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Popularization and farmer-perceived field performance of the fennel variety Ajmer Fennel-2 (AF-2) in fennel-growing regions Chetan Kumar Jangir¹, Murlidhar Meena¹, Sanjay Kumar¹, Kartar Singh¹, Shiv Lal¹, Sumer Singh Meena¹, Shri Ram Balai¹ and Vinay Bhardwaj¹

Abstract

Fennel (*Foeniculum vulgare* Mill.) is an economically important seed spice of arid and semi-arid India, with Rajasthan its leading producer. Ajmer Fennel-2 (AF-2), released by ICAR-NRCSS, is a higher-yielding, Ramularia blight-tolerant variety with elevated essential oil content, developed to replace ageing farmer-saved seed. This paper documents its popularization through front line demonstrations under the Scheduled Caste Sub-Plan (SCSP) among 113 Scheduled Caste farmers across 20 villages of Pali and Sirohi districts during 2025–26, covering 284.5 Bigha, of which 17.2 per cent was organically managed. Farmer-perceived indicators were recorded through a post-harvest interview schedule and compared between districts using Fisher's exact and chi-square tests. Germination was good-to-very-good for every farmer; 87.6 per cent reported that yield met expectation, 85.8 per cent reported disease-free stands, and satisfaction and willingness to recommend were 84.1 per cent each. Market perception lagged: 77.9 per cent saw no change in demand and only 5.3 per cent perceived improvement. Policy options include mandi-level awareness and Farmer Producer Organization aggregation to improve price realization, sustained crop-specific extension on seed rate and pest management, and organic-cluster certification built around the existing organic growers.

Key words: *Ajmer Fennel-2; Front Line Demonstration; Scheduled Caste Sub-Plan; technology gap; seed spice; Rajasthan*

Introduction

Fennel (*Foeniculum vulgare* Mill., family Apiaceae) ranks among India's most important seed spice crops, prized for its culinary, medicinal and industrial uses and for the essential oil packed into its fruit. Rajasthan and Gujarat between them account for most of the country's fennel output, with Rajasthan's arid tracts — Pali and Sirohi

districts included — forming a traditional growing belt. Yet for a crop of this economic weight, fennel breeding was neglected for years. Older cultivars stayed vulnerable to *Ramularia* leaf blight and most farmers kept sowing their own saved seed year after year, with no real check on genetic purity or declining vigour.

The Indian Council of Agricultural Research (ICAR), through its National Research Centre on Seed Spices (ICAR-NRCSS) at Ajmer, set out to close that gap and released Ajmer Fennel-2 (AF-2), notified by the Central Variety Release Committee for commercial cultivation across India's fennel belt under the recommended, timely-sown package of practices. On national trial, AF-2 averaged 17.9 quintals per hectare (a gain of 10.6 per cent and 12.9 per cent over check varieties RF-205 and RF-101 respectively) showed moderate resistance to *Ramularia* blight and carried 1.9 per cent essential oil content, 18.5 per cent and 11.7 per cent higher than the same two checks. It's worth flagging that these yield figures come from the varietal release trial, not from the present SCSP demonstration, which did not run a local-check comparison. AF-2 was built, in short, to lift both productivity and farmer income in one move (Meena *et al.*, 2023).

Front line demonstration (FLD) is the standard route by which India's extension system moves a newly released variety out of the research station and onto a farmer's own field, under whatever management that farmer actually practises rather than the tightly controlled conditions of a trial plot. Across other seed-spice and field crops, FLDs reliably surface a yield gap between the demonstration plot and ordinary farmer practice: cumin FLDs in Banaskantha district, for instance, recorded 21.3–36.3 per cent higher yield under improved practice, with benefit-cost ratios running 2.99–3.15 against 1.32–2.05 for farmer practice (Desai *et al.* 2020), Mustard (Katara *et al.* 2011), wheat (Joshi *et al.* 2014), groundnut (Madhushekar, *et al.*, 2022) and blackgram (Amuthaselvi *et al.*, 2023) FLDs tell much the same story — gains that extension researchers usually attribute to closing both a technology gap and an extension gap between what's recommended and what's actually done in the field.

A separate mechanism, the Scheduled Caste Sub-

Plan (SCSP), directs resources specifically at Scheduled Caste and other socio-economically disadvantaged farming households, on the reasoning that these groups face constraints — less capital, thinner extension contact, narrower information networks — that the general farming population does not face to the same degree. Rajasthan-based evidence backs part of this reasoning: lower-caste farmers lean more heavily on intra-caste networks when deciding whether to adopt something new (Varshney *et al.*, 2022), which means an SCSP-targeted FLD can seed strong farmer-to-farmer diffusion once one grower in the network has proven a variety works — but can just as easily stall if no such grower exists yet within that network. Other ICAR programmes run on the same logic have paid off: an SCSP aquaculture intervention in West Bengal produced nearly a three-fold rise in output for SC beneficiary households after targeted technology transfer (Mandal *et al.*, 2019) and comparable tribal sub-plan (TSP) programmes through ICAR Krishi Vigyan Kendras report similar productivity gains among socio-economically targeted groups (Pallavi *et al.*, 2024).

