengal state, and has been cultivated there during the rabi season. Seed production for this hybrid was taken up on 10 hectares of land directly in a 4:1 ratio of female to male sown at a 5-day interval,

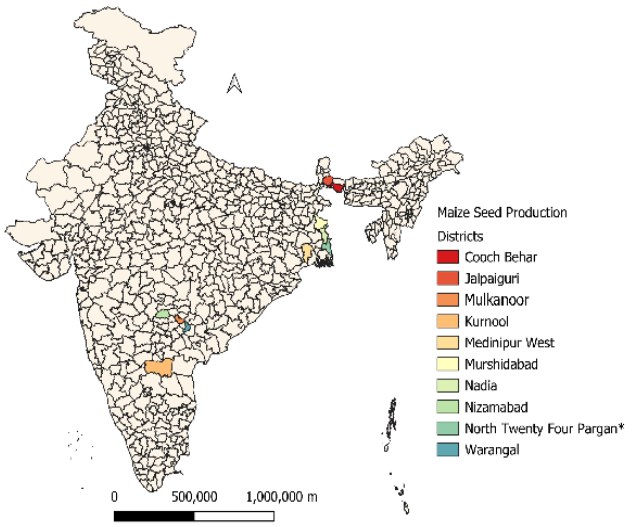

Figure 3: Representation of production sites on map where commercial seed production is going on for DMRH 1308, DMRH 1301 and LQMH1 in Andhra Pradesh, Telangana and West Bengal

e.g., male (HKI 163) was planted after 5 days of female (BML 6) sowing. Additionally, for both hybrids, seed production was started in the Kurnool district of Andhra Pradesh in Rabi 2020-21 and in the Warangal district of Telangana in 2021-22. State farmers were involved in the production through a cooperative located at Mulkanoor in Telangana, and two MSMEs in Andhra Pradesh. In both states, a 4:1 ratio was used for female and male sowing on the same day from 5 to 15th November. This was done with certain agronomical interventions, such as a spray of 2% urea only to females at the knee-high stage. Similarly, LQMH 1 seed production was started in *Rabi* 2021-22 in West Bengal as well as in Andhra Pradesh. The sowing of female and male was taken up on the same day in the ratio of 4:1 in Andhra Pradesh and with a one-week gap between male (sown before) and female in West Bengal. In Andhra Pradesh, 2% urea was sprayed on males at the knee-high stage, repeated the same at 10-day intervals. Now the seed production for all said hybrids have extended to various districts/locations in the state such as Jalpaiguri, Cooch Behar, Murshidabad, Medinipur West, and North 24 pargan in West Bengal and Warangal, Mulkanoor, and Nizamabad in Telangana (Figure 3). The details of the weather conditions, soil types, and geographical locations of all these sites have been provided in Table 1. All recommended packages of practices were followed in each state for growing a healthy crop.

Supporting hybrid seed production

The ICAR-Indian Institute of Maize Research, Ludhiana, also supports the production of hybrid seeds developed by their public partners. As part of their efforts to promote their products, the institute also displays public-bred hybrids *vis-à-vis* private in farmers' fields and at the institute's

Table 1: Meteorological data averaged over the past five years (2018-2022) for seed production sites during the crop period (November to April), along with topographical conditions

District	*State*	*Latitude*	*Longitude*	*Soil Type*	*Temp. (°C) (Max.)*	*Temp. (°C) (Min.)*	*Rainfall (mm/ day)*	*RH (%)*
Nadia	West Bengal	23.471°N	88.5565°E	Alluvial Soil	33.43	12.07	1.16	63.02
Cooch Behar	West Bengal	26.3234°N	89.3227°E	Alluvial Soil	30.21	12.16	1.62	63.02
Jalpaiguri	West Bengal	26.6967°N	88.7109°E	Alluvial Soil	30.87	12.74	1.45	58.97
Murshidabad	West Bengal	24.229°N	88.2461°E	Alluvial Soil	33.36	11.69	0.73	59.34
Medinipur West	West Bengal	22.424°N	87.319°E	Alluvial Soil	32.31	11.31	1.01	69.91
North Twenty Four Pargan	West Bengal	22.72°N	88.7°E	Alluvial Soil	33.57	12.81	1.31	65.83
Kurnool	Andhra Pradesh	15.6443°N	78.1108°E	Red Soil	37.1	16.52	0.39	55.32
Warangal	Telangana	17.9693°N	79.5926°E	Red Soil	35.78	14.62	0.32	54.66
Nizamabad	Telangana	18.6725°N	78.0941°E	Red Soil	36.20	14.50	0.15	45.97
Mulkanoor	Telangana	17.4879°N	80.14281°E	Red Soil	36.20	15.63	0.42	59.33

