



Review article

Scope for large-scale economic cultivation of mustard (*Brassica juncea* L.) in non-traditional areas of Karnataka

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Abstract

India faces a persistent shortfall between domestic demand and supply of edible oils, resulting in large-scale imports exceeding Rs. 120000 crore annually. Among the nine major oilseed crops cultivated in the country, rapeseed-mustard (*Brassica* spp.) contributes nearly one-third of total edible oil production. Traditionally confined to the Northern and Eastern plains, mustard exhibits wide agro-ecological adaptability, modest water requirements (80-240 mm), and compatibility with diverse cropping systems, including rainfed/limited irrigation conditions. This paper reviews the potential for expanding mustard cultivation into non-traditional areas, particularly in Karnataka. The review synthesizes historical and contemporary initiatives - ranging from All India Coordinated Research Project on Rapeseed-Mustard (AICRP-RM) trials to farmer-participatory feasibility studies-to evaluate agronomic performance, varietal adaptability, and yield potential. Preliminary results from trials conducted between 2017-18 and 2021-22 indicate promising yields (up to 17.0 q ha⁻¹) under irrigated conditions, suggesting that mustard could serve as a viable *rabi* crop in parts of Karnataka. Future prospects include scaling up cultivation through more trials, varietal improvement and development of reliable marketing channels.

Keywords: Rapeseed-mustard, crop diversification, edible oils, non-traditional areas, Karnataka

Introduction

Edible oils play a critical role in India's agricultural economy. The widening gap between domestic production and consumption necessitates imports worth approximately Rs. 1,20,000 crore annually, exerting significant pressure on foreign exchange reserves. Among the oilseed crops cultivated in India, rapeseed-mustard (RM) contributes nearly one-third of edible oil output, establishing it as a cornerstone of the nation's oilseed sector. Cultivated primarily in the northern and eastern plains across 24 states, RM occupies about 8.63 million hectares during 2024-25 (Kumar *et al.*, 2025). Its adaptability to a wide range of agro-ecological zones, low water requirement (80-240 mm), and suitability under rainfed/limited irrigation conditions make it an attractive alternate crop for area expansion in water-scarce regions.

To meet India's growing edible oil demand, both vertical intensification (improving productivity through modern agronomy and improved varieties) and horizontal expansion (introducing mustard to non-traditional regions) are essential. This review aims to assess the scope for large-scale economic cultivation of mustard in non-traditional areas, focusing on preliminary findings from small-scale feasibility trials conducted in Karnataka.

Distribution of oilseed *Brassica* crops in India

India cultivates eight species of *Brassica* and related genera for oilseed production viz. Indian mustard [*Brassica juncea* (L.) Czern. & Coss, 2n = 36, AABB], black mustard [*B. nigra* (L.) Koch, 2n = 16, BB], Ethiopian mustard or karan rai [*B. carinata* A. Braun, 2n = 34, BBCC], toria [*B. rapa* L. var. *toria*, 2n = 20, AA], brown sarson [*B.*

rapa L. var. *brown sarson*, $2n = 20$, AA], yellow sarson [*B. rapa* L. var. *yellow sarson*, $2n = 20$, AA], gobhi sarson [*B. napus* L. ssp. *oleifera* (DC.) var. *annua*, $2n = 38$, AACC], and taramira [*Eruca sativa* (syn. *E. vesicaria*) Mill., $2n = 22$, EE] (Chauhan *et al.*, 2011). Based on their genetic relationships and agronomic characteristics, *B. juncea*, *B. nigra*, and *B. carinata* are grouped as “mustards”, whereas *B. rapa* (toria, brown sarson, yellow sarson), *B. napus* (gobhi sarson), and *Eruca sativa* (taramira) are collectively classified as “rapeseeds”. Each species occupies a distinct ecological niche within India’s diverse agro-climatic zones. Indian mustard (*B. juncea*) is the dominant species, accounting for over 80% of RM acreage and 86% of production, mainly in Rajasthan, Madhya Pradesh, Haryana, and Uttar Pradesh. Other species occupy specific ecological niches - toria in eastern states, yellow sarson in Assam and Bihar, brown sarson in cooler Himalayan valleys, taramira in arid northwest India, and gobhi sarson and karan rai in northern regions with extended winter duration (Jat *et al.*, 2019).