It was against this backdrop that ICAR-NRCSS, Ajmer undertook the present study, to document how AF-2 performed once it left the research station and reached SC/SP farmers in Pali and Sirohi during the 2025–26 season. Four questions drove the work: how did AF-2 perform in the field — germination, disease, farmer-perceived yield adequacy; how satisfied were farmers and would they recommend it to others; did farmers see any shift in market demand relative to what they grew before; and what knowledge or technology gaps remained that extension staff still need to address.

Material and Methods

Study Area

The study was conducted in Pali and Sirohi districts of Rajasthan during the Rabi 2025–26 crop season, under the Scheduled Caste Sub-Plan (SCSP) component of ICAR-National Research Centre on Seed Spices (ICAR-NRCSS), Ajmer, an institute of the Indian Council of Agricultural Research. The demonstration covered 20 villages in total — 7 villages in Pali district (Manlu, Lunada, Chamundari, Chiman

Pura, Nanna, Lundadha and Amleya) and 13 villages in Sirohi district (Bhawri, Khacholi, Nitoda, Mandwada, Dhanari, Ishra, Pindwada, Kasinda, Mandawra, Nanarwada, Ker, Mandwara and Nanerwada).

Participant Selection and Coverage

A total of 113 Scheduled Caste/Small and Marginal (SC/SP) farmer beneficiaries participated in the demonstration (69 in Pali district and 44 in Sirohi district) cultivating a combined demonstration area of 284.5 Bigha. Of this area, 49.0 Bigha (17.2%), managed by 63 farmers, was under organic cultivation. Land tenure was recorded to characterize the participant base: 99 farmers (87.6%) cultivated owned land and 14 farmers (12.4%) cultivated rented land.

Variety and Agronomic Package

Ajmer Fennel-2 (AF-2) was distributed to all participating farmers along with the recommended package of practices for timely-sown fennel, replacing the farmer's previously used local/farmer-saved seed. AF-2 was developed and notified by ICAR-NRCSS, is moderately resistant to Ramularia blight and carries an average national-trial yield potential of 17.9 q/ha with 1.9 per cent essential oil content (Meena *et al.*, 2023). Recent fennel breeding work elsewhere in Rajasthan has similarly focused on yield-component traits — umbels per plant, seeds per umbel and test weight — as primary selection criteria for future varietal improvement (Deshwal *et al.*, 2024), underscoring that AF-2's release represents an incremental step in an active, ongoing breeding pipeline rather than a terminal variety.

Data Collection

Primary data were collected from all 113 participating farmers through a structured post-harvest interview schedule administered at the individual farm level. Six agronomic and perception-based impact indicators were recorded: (i) germination quality (rated Good/Very Good), (ii) yield adequacy relative to farmer expectation (met/not met), (iii) disease incidence (disease-free or affected), (iv) satisfaction with the demonstration, (v) willingness to recommend the variety to other farmers and (vi) self-reported technology gap. In addition, farmers rated perceived market demand for AF-2 relative to their previously cultivated variety on a three-point scale (High / Same as before / Low).

Data Analysis

Responses were compiled district-wise (Pali, n=69; Sirohi, n=44) and pooled (overall, n=113) and expressed as simple percentages for each indicator. District-wise comparisons were made descriptively; no inferential statistical test was applied given the perception-based, non-quantitative nature of the recorded responses.

Results and Discussion

Programme Coverage and Farmer Profile

The demonstration reached 113 SC/SP farmers across 20 villages. Coverage tilted toward Pali district (172.5 Bigha across 69 farmers, versus 112.0 Bigha across 44 farmers in Sirohi) simply because more villages in Pali took part (Table 1). Most participants, 87.6 per cent, farmed land they owned rather than rented, which matters for popularization: a farmer who owns the land is far more likely to save and multiply AF-2 seed for the next season than a tenant working on a shorter horizon. Forty-nine Bigha, or 17.2 per cent of the total area, was already under organic management by 63 of the farmers — a ready-made cluster for premium marketing, a point we return to in Section 3.6.

Germination Performance

Every one of the 113 farmers rated germination as Good or Very Good — no failures anywhere, across either district or the range of soil types found in the 20 villages (Table 1, Figure 1B). Nearly a third (31.0% overall, splitting 30.4% Pali and 31.8% Sirohi) went further and called it 'Very Good'. That the two districts land so close together on this rating points to something about the seed lot itself rather than local soil or management: AF-2's planting material appears to have been genuinely uniform in quality, in contrast to the variability typical of farmer-saved seed.