farm. To accelerate commercialization and large-scale seed production, we also planned visits by state and central government officials, representatives of private organizations, and farmers. The lead breeder of the hybrids and various experts from the institute, as well as state seed corporations, cooperatives, and boards, visit seed production sites in farmers'/government fields every year. They give training to seed growers, officers, and farmers on seed production and commercial maize cultivation technologies. ICAR-IIMR, Ludhiana, plays a leading role in providing training and providing breeders' seeds for further taking up seed production. Seed growers plan their seed production based on advance demands received from state, central, and other agencies for specific hybrids.

Estimating Acreage

For calculating acreage, only the breeder seed supplied through DAC, the Government of India demand, was considered every year. Even for the DAC breeder seed indent, we only considered the female seed quantity since hybrid seeds are purely harvested from female lines. To estimate the lowest acreage possible, each parameter of seed production was taken into account to the minimum extent possible. As an example, if we take 2.0 t/ha female productivity in each category of seed production, such as breeder to foundation and foundation to certified in a 3:1 ratio, then from 1-kg of breeder seeds we get 13333 kg of hybrid seeds. Among the criteria used to identify maize hybrids for release, the female productivity should be at least 2.5 t/ha for medium and late duration hybrids, and around 2.0 t/ha for short duration hybrids. In the rabi season, female line yields range from 2.0 to 3.5 t/ha for both medium duration maize hybrids, such as DMRH 1301 and DMRH 1308. In estimating the acreage, we took the lowest possible female productivity under any circumstances, e.g., 1.5 t/ha for these hybrids. For LQMH 1 hybrid, which is a short-duration biofortified hybrid, we considered 1.2 t/ha female productivity when estimating the acreage, but it produces 2.0 to 3.0 t/ha. Most of the seed production takes place in fertile land during productive seasons with good management practices, so yields will always be higher than what is considered here. Most of the commercial hybrid seeds are produced in a 4:1 ratio. Moreover, sufficient quantities of parental lines seed enter the seed chain every year as per non-DAC demand, e.g., directly received at the institute from seed-producing agencies; however, it was not included in acreage estimations. Therefore, we estimated the possible acreage of hybrids by using all parameters as minimally as possible.

Results and Discussion

The majority of maize hybrid seeds are produced in peninsular regions of the country, particularly in Andhra Pradesh and Telangana. It is a neutral kind of ecology free from the adverse effects of climate (Table 1). In this ecology, maize can be grown all year round. Further, in the regions, well-developed seed processing plants have been established and farmers are well trained. The soil is fertile and suited for maize cultivation (Table 1). Commercial seed production requires good transportation and irrigation facilities, both of which are well developed in these states. Now, West Bengal (WB) is stepping up in a big way, where new sites have been identified for maize seed production. Specifically for public sector hybrids, maize seed is being produced on a large scale. In the last five years, nearly 32465 q (including estimated production for *Rabi* 2024-25) of hybrid seed have been produced for DMRH 1308, DMRH 1301, and LQMH 1. Nadia, Jalpaiguri, Cooch Behar, Murshidabad, and Medinipur West, and North 24 Parganas are the districts of WB where seed production of DMRH 1301, DMRH 1308 and LQMH 1 has been well standardized and taken up on a large scale (Figure 3). November to April (*Rabi* season) is the favourable season for seed production

