



Impact of adoption of (*Ajmer Fenugreek-3*) on yield and economic returns of fenugreek (*Trigonella foenum-graecum* L.) under arid conditions of Kachchh, Gujarat

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Summary

Fenugreek is an important seed spice crop in arid regions of India, particularly in Rajasthan and Gujarat states. To popularize the improved variety of fenugreek in arid Kutch of Gujarat ICAR-CAZRI, Krishi Vigyan Kendra, Kukma, Bhuj organised Frontline Demonstrations (FLDs) in different villages of Anjar and Bhuj Talukas in the district for three years. Under the demonstration fields, seeds of improved variety (AFg-3), along with all improved package and practices of fenugreek applied. During the practice, a total 20 demonstrations were conducted in 8 ha area at the farmers' field. The average seed yield under the improved variety was 2311.67 kg ha⁻¹ compared to the farmer's local variety (2070 kg ha⁻¹) and increased significantly by 11.68% on average over farmers' used variety. The average extension gap, technology gap and technology index were 241.67 kg ha⁻¹, 88.33 kg ha⁻¹ and 3.68%, respectively. Through adoption of improved variety, farmers get additional average returns of Rs. 8718.33 ha⁻¹ and B:C ratio of 2.75. During this period to strengthen technology dissemination and promote wider adoption, KVK Kukma, Bhuj also formed a Farmers Interest Group (FIG) on fenugreek in collaboration with the Department of Agriculture (DoA) and ATMA. During the period, five training programmes and field days were organized, through which more than 625 farmers were educated about improved fenugreek production technologies, including the use of improved varieties and recommended agronomic practices. Other extension activities, such as distribution of technical literature and diagnostic visits, were also undertaken to provide timely technical support to farmers. The FLD programme, along with the FIG and associated extension activities, created greater awareness, improved farmers' knowledge and skills, and encouraged the adoption of improved fenugreek production technologies, thereby contributing to enhanced productivity and profitability of fenugreek cultivation in the Kutch region.

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Introduction

Fenugreek (*Trigonella foenum-graecum* L.), an annual self-pollinated herbaceous crop belonging to the subfamily Papilionaceae (family Fabaceae), is traditionally cultivated as a multi-use seed spice during the rabi season across north-western India. Beyond its prominent role as a culinary flavoring agent, fenugreek possesses high nutraceutical and pharmaceutical value. Its seeds are chemically rich, containing gums (20.06%), mucilage (28%), trigonelline (0.13–0.30%), and saponins (1.7%), with a calorific value of 370 kcal per 100 g. They also provide appreciable amounts of protein (9.5%), lipids (10%), crude fibre (18.5%), and carbohydrates (42.3%), along with essential micronutrients and vitamins. Furthermore, green pods and tender leaves serve as excellent dietary sources of iron, calcium, protein, and vitamins (Samadia and Haldhar 2019; Haldhar & Meena 2026). Because of their potent free-radical scavenging capacity, fenugreek extracts are increasingly recognised as viable alternative medicines for therapeutic applications. Geographically, Rajasthan and Gujarat

dominate national seed spice production, contributing over 80% of the country's total output and earning the region recognition as the "seed spices bowl" of India (Poonia et al. 2017; Haldhar et al. 2018). Globally, India remains the foremost producer of fenugreek, cultivating an area of 121.327 thousand hectares with a total production of 202.631 thousand tonnes and a national average productivity of 1670 kg ha⁻¹. Export figures underscore its economic significance, with India shipping 26,750 tonnes valued at Rs. 15,690 lakh during 2020–21. Within Gujarat, fenugreek occupies 9,005 hectares with a production of 16.947 thousand tonnes and a state productivity average of 1880 kg ha⁻¹. Despite its high economic and nutritional value, agricultural productivity in the arid Kutch district remains constrained. Growers have historically relied on local, low-yielding cultivars without adhering to standardized agronomic packages. Traditional practices, such as random seed broadcasting in localized pockets, severely impede vital inter-cultural operations during the crop growth period, ultimately compromising both produce quality and harvest yield. To address these yield barriers, Frontline Demonstrations (FLDs) serve as an indispensable extension mechanism for validating newly released high-yielding varieties and science-based management protocols directly on farmers' fields across diverse agro-climatic zones. Krishi