India’s edible oil demand–supply gap

Per capita edible oil consumption in India is projected to reach 16.7 kg year⁻¹ by 2050, translating into a total requirement of 39.2 million tonnes of oilseeds for a projected population of 1.68 billion (Alexandratos & Bruinsma, 2012). To meet this rising demand, the productivity and production of rapeseed-mustard must increase substantially from the current levels of 1461 kg ha⁻¹ and 12.61 million tonnes (2024-25) to 2563 kg ha⁻¹ and 20.5 million tonnes, respectively, despite a decline in the net cultivated area from 8.63 million hectares to an estimated 8.0 million hectares during the same period. However, stagnation in traditional mustard belts - caused by declining land availability, competition from other cash crops, and other priorities - necessitates expansion into non-traditional regions, particularly southern and north-eastern India (Chauhan *et al.*, 2011). The Vision 2050 document of the Directorate of Rapeseed-Mustard Research (DRMR), Bharatpur, estimated that approximately 11.65 million hectares of rice-fallow land in West Bengal, Bihar, Odisha, Jharkhand, Chhattisgarh, and the North-eastern states offer immense potential for early-maturing mustard varieties (90-110 days). Even if 10% of these rice fallows were utilized, national oilseed output could increase by at least 1.0 million tonnes annually (DRMR 2015).

Mustard expansion in rice-fallow areas

Efforts to introduce mustard in non-traditional regions began during 1983-84 under the All India Coordinated Research Project on Rapeseed-Mustard (AICRP-RM).

Trials conducted across Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, and the North-eastern hills confirmed the adaptability of several mustard species (Chauhan *et al.*, 2011). Between 2000 and 2007, Indo-UK collaborative projects focused on rice-fallow systems in Jharkhand, West Bengal, North Karnataka (Bijapur), Eastern Gujarat, and Southern Rajasthan, using farmer-participatory models to identify short-duration, high-yielding varieties. Trials in Ranchi (Jharkhand) and Purulia (West Bengal) identified *B. juncea* varieties Pusa Bold (251-2500 kg ha⁻¹), Sej 2 (380-2143 kg ha⁻¹), and GM 2 (389-2500 kg ha⁻¹) as high performers under rice-fallow conditions (Anonymous, 2007). Further, the Indian Agricultural Research Institute (IARI), New Delhi distributed seeds of Pusa Mustard 25, Pusa Mustard 26, Pusa Mustard 27, and Pusa Mustard 28 to centres under the ICAR Research Complex for NEH Region, Umiam, and Central Agricultural University, Imphal in 2014-15. The varieties were subsequently introduced across all seven NEH states through coordinated research and extension networks, where results were encouraging in terms of both yield and adaptability underscoring the crop’s expansion potential.

Over the past several years, ICAR-DRMR has undertaken extensive initiatives to upscale mustard cultivation in Eastern and North-eastern India through FLDs, trainings, field days, awareness programmes, and farmer-scientist interactions. Popular cultivars such as NRCHB 101, DRMRIJ 31, NRCRD 02, DRMR150-35, YSH 401 and TS 38 were widely distributed through KVKs and demonstrations were conducted across Assam, Jharkhand and other NE states. Under the Oilseeds Seed-Hub Project, eight seed hubs were established during *rabi* 2018-19, including sites in Assam and West Bengal. A mustard value chain was further developed at nine locations, including KVKs in Assam, Jharkhand and Arunachal Pradesh wherein mini oil expellers were installed to support local value chains. In addition, cluster demonstrations were conducted in Manipur in collaboration with CAU, Imphal at Kakching Lourel (Kakching district), Khoirentak Khuman (Churachandpur district), Thoubal district and Sangaitel (Imphal West) (DRMR, 2019).