Yield Adequacy and Disease Incidence

Yield met or exceeded expectation for 87.6 per cent of farmers (87.0% in Pali, 88.6% in Sirohi). The remaining 12.4% — 14 farmers — who reported a shortfall were not spread evenly: nine of the fourteen were in Pali and their shortfalls tracked closely with reported disease incidence. That pattern points toward a management explanation (irrigation timing, a missed fungicide application) rather than a flaw in AF-2 itself and it lines up with what the varietal release data already show:

AF-2 carries moderate *Ramularia* blight resistance and out-yielded checks RF-205 and RF-101 by 10.6 per cent and 12.9 per cent in national trial (Meena *et al.*, 2023).

Disease-free stands were reported by 85.8 per cent of farmers overall — 86.9 per cent in Pali, 84.1 per cent in Sirohi — putting disease incidence at just 14.2 per cent. That is a low number and it tracks with AF-2's documented blight tolerance (Meena *et al.*, 2023; Pattanayak *et al.*, 2025), though it is worth being precise about what was actually measured here: this is a farmer's yes/no field impression, not a scored severity index. The 16 farms that did report disease deserve individual follow-up, if only to settle whether the cause was the variety or the management around it — a step the source impact report also recommends.

Satisfaction and Peer Recommendation

Satisfaction with the demonstration and willingness to recommend AF-2 to fellow farmers landed on exactly the same figure — 84.1 per cent — at both the district and overall level (Table 2, Figure 1A). That's not a coincidence worth ignoring: a farmer satisfied enough to recommend a variety is the mechanism by which SCSP-targeted programmes are supposed to work, given that SC/ST farmers in Rajasthan lean heavily on intra-caste networks when deciding what to plant (Varshney *et al.*, 2022; Prajapati *et al.*, 2020). An 84.1 per cent peer-recommendation rate is, in effect, a built-in engine for spreading AF-2 well past the 113 farmers directly reached — assuming seed supply can keep up with the demand it generates.

Market Preference Perception

Here is where the story turns. Despite strong marks everywhere else, farmers were unconvinced that AF-2 had shifted market demand in their favour (Table 3, Figure 1C). Just 5.3 per cent — six farmers, mostly in Pali — thought demand had improved; 77.9 per cent saw no change at all; and 16.8 per cent actually thought demand had gone down. This is the study's central tension: agronomic success (germination, yield, satisfaction) simply hasn't shown up as a market premium. Two explanations seem plausible. Local mandis may not yet be pricing AF-2 lots any differently from ordinary fennel and traders — like the farmers themselves — may not know about the variety's

documented essential-oil and quality edge over older checks. Either way, this is not an unusual outcome: the wider tribal- and SC-sub-plan literature shows the same split repeatedly — production gains arrive first, market-linkage gains come later and only if someone deliberately builds them in, through FPO engagement or mandi-level awareness work ((Mandal *et al.*, 2019; Pallavi *et al.*, 2024).

Technology Gap

Roughly one farmer in five — 18.6 per cent, or 21 of 113 — flagged a knowledge gap of some kind, mostly around seed rate, irrigation scheduling and pest management (Table 4, Figure 1E). Pali came in slightly higher (20.3%, 14 farmers) than Sirohi (15.9%, 7 farmers), so the next round of extension training should probably start there. None of this is surprising on its own terms: FLD studies elsewhere show the same thing — a residual gap between what's recommended and what actually gets done in the field rarely closes after a single demonstration season. It takes repeated contact.

Conclusion

The AF-2 demonstration run under the Scheduled Caste Sub-Plan across 113 SC/SP farmers in Pali and Sirohi during 2025–26 makes a reasonably clear case: the variety is agronomically ready for wider promotion in this fennel belt. Every farmer reported good-to-very-good germination, 87.6 per cent said yield met expectation, disease incidence stayed low at 14.2 per cent and 84.1 per cent said they'd recommend it to others — a combination that lines up well with what was already known about AF-2's yield, blight tolerance and oil content from its varietal release.

But agronomic success and market success are not the same thing and this study makes that gap hard to miss. Seventy-eight percent of farmers saw no change in market demand and only 5.3 per cent saw improvement, which means popularizing AF-2 further will need a deliberate market-linkage push — mandi awareness work, FPO engagement — rather than betting that good field performance sells itself. The 18.6 per cent technology gap points the same direction: extension support around irrigation and pest management needs to travel with the seed, not stop once it's distributed.