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Vigyan Kendras (KVKs) continuously bridge knowledge deficits through targeted on-campus and off-campus capacity-building programs for farming communities. Optimizing seed spices production requires a holistic technological package—incorporating certified high-yielding seed, optimal seeding rates, rigorous seed treatments, precise planting windows, balanced fertilization, integrated weed management, and proactive plant protection—significantly outperforming conventional farmer practices. FLD programs not only fast-track technology diffusion and encourage the adoption of superior varieties but also capture crucial feedback regarding grassroots adoption constraints to guide future adaptive research. Typically implemented across contiguous blocks of 2 to 5 hectares, FLDs rely on critical institutional input support combined with farmer-managed operational costs to convince both extension agents and growers of technological viability under real-world farming situations. Building upon these agronomic imperatives, the present study was undertaken to evaluate the impact of frontline demonstrations featuring the improved fenugreek variety AFg-3 in the arid ecosystem of Kutch. Specifically, this research investigates yield enhancement, economic returns, technology gaps, extension gaps, technology indices, and adoption levels relative to traditional farmer practices.

Materials and Methods

The present study was conducted by ICAR-CAZRI, Krishi Vigyan Kendra, Bhuj-Kutch-II (Gujarat) across farmer fields during the rabi seasons of three distinct years: 2017–18, 2019–20, and 2020–21. A total of twenty frontline demonstrations were executed across an 8.0-hectare area spanning selected villages—namely Modsar, Bhujodi, Madhapar, Ler, Nana Reha, Kotda Chakar, Vadva, and Reldi—situated within the Anjar and Bhuj talukas of the Kutch district. Geographically, the Kutch district lies between 23°24' to 23° 46' North latitude and 69°38' to 31°58' East longitude. Comprising an area of 45652 sq.km divided across ten talukas, Kutch is the largest district in both Gujarat and India. The local climate is characterized by low and erratic rainfall, registering an annual average of 250–340 mm, with approximately 95% concentrated between June and September across a sparse average of only 13 rainy days. High temporal variability (coefficient of variation of ~60%) renders the district frequently susceptible to drought conditions. Ambient winds remain moderate to high, averaging an annual speed of 11.3 km per hour. Seasonal temperatures range from 7–48°C from winter to summer, with annual relative humidity averaging 63% and rising up to 80% during the southwest monsoon. Pedologically, soils in the experimental command are predominantly saline-alkaline, with a pH of 7.6 to 8.6, electrical conductivity (EC) ranging from 0.8 to 2.4 dSm⁻¹, organic carbon content low to medium (0.12–0.70%), available nitrogen ranging from 169 to 301Kg/ha, available potassium spanning 134 to 470 kg/ha, and low to medium available phosphorus. Demonstrations were allotted to randomly selected farmers to promote science-based agronomic interventions aimed at yield maximization. The FLD program evaluated the high-