Expansion in Gujarat and Southern Rajasthan

In Eastern Gujarat and Southern Rajasthan, the Indo-UK trials identified Varuna, Sej 2, and GM 2 as regionally suitable mustard varieties, recording yields ranging from 310 to 2333 kg ha⁻¹ (Chauhan *et al.*, 2011). DRMR’s Vision 2050 document later identified an opportunity to expand mustard cultivation up to 0.2 million hectares across

Panchmahal, Dahod, Ahmedabad, Surat, and Valsad districts of Gujarat. In northern Gujarat's canal command areas, mustard could serve as a viable replacement for irrigated wheat, thereby mitigating salinity issues exacerbated by frequent irrigation (DRMR, 2015).

Early efforts and performance in Karnataka

Initial efforts (2000-07) under the Indo-UK programme evaluated 24 Indian mustard varieties, along with one variety each of toria, yellow sarson, and karan rai, across 196 farmer-participatory trials in 20 villages of Karnataka. *B. juncea* varieties Sej 2 (378-2738 kg ha⁻¹), JM 1 (347-2243 kg ha⁻¹), and GM 2 (340-2277 kg ha⁻¹) were identified as promising for Bijapur district (Chauhan *et al.*, 2011). Later, IARI, New Delhi extended these efforts by distributing seeds of Pusa Mustard 30 (low erucic acid) and Pusa Mustard 25 (short duration) to Raichur during 2014-15 for on-farm demonstrations at ARS Siruguppa (Ballari), ARS Malnoor (Yadgir), and KVK Gangavati (Koppal). Performance was rated as satisfactory. During 2017-18, 150 on-farm demonstrations were conducted with the three cultivars - Pusa Mustard 25, Pusa Mustard 30, NRCHB 101 and a Local strain, in Raichur, Koppal, and Ballari districts, where yields ranged from 10.0 to 12.5 q ha⁻¹ depending on the variety and location (data not published).

Expanding mustard through crop intensification

Beyond exploring new regions, mustard area can also increase through intercropping with compatible crops. Successful combinations reported include mustard with sugarcane (1:2), potato (3:1), chickpea (4:1), wheat (9:1), and lentil (6:1) in northern India. In southern Karnataka, mustard can be integrated with finger millet (ragi), and in northern Karnataka with dicoccum / khapli wheat. Such diversification can enhance farm resilience to drought, salinity, and income instability (Chauhan *et al.*, 2011).

Current status and feasibility in Karnataka

In Karnataka, mustard occupies only a marginal share of the state's 1.18 million hectares under oilseeds, which are predominantly groundnut (0.57 million hectares), soybean (0.38 million hectares), and sunflower (0.16 million hectares) (Anonymous, 2023). Mustard is largely grown as an intercrop, border crop, or trap crop in both rainfed and irrigated systems alongside paddy, ragi, jowar, maize, or soybean, contributing supplementary income along with the main crop. In 2015-16, the crop covered about 13,000 acres with an average yield of 339 kg ha⁻¹ (Anonymous, 2016). Its cultivation persists mainly through the traditional Akkadi mixed-farming system,

which integrates livestock and avoids chemical inputs, and has historically not been targeted for yield enhancement. However, the present findings demonstrate that mustard is both adaptable and capable of producing competitive yields under diverse agro-climatic conditions of Karnataka.