in the state. Due to excessive rainfall, it is not feasible to take production during the *kharif* season. For sowing, the 4:1 ratio for female to male during the first fortnight of November has been identified as ideal for commercial seed production. Pollen from the male parents (IML 418-1, HKI 163) of all three hybrids is available for 7 to 8 days continuously. As a result, the 4:1 ratio of females and males is highly successful and produces good hybrid seeds. There are two staggered sowings of males in cases of DMRH 1301 and 1308, e.g., one at the time of main sowing (with female), and another after 5 days. At some places, they only take one sowing of the male parent, which is 5 to 6 days after sowing the female parent. In staggered sowing, the 1st male sowing is done with a space of about 35 to 40 cm between plants so that the 2nd sowing can maintain around a 20 cm spacing between plants. They maintained a distance of approximately 60 to 65 cm between rows. The male is sown one week earlier than the female in LQMH 1. The seed production of these three hybrids, such as DMRH 1301, DMRH 1308 and LQMH 1 in Andhra Pradesh and Telangana starts on 20th October and continues till November. The commercial seed production of all three hybrids is carried out in the Kurnool district of Andhra Pradesh, and the Warangal and Nizamabad districts of Telangana. Female and male seeds are sown in ratios of 4:1 and 5:1. A foliar spray of 2% urea is applied at the knee-high stage to the female line in DMRH 1301 and DMRH 1308, i.e., without staggered sowing. For LQMH 1, some sow the male and female on the same day and spray 2% urea on the male at the knee-high stage, or they sow the female six days after the male.

Maize flowering is affected significantly by environmental factors, including temperature, water availability, humidity and photoperiod (day length), which can delay or accelerate flowering and affect yield (Khan *et al.,* 2022; Choquette *et al.,* 2023). Before starting large-scale seed production, it is advisable to check for the flowering synchrony of males and females at the new site. The farmers of these three states are perfectly trained for detasseling of female and other packages of practices for raising a healthy crop. The detasseling of female lines is an essential step in producing hybrid maize seeds (Singh *et al.,* 2021). After tassels emerged from the boot leaf, it continued for about 10 to 12 days. Ideally, this should be done before the anthers begin to burst or shed pollen. This is a must for avoiding selfing in females and hence to get pure hybrid seed. It ensures cross-pollination with the desired male line in hybrid seed production. Hybrid seed production in maize necessitates meticulous management to ensure genetic purity and high seed quality (Macrobert *et al.,* 2014). Controlled pollination techniques such as detasseling and isolation are fundamental practices. Isolation requirements, both spatial and temporal, minimize the risk of outcrossing and maintain the genetic purity of hybrid seeds.

In maize seed production, harvesting is an important activity that impacts seed quality. Physiological immaturity and high moisture content will strongly affect seed germination (Singh *et al.,* 2021). Thus, it should be done when the kernel attains complete physiological maturity, e.g., when a black layer gets fully developed at the kernel base and when the moisture content is < 25%. Harvesting begins in Andhra Pradesh and Telangana in mid-March and in West Bengal in mid-April. They first harvest males and remove them from the field for use as commercial grain, then they harvest females for use as hybrid seed in bulk. In general, farmers are harvesting 2.5 to 3.5 t/ha hybrid seed yields for DMRH 1308 and DMRH 1301. However, in the case of LQMH, which is a short-duration hybrid, they are able to harvest 2.0 to 2.5 t/ha of hybrid seed yield.