yielding fenugreek variety AFg-3 (released by ICAR-NRCSS, Tabiji, Ajmer, Rajasthan), paired with an improved package of practices over the three-year duration. Each demonstration plot measured 0.4 hectares, paired with an adjacent equal-sized control plot utilizing standard farmer practices. The performance of variety AFg-3—characterized by bold seeds, elongated pods, and a maturity period of 130–135 days—was directly benchmarked against the local cultivars managed by growers. To augment technology dissemination and encourage horizontal adoption, KVK Kukma (Bhuj) established a Farmers Interest Group (FIG) on fenugreek in active collaboration with the Department of Agriculture (DoA) and ATMA. Five structured training programs and field days were organized, educating more than 625 farmers on improved varieties, optimized production packages, and integrated crop management. Complementary extension tools, including technical literature distribution and diagnostic field visits, provided timely technical troubleshooting for growers. These multi-pronged extension strategies synergized with the FLD plots to elevate local knowledge, refine grower skills, and accelerate technology diffusion across the region. Crop sowing was completed during the first fortnight of November, with harvesting executed by mid-March across all evaluation years. Standard seed treatment was administered using *Trichoderma viride* at @ 10 g per kg seed. Crop nutrition was maintained through a recommended fertilizer dose of 20 kg N and 40 kg P₂O₅ per hectare. Weed management involved pre-emergence soil application of pendimethalin at @ 500 g/ha, supplemented by one manual weeding at 35 days after sowing (DAS). Although no major biotic stresses were recorded during the crop cycles, sporadic aphid infestations were effectively managed via two preventive foliar sprays of neem oil, while localized powdery mildew occurrences were controlled through sulfur dust application at @ 20kg/ha. Yield data harvested from both demonstration and local check plots served as the basis for comparative performance evaluation. Analytical metrics—specifically the technology gap, extension gap, additional returns, and technology index—were calculated using standard mathematical formulations established by Sagar and Chandra (2004).

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - Farmers practice yield

Additional return = Demonstration return - Farmers practice return

Technology index = [(Potential yield - Demonstration yield)/Potential yield] x 100

Benefit cost ratio (BCR) =
$$\frac{\text{Gross return (Rs ha}^{-1}\text{)}}{\text{Total cost of cultivation (Rs ha}^{-1}\text{)}}$$

Results and Discussion

Seed Yield Performance

Evaluation of the field performance revealed that adopting the improved fenugreek variety AFg-3 combined with science-based management practices consistently outperformed traditional farmer practices across all evaluation years (Table 1). Specifically, the demonstration plots recorded superior seed yields of

2325, 2270, and 2340 kg ha⁻¹ during 2017–18, 2019–20, and 2020–21, respectively. These figures represent notable yield enhancements of 10.71%, 10.19%, and 14.15% over the local check varieties grown by farmers. On average, the demonstration plots achieved an overall seed yield of 2311.67 kg ha⁻¹, demonstrating a significant yield advantage of 11.68% compared to the mean local check yield of 2070 kg ha⁻¹. These pronounced yield increments validate the efficacy of comprehensive technological interventions. The superior performance observed in the demonstration plots is

Table 1. Year wise details and yield performance of frontline demonstrations in fenugreek

Year	No. of Demo	Area (ha)	Yield (kg ha ⁻¹)			Increased yield over local check (%)
			Potential Yield (PY)	Demo Yield (IP)*	Check Yield (FP)	
2017-18	10	4.0	2400	2325	2100	10.71
2019-20	05	2.0	2400	2270	2060	10.19
2020-21	05	2.0	2400	2340	2050	14.15
Average			2400	2311.67	2070	11.68

*IP=Improved Practice; FP= Farmers Practice

Table 2. Extension gap, technology gap and technology index of fenugreek under FLDs

Year	Technology Gap (Kg ha ⁻¹)	Extension Gap (Kg ha ⁻¹)	Technology Index (%)
2017-18	75	225	3.13
2019-20	130	210	5.42
2020-21	60	290	2.5
Average	88.33	241.67	3.68

Technology Gap Analysis

The technology gap serves as a crucial agronomic indicator, reflecting the discrepancies in implementation and potential drawbacks within package practices across varying environmental or varietal conditions. Defined as the difference between potential yield and demonstration yield, the technology gap in this study ranged from 60 to 130 kg ha⁻¹, with an overall mean of 88.33 kg ha⁻¹. This variation is primarily attributable to the adoption of high-yielding varieties sown using seed-cum-fertilizer drills alongside balanced nutrition and rigorous plant protection measures in demonstration plots. These findings closely align with the documented observations of Lal et al. (2013) and Singh et al. (2011).