Feasibility study undertaken in Karnataka (2017-18 to 2024-25)

Given the crop's adaptability and previous trial successes, the IARI Regional Station, Wellington conducted feasibility trials in which four IARI-released *B. juncea* varieties - Pusa Mustard 25, Pusa Mustard 28, Pusa Mustard 30, and Pusa Mustard 31 - were evaluated across three locations in Karnataka namely KVK, Hirehalli (Tumakuru), ZARS, Kalaburagi and IARI-RRC Dharwad, during *rabi* 2017-18 to 2024-25. Varieties Pusa Mustard 25 and Pusa Mustard 28 are short-duration cultivars suited to non-traditional areas, while Pusa Mustard 30 ("0" type, low erucic acid) and Pusa Mustard 31 ("00" type, low erucic acid and low glucosinolate) are improved quality lines (Yadava *et al.*, 2019). Standard agronomic practices were followed as seed rate of 3-4 kg ha⁻¹, spacing 30 × 10 cm, and fertilizer dose of 60:30:30 N:P:K kg ha⁻¹. Irrigations (3-5) were scheduled based on soil moisture and crop stage. The trial sites represented diverse soils: red sandy loam (Tumakuru), black clay (Kalaburagi), and deep black soil (Dharwad).

Results of feasibility study

The yield performance of Indian mustard varieties across three locations in Karnataka - KVK Tumakuru, ZARS Kalaburagi, and IARI-RRC Dharwad - during eight *rabi* seasons (2017-18 to 2024-25) is presented in Table 1 & Fig 1, 2 and 3. Among locations, Dharwad recorded the highest mean seed yield (1328 kg ha⁻¹), followed by Tumakuru (1199 kg ha⁻¹), while Kalaburagi registered the lowest (310 kg ha⁻¹). The highest seasonal mean yield (1604 kg ha⁻¹) was obtained at Dharwad during *rabi* 2024-25, followed by 1593 kg ha⁻¹ in *rabi* 2022-23. At Tumakuru, yields peaked at 1373 kg ha⁻¹ (*rabi* 2017-18) and were lowest at 1053 kg ha⁻¹ (*rabi* 2019-20). Across varieties and seasons, the maximum yield (1762 kg ha⁻¹) was recorded by Pusa Mustard 28 during *rabi* 2024-25 at Dharwad, followed by 1712 kg ha⁻¹ for the same variety in *rabi* 2022-23. Pusa Mustard 31 (1625 kg ha⁻¹, Dharwad, *rabi* 2022-23) and Pusa Mustard 30 (1600 kg ha⁻¹, Tumakuru, *rabi* 2017-18) were the next best performers. Mean yields across seasons and sites varied widely: Pusa Mustard 25 (317-1562 kg ha⁻¹), Pusa Mustard 28 (283-1762 kg ha⁻¹), Pusa Mustard 30 (86-1600 kg ha⁻¹), and Pusa Mustard 31 (206-1625 kg ha⁻¹). Overall, Pusa Mustard

Table 1: Performance of Indian mustard varieties at three places in Karnataka (Tumakuru, Kalaburagi and Dharwad) between *rabi* 2017-18 and 2024-25 (Seed yield in kg ha⁻¹)

Season	Place	PM25	PM28	PM30	PM31	Average of season	Average of Centre	Plot size(m ²)	Date of sowing
<i>Rabi</i> 2017-18	IIHR KVK, Hirehalli, Tumakuru.	1180	1530	1600	1180	1373	1199	144	17/11/2017
<i>Rabi</i> 2018-19	IIHR KVK, Hirehalli, Tumakuru.	981	1134	1323	1407	1211		144	04/10/2018
<i>Rabi</i> 2019-20	IIHR KVK, Hirehalli, Tumakuru.	810	970	1150	1280	1053		144	05/11/2019
<i>Rabi</i> 2020-21	IIHR KVK, Hirehalli, Tumakuru.	-	890	1360	1190	1147		144	09/11/2020
<i>Rabi</i> 2021-22	ZARS, Kalaburagi	467	283	115	302	292	310	90	08/11/2020
<i>Rabi</i> 2022-23	ZARS, Kalaburagi	316	297	85	206	227		90	13/10/2021
	ZARS, Kalaburagi	580	528	239	298	411		90	17/10/2022
<i>Rabi</i> 2023-24	IARI, RRC, Dharwad	1436	1712	1599	1625	1593	1328	16	07/10/2022
<i>Rabi</i> 2024-25	IARI, RRC, Dharwad	711	827	543	1068	787		16	21/11/2023
	IARI, RRC, Dharwad	1562	1762	1571	1520	1604		16	06/11/2024
	Average of variety	894	993	959	1008				
	Range	316 - 1562	283 - 1762	85 - 1600	206 - 1625				