Every year, ICAR-IIMR Ludhiana is demonstrating public-bred hybrids *vis-à-vis* private at its experimental farms situated at Ludhiana, Delhi, Begusarai and Hyderabad. Stakeholders from all backgrounds are invited to showcase the strength of public-bred hybrids. By doing so, the institute has been able to popularize the technologies among various stakeholders. Through the DAC, the highest ever demand has been received for public sector maize bred hybrids in *Kharif* 2025 (126 q). The share of public sector-bred cultivars of maize has increased to nearly 25%. In recent years, public-bred hybrids have been commercialized in a significant way. 24 different private seed companies have adopted DMRH 1301, DMRH 1308 and LQMH 1 [DMRH 1301(12), DMRH 1308 (17) and LQMH 1(7) with the institute (Table 2). In the past four years, IIMR-bred hybrids topped the DAC maize breeder seed demand with shares ranging from 26.4 to 62.4% [Anonymous 2023 & 2024 (in press)]. In this, DMRH 1308 has consistently topped the country for the last four years with its breeder seed share ranging from 20.1 to 34.9% [Anonymous 2023 & 2024 (in press)]. The ICAR-IIMR acknowledged the active participation of West Bengal State Seed Corporation, Kolkata, the state department of Agriculture, WB, National Seeds Corporation, New Delhi, and Rajasthan State Seed Corporation, Jaipur. During the seed production of said hybrids, the lead breeder, Director IIMR, and various state and central officials visited seed production sites in the states and conducted trainings, held on farm discussions, delivered lectures on seed production, commercial maize cultivation, and interacted with a variety of stakeholders including farmers, cooperatives, MSMEs, and state officials. As of today, >10 readings have been delivered, and 7 training sessions have been conducted for the stakeholders involved. Each year, IIMR conducts training and pays visits to the various stakeholders who produce hybrid seeds directly in contact with the institute and collect the figures on hybrid seeds produced. As result, so far around 50,625 q (including the estimated figure for Rabi 2024-25 production) hybrids seeds are produced for these hybrids

Table 2: Details of breeder seed supplied as per DAC Govt of India demand as well as through non-DAC channels, hybrid acreage and MoUs signed by private seed companies

Year	*Total breeder seed demand through DAC (kg)*	*Female breeder seed demand through DAC (kg)*	*Parental seed* demand other than DAC (kg)*	*Estimated Area Coverage (000' Hectares) (based on female DAC breeder seed supplied)*	*MOU signed (No.)*
DMRH 1301					
2018-19	0.0	0.0	1405.0	0.0	0.0
2019-20	8.0	5.0	240.0	1.9	3.0
2020-21	220.0	140.0	1800.0	52.5	4.0
2021-22	255.0	150.0	345.0	56.3	3.0
2022-23	600.0	380.0	555.0	142.5	1.0
2023-24	555.0	350.0	0.0	131.3	0.0
2024-25	199.0	150.0	0.0	56.3	1.0
2025-26*	135.0	90.0	0.0	33.8	0.0
Total	1972.0	1265.0	4345.0	474.6	12.0
DMRH 1308					
2019-20	0.0	0.0	0.0	0.0	1.0
2020-21	30.0	20.0	1316.0	7.50	1.0
2021-22	55.0	35.0	6982.0	13.13	0.0
2022-23	963.0	642.0	4421.0	240.75	2.0
2023-24	1290.0	860.0	6910.0	322.50	3.0
2024-25	2290.0	1527.0	8936.0	572.63	4.0
2025-26*	2745.0	1830.0	0.0	686.25	0.0
Total	7373.0	4914.0	28565.0	1842.76	11.0
LQMH 1					
2021-22	15.0	10.0	30	2.4	2.0
2022-23	42.0	28.0	18	6.7	3.0
2023-24	0.0	0.0	0	0.0	0.0
2024-25	275.0	255.0	410	61.2	1.0
2025-26*	393.0	263.0	0	63.1	0.0
Total	725.0	556.0	458.0	133.4	6.0

Note*: 1 During 2021-22, 2794 Kg, during 2022-23, 160 Kg, in 2023-24, 510 kg, during 2024-25, 1400 Kg female line seed of DMRH 1308 was produced and sold @ breeder seed price through AICRP on Maize Hyderabad. 2. During 2021-22, 783 Kg, in 2022-23, 3174 Kg, in 2023-24, 6600 Kg and in 2024-25,6200 Kg parental lines seed of DMRH 1308 and 300 Kg of LQMH 1 in 2024-25 and 150 Kg of DMRH 1301 in 2023-24 was produced and sold @ foundation seed price through Zonal Adaptive Research Station Krishnagar Farm, Nadia WB. Rest of the quantity was produced at IIMR Farm Begusarai Bihar. For 2025-26, the advance DAC demand received from DAC Govt. of India for DMRH 1308, DMRH 1301 and LQMH 1 has been mentioned. It will be ready by May 2025 as it is being produced in Rabi 2024-25.