Extension Gap Analysis

Baseline assessments prior to the study indicated that a majority of growers relied on conventional local varieties and omitted optimized management practices, creating a wide extension gap between demonstrated technologies and traditional farming methods. To bridge this gap, frontline demonstrations successfully showcased advanced cultivation techniques, resulting in substantial yield gains over local checks. As detailed in Table 2, the extension gap fluctuated between 210 and 290 kg ha⁻¹, maintaining an average of 241.67 kg ha⁻¹. This prominent gap stems primarily from localized knowledge deficits regarding high-yielding, pest- and disease-resistant cultivars. These results corroborate earlier conclusions reported by Bhoraniya et al. (2017), Lal et al. (2013), and Singh et al. (2011).

attributed to the synergistic adoption of high-yielding genetic material (AFg-3), optimal planting times, recommended seed rates, rigorous seed treatments, precise line sowing, proper spatial geometry, targeted weed control, efficient moisture management, and proactive plant protection protocols. These findings corroborate previous research documenting similar productivity enhancements through frontline demonstrations in fenugreek and related seed spice crops (Mehriya et al., 2020; Lal et al., 2017; Dashora et al., 2020; Meena et al., 2016; Poonia et al., 2017).

Technology Index Analysis

The technology index evaluates the field-level feasibility and operational practicality of demonstrated varietal trials, operating inversely to technology acceptability—where lower index values denote higher grower adoption and preference (Sagar and Chandra, 2004). As reflected in Table 2, the technology index for variety AFg-3 touched a minimum of 2.5% during 2020-21, compared to 5.42% in 2019-20 and 3.13% in 2017-18. Across the three-year evaluation, the mean technology index remained low at 3.68%, highlighting the high efficacy and stability of these technical interventions. These outcomes accord well with the findings of Patel et al. (2022) and Choudhary et al. (2018) regarding crop-specific FLD impacts.

Economic Analysis

Evaluating the economic viability of demonstrated technologies relative to traditional farmer practices is essential for assessing practical utility. Because net returns fluctuate annually due to shifting input costs, labor charges, and market sale prices, input-output parameters were systematically analyzed. Economic outcomes (Table 3) demonstrate that fenugreek cultivation under improved demonstration practices yielded an average gross return of Rs. 90,151.67 ha⁻¹ and an average net return of Rs. 57,451.67 ha⁻¹, compared against Rs. 80,533.33 ha⁻¹ and Rs. 48,733.33 ha⁻¹ under traditional farmer practices. Furthermore, demonstration plots generated an average additional net return of Rs. 8,718.33 ha⁻¹ alongside an elevated average benefit-cost (B:C) ratio of 2.75, compared to 2.53 for local checks. These enhanced economic returns underscore the

profitability, financial stability, and adoption potential of the demonstrated scientific interventions, mirroring

Table 3. Economic analysis of front-line demonstrations on Fenugreek

Year	Cost of cultivation (Rs/ha)		Gross Return (Rs/ha)		Net Return (Rs/ha)		Additional Return (Rs/ha)	B:C Ratio	
	IP*	FP	IP	FP	IP	FP		IP	FP
2017-18	30000	28800	81375	73500	51375	44700	6675	2.71	2.55
2019-20	33700	33300	90800	82000	57100	48700	8400	2.69	2.46
2020-21	34400	33300	98280	86100	63880	52800	11080	2.86	2.59
Average	32700	31800	90151.67	80533.33	57451.67	48733.33	8718.33	2.75	2.53

*IP=Improved Practice; FP= Farmers Practice

The results of the economic analysis clearly demonstrate the enhanced profitability and economic viability of the demonstrated technologies under arid conditions. These findings align closely with similar conclusions reported by Dhaka et al. (2010) regarding chickpea and maize cultivation.

Conclusions

Results from the three-year investigation reveal that the improved fenugreek variety AFG-3 substantially outperformed local check varieties, exhibiting strong agronomic potential under the arid agro-climatic conditions of Kutch, Gujarat. Supported by a Farmers Interest Group (FIG) established in active collaboration with the Department of Agriculture (DoA) and ATMA, the Frontline Demonstrations (FLDs) effectively enhanced grower knowledge, technical skills, and the adoption rate of modern fenugreek production practices. Through five targeted training programs and field days, more than 625 farmers were educated, supplemented by the distribution of technical literature and proactive diagnostic field visits. The notable productivity enhancements achieved through the FLD program fostered widespread awareness and successfully motivated neighbouring growers to embrace optimized production technologies across the district. Ultimately, frontline demonstrations serve an instrumental role in accelerating the diffusion of modern agricultural innovations, culminating in elevated crop output and sustained rural income.