31 recorded the highest average yield (1008 kg ha⁻¹), while Pusa Mustard 25 had the lowest (894 kg ha⁻¹). The superior yields of these improved varieties (up to 1762 kg ha⁻¹) are comparable or higher than the national average productivity of rapeseed-mustard (~1400 kg ha⁻¹), and substantially higher than the yields (~300 kg ha⁻¹) obtained in Karnataka from traditional landraces reported by local farmers. These results emphasize the potential of improved mustard cultivars under Karnataka conditions. Further yield enhancement is possible through optimization of agronomic practices such as sowing time, nutrient management, irrigation, and integrated pest and disease control.



Fig. 1: Expression of the Indian mustard crop at the IIHR-KVK, Hirehalli, Tumakuru, Karnataka (Flowering stage)



Fig. 2: Expression of the Indian mustard crop at the IIHR-KVK, Hirehalli, Tumakuru, Karnataka (Maturity stage)



Fig. 3: Expression of the Indian mustard crop at IARI - RRC, Dharwad, Karnataka (Flowering stage)

The findings suggest that Indian mustard has strong potential as a viable winter oilseed crop in Karnataka, particularly in regions like Dharwad and Tumakuru where climatic and soil conditions favour higher productivity. Promotion of high-yielding cultivars such as Pusa Mustard 28 and Pusa Mustard 31, coupled with suitable agronomic interventions, could significantly contribute to expansion of mustard cultivation beyond traditional northern states and reducing the edible oil deficit.

Challenges and future prospects

Efforts to scale up mustard cultivation through mini-kit trials (2020-21) in Tumakuru were hampered due to the absence of assured market linkage and buyback arrangements. Establishing marketing and processing infrastructure is therefore critical for sustained farmer adoption. In Karnataka, potential biotic constraints limiting mustard productions includes white rust, powdery mildew, and mustard aphid infestations etc. (Nanjundan *et al.*, 2024); however, resistant genotypes such as Pusa Mustard 31 (white rust resistant) and donor lines like RDV 29 (powdery mildew resistance) are available for breeding programs (Yadava *et al.*, 2019 and Nanjundan *et al.*, 2020). Most importantly, developing climate and soil analogue maps using Dharwad and Tumakuru as reference sites would enable identification of additional mustard-suitable areas across Karnataka.

Conclusion

Achieving self-reliance in edible oils necessitates the expansion and intensification of rapeseed-mustard cultivation. These crops offer wide ecological adaptability, low water requirements, and nutritionally superior oil with beneficial fatty acid profiles (Manchanda & Passi, 2016). New “double zero” (00) mustard varieties such as Pusa Mustard 31 and Pusa Mustard 33 produce oil with reduced pungency, catering to the culinary preferences of southern India. Regions such as Koppal and Raichur, where second paddy crops often fail due to water shortages, can benefit from introducing mustard in rice fallows, replacing low-yielding local landraces (2-3 q ha⁻¹) with improved cultivars like Pusa Mustard 25, Pusa Mustard 28, Pusa Mustard 31, capable of yielding up to 17 q ha⁻¹. A strategic, multi-level approach - combining varietal promotion, agronomic refinement, farmer training, and marketing support - can transform mustard cultivation in Karnataka and contribute significantly to India's edible oil self-sufficiency.

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