by selected agencies which collaborate and are in contact with ICAR-IIMR. In this total, nearly 75% of production is for DMRH 1308 and the remaining 24 and 1% are produced for DMRH 1301 and LQMH 1, respectively.

Using the DAC Govt of India female seed demand for each hybrid from release to 2024, the total estimated acreage for DMRH 1308, DMRH 1301 and LQMH 1 was calculated as 11.57, 4.41 and 0.70 lakh hectares, respectively (Figure 4a-c). In addition, the highest ever DAC breeder seed demand of DMRH 1308 (2445 Kg) has been received for *Kharif* 2025 as well. Based on female demand for it, the additional 6.86 lakh hectare acreage can be estimated over the given figure (Table 2, Figure 4a-c). Besides the DAC, sufficient quantities of parental seed were also supplied to various seed-producing agencies according to their demands (Figure 4a-c). To meet this demand, along with IIMR farms, production was also taken up in the AICRP's partners and state department farms (Table 2). A substantial contribution has been made to improve maize productivity and farmer income through the release and cultivation of DMRH 1308, DMRH 1301, and LQMH 1. Since release, there has been a good quantity of hybrid seed production and commercial cultivation for DMRH 1301 and DMRH 1308 in the recommended states. Further, LQMH 1 is also gaining popularity and is expected