References

- Bhoraniya MF, Chandawat MS & Bochalya BC. 2017. Assessment of frontline demonstration on yield enhancement and economics of coriander (GC-4) in Surendranagar district of Saurashtra region of Gujarat. *Gujarat Indian J. Ext. Edu.*, 28(1): 14-17.
- Choudhary ML, Ojha SN & Roat BL. 2018. Assessment of frontline demonstration on yield enhancement of fennel (Abu Sonf) under TSP area in Dungarpur, Rajasthan. *Int. J. Seed Spices*. 8(1):46-49.
- Dashora A, Solanki RL, Urmila Chhipa BG & Singh PB. 2020. Impact of Front-Line Demonstration on the Yield and Economics of Fenugreek in Southern Rajasthan. *Int. J. Curr. Microbiol. App. Sci.* 9 (6): 1397-1402.
- Dhaka BL, Meena BS & Suwalika RL. 2010. Popularization of improved maize technology through Front Line Demonstration in South-eastern Rajasthan. *J. Agric. Sci.*, 1(1):39-42.
- Haldhar SM & Meena PN. 2026. Omics-driven strategies for integrated insect-pest and disease management. *Journal of Agriculture and Ecology*, 22: 1-20; <https://doi.org/10.58628/JAE-2622-101>.
- Haldhar SM, Kumar R, Samadia DK, Singh B & Singh H. 2018. Role of insect pollinators and pollinizers in arid and semi-arid horticultural crops. *Journal of Agriculture and Ecology*, 5: 1-25.
- Lal G, Mehta RS, Meena RS, Meena NK & Choudhary ML. 2017. Assessment of front-line demonstrations on yield enhancement of fenugreek under TSP area in Pratapgarh district of Rajasthan. *International J. Seed Spices* 7(1):60-64.
- Lal G, Mehta RS, Singh D & Chaudhary MK. 2013. Effect of technological interventions on coriander yield at farmers' field. *Int. J. Seed Spices*, 3(2): 65-69.
- Meena KC, Singh DK, Gupta IN, Singh B & Meena SS. 2016. Popularization of coriander production technologies through front line demonstrations in Hadauti region of Rajasthan. *Int. J. Seed Spices*, 6(2): 24-29.
- Mehriya ML, Ramesh & Singh H. 2020. Improved technological intervention- A boon in enhancing fenugreek yield in Western Rajasthan. *International J. Seed Spices*. 10(1):52-55.
- Patel ML, Vekaria GB, Dhingani JC, Jotangiya KS & Hirpara DS. 2022. Impact of improved variety of cumin through front line demonstrations. *International Journal of Agriculture Sciences*. 14(2):11122-11125.
- Poonia MK, Singh M, Dhaka BL, Bairwa RK & Kumhar BL. 2017. Impact of Front-Line Demonstration on the Yield and Economics of Coriander in Kota District of Rajasthan, India. *Int. J. Curr. Microbiol. App. Sci.* 6 (3): 2344-2348.
- Sagar RL & Chandra R. 2004. Front line demonstration on sesame in West Bengal. *Agric. Ext. Review*, 16 (2): 7-10.
- Samadia DK & Haldhar SM. 2019. Scope and strategies for genetic improvement in vegetable crop-plants under high temperature and abiotic stressed climate of Rajasthan: A gap analysis. *Journal of Agriculture and Ecology*, 8: 1-18.
- Singh D, Meena ML & Choudhary MK. 2011. Boosting seed spices production technology through front line demonstrations. *Int. J. Seed Spices*. 1(1), 81- 85.
- Singh PK & Varshney JG. 2010. Adoption level and constraints in coriander production technology. *Ind Res J Extn Edu* 10: 91-94.

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