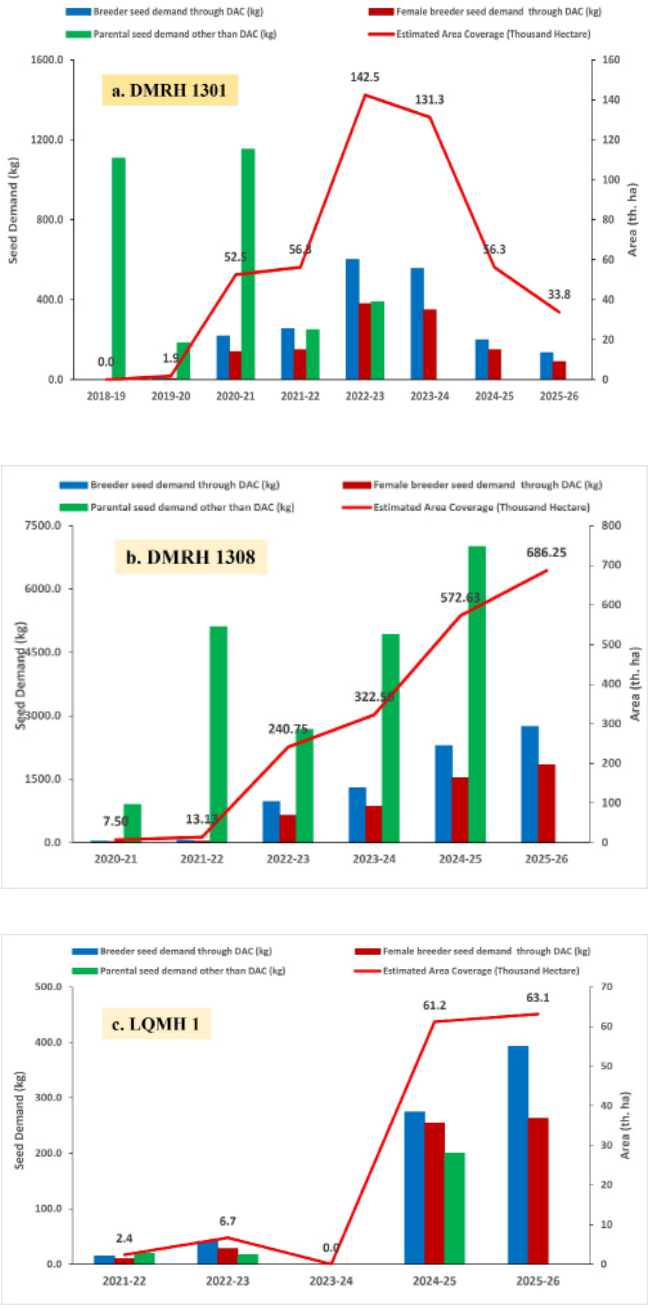

Figure 4: Details of year-wise acreage calculated based on female line breeder seed supplied as per the DAC, Govt. of India demand. The detailed procedure of same has been explained in materials and methods

to have more impact in the times to come. A significant impact is also seen in the fact that WB has the highest Rabi maize productivity (7.65 t/ha) in the country (DAC, 2021-22) where a significant quantity (around 65% of the total hybrid seed produced) of DRMH 1301 & 1308 hybrid seed is produced and supplied into the seed chain. We are working on identifying alternate seed hubs/new sites in states such as Uttar Pradesh, West Bengal, Punjab, and Rajasthan to produce maize seeds. It will help in controlling seed price and the timely supply of good-quality seed for farmers. The seed is the basic input in any crop and plays an important role in expressing its commercial potential. In order to avoid detasselling in hybrid maize seed production, the cytoplasmic male sterility system (CGMS) should be explored to cope with labour shortages. Yet challenges related to seed access, affordability, and equitable benefits remain critical considerations, particularly for smallholder farmers (Almekinders *et al.,* 2019). Integrating advanced breeding technologies, promoting sustainable agricultural practices and implementing supportive policy frameworks are crucial for ensuring better-quality seed in maize.

Conclusion

The private sector plays a major role in maize seed supply, while public institutions also develop hybrids to control prices and face climate change. The two hybrids, such as DMRH 1301 and DMRH 1308, developed and released from ICAR-IIMR Ludhiana in the year 2017, have created a significant impact. Since their release, these two hybrids are in the seed chain and have been taken up by 24 different private seed companies by signing a total of 29 MoUs with the institute. Based on the DAC breeder seed demand for females, the total estimated acreage was calculated as 11.57 and 4.41 lakh hectares for DMRH 1308 and DMRH 1301, respectively. Similarly, LQMH 1 is also gaining popular after its release (2020) and has an estimated coverage pf 0.70 lakhs hectares. This hybrid has been taken up by six different private seed companies. Still, there are challenges in seed access, affordability, and equitable benefits, especially for smallholders. Integrating advanced breeding, sustainable practices, and supportive policies is crucial for ensuring better-quality maize seed.

Acknowledgments

The authors acknowledge the support from ICAR, National Seed Corporation, State Seed Corporations, especially West Bengal State Seed Corporation and Rajasthan State Seed Corporation, State Department of Agriculture, WB, Agrinnovate India Ltd., MSMEs, AICRPs Partners, Farmers groups, Cooperatives, FPOs, ICAR-IISS, Mau, and all collaborators who helped in seed production and popularizing of these hybrids. Authors also acknowledged the conduct of the National seminar on hybrid technologies by the TAAS and giving the opportunity to present the work.

References

Anonymous (2023) ICAR-IIMR Annual Report 2020, ICAR-Indian Institute of Maize Research Punjab Agricultural University campus, Ludhiana – 141004.

Almekinders CJM, Beumer K, Hauser M, Misiko M, Gatto M, Nkurumwa AO, and Erenstein O (2019) Understanding the relations between farmers' seed demand and research methods: The challenge to do better. *Outlook on Agriculture, 48*(6), 003072701982702. https://doi.org/10.1177/0030727019827028.

Choquette NE, Holland JB, Weldekidan T, Drouault J, Leon N de, Flint-Garcia S, Lauter N, Murray SC, Xu W, and Wisser RJ (2023) Environment-specific selection alters flowering-time plasticity and results in pervasive pleiotropic responses in maize. *New Phytol.* 238 (2):737–749.

Directorate of Maize Research (DMR) (2013). *DMR Vision 2030*. Project Director, Directorate of Maize Research, ICAR, Pusa, New Delhi. 37p. Retrieved from https://iimr.icar.gov.in/wp-content/uploads/2020/05/Vision-2030-.pdf

Directorate of Seed Research (DSR) (2016) *International Certificate Course on Requisites of Seed Production, Processing, Testing and Quality Assurance.* ICAR-Directorate of Seed Research, Mau, Uttar Pradesh. 73p. Retrieved from https://krishi.icar.gov.in/jspui/bitstream/123456789/6130/1/International%20Certificate%20Course%20Requisites%20of%20seed%20production,%20processing,%20testing%20and%20quality%20assurance%20Mannual%20Volume%20I.pdf

Duvick DN (2005) The contribution of breeding to yield advances in maize (*Zea mays* L.). *Adv. Agron.* 86: 83-145.

Federation of Indian Chambers of Commerce & Industry (FICCI) (2022) *FICCI Maize Vision 2022: Agriculture Minister pitches for a package of measures to boost maize productivity.* Retrieved from https://ficci.in/press_release_details/3063.

Food and Agriculture Organization (FAO) (2023) *FAOSTAT database*. Retrieved from http://www.fao.org/faostat/en/#data.

Khan SU, Zheng Y, Chachar Z, Zhang X, Zhou G, Zong N, Leng P, Zhao J (2022) Dissection of maize drought tolerance at the flowering stage using genome-wide association studies. *Genes (Basel)* 13(4), 564. https://doi.org/10.3390/genes13040564

Kumar A, Jat SL, Kumar R and Yadav OP (2013) *Maize production system*. Directorate of Maize Research, Pusa Campus, New Delhi. 123p. Retrieved from https://iimr.icar.gov.in/wp-content/uploads/2020/03/Maize-production-system-book.pdf

Kumar B, Sekhar JC, Singh SB, Yadav OP, Jat SL, Kumar R, Soujanya PL, Aggarwal SK, Sheoran S, Yadava DK and Rakshit S (2019) Newly released high-yielding single cross maize hybrids for different agro-climatic zones. *Indian J. Agric. Sci.* 89 (2):371-375.

Kumar B, Singh SB, Singh V, Jat SL, Soujanya PL, Sekhar JC, Aggarwal SK, Yadava DK, and Rakshit S (2021) Newly released high-yielding single cross maize hybrids for different regions. *Indian J. Agric. Sci.* 91(12): 1823–1828.

MacRobert J, Setimela P, Gethi J, and Regasa MW (2014) *Maize hybrid seed production manual.* CIMMYT. Retrieved from http://hdl.handle.net/10883/4026.

Ministry of Agriculture & Farmers Welfare (MoA&FW) (2024) *Unified Portal for Agricultural Statistics*. Government of India. Retrieved from https://upag.gov.in/

SeedNet India Portal (n.d.). *SATHI Portal: National Initiative for Information on Quality Seed.* Retrieved from SeedNet India Portal.

Singh H, Sekhon BS, Kumar P, Dhall RK, Devi R, Dhillon TS, Sharma S, Khar A, Yadav RK, Tomar BS, Ntanasi T, Sabatino L and G Ntatsi (2023) Genetic mechanisms for hybrid breeding in vegetable crops. *Plants (Basel).* 12 (12):2294. https://doi.org/10.3390/plants12122294

Singh SB, Karjagi CG, Kumar B, Kumar R, Jat SL, Soujanya PL, Aggarwal SK, Sheoran S, Sekhar JC, Yadava DK, and Rakshit S (2021) *Manual of hybrid seed production technology in maize.* IIMR Technical Bulletin 2021/3. ICAR-Indian Institute of Maize Research, PAU Campus, Ludhiana. 76p.