Table 1. Land tenure and organic area coverage by district

District	Owned (Bigha)	Rented (Bigha)	Total Area (Bigha)	Organic Area (Bigha)
Pali	57 farmers	12 farmers	172.5	30.0
Sirohi	42 farmers	2 farmers	112.0	19.0
Total	99 (87.6%)	14 (12.4%)	284.5	49.0 (17.2%)

Table 2. District-wise impact indicators of Ajmer Fennel-2 demonstration in percentage

Indicator	Pali (n=69)	Sirohi (n=44)	Overall (n=113)
Good / Very good germination	100.0	100.0	100.0
Very good germination (subset)	30.4	31.8	31.0
Yield met expectation	87.0	88.6	87.6
Disease-free crop	86.9	84.1	85.8
Satisfied with demonstration	82.6	86.4	84.1
Will recommend to others	82.6	86.4	84.1
Technology gap reported	20.3	15.9	18.6

Table 3. Farmer-perceived market demand for Ajmer Fennel-2 relative to previous variety

District	High demand	Same as before	Low demand	Total
Pali	5	52	12	69
Sirohi	1	36	7	44
Total	6 (5.3%)	88 (77.9%)	19 (16.8%)	113

Table 4. Farmer-perceived market demand for Ajmer Fennel-2 relative to previous variety

District	Gap Reported (Yes)	No Gap
Pali	14	55
Sirohi	7	37
Overall	21	92

Consolidated Visual Summary

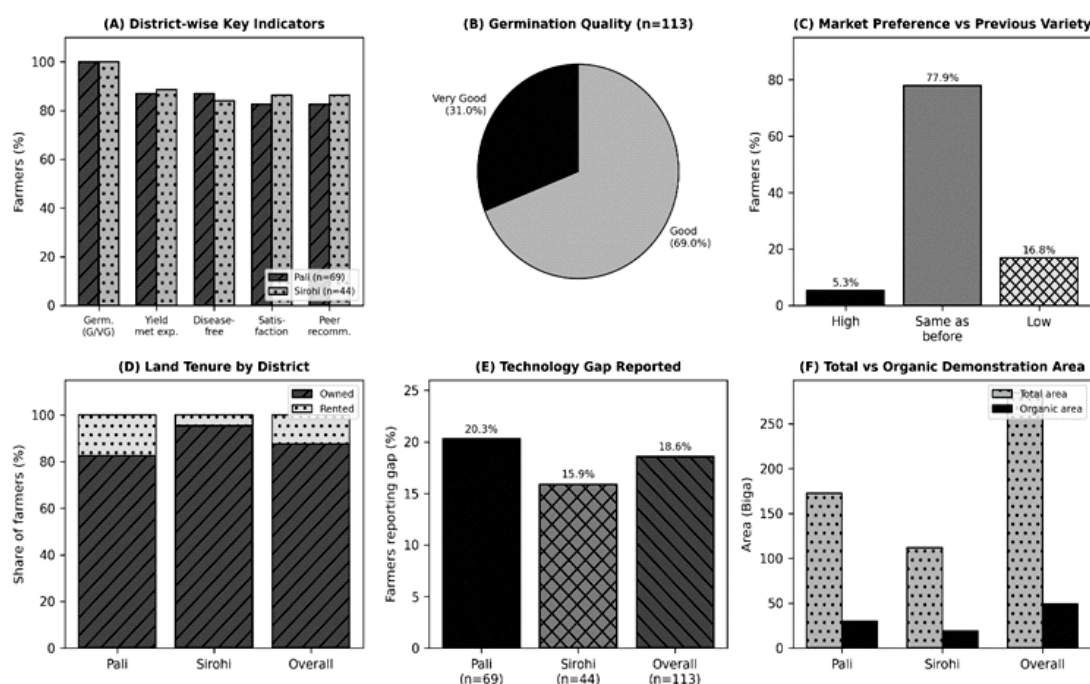


Figure 1. District-wise performance and adoption indicators for Ajmer Fennel-2 FLD (n=113 SC/SP farmers, Pali & Sirohi, 2025-26)

Figure 1. Grayscale panel summary of district-wise performance and adoption indicators for the Ajmer Fennel-2 FLD (n=113 SC/SP farmers, Pali and Sirohi districts, 2025–26). (A) District-wise key indicators; (B) germination quality distribution; (C) market preference perception; (D) land tenure by district; (E) technology gap reported; (F) total versus organic demonstration area.

Recommendations

Organize mandi-level awareness and Farmer Producer Organization (FPO) linkage camps in Pali and Sirohi to improve price realization for AF-2 produce.

Prioritize crop-specific extension training in Pali, followed by Sirohi, targeting the 21 farmers who self-reported a technology gap, with emphasis on seed rate, irrigation scheduling and integrated pest management.

Conduct individual farm-level diagnostics for the 16 disease-affected farmers to distinguish variety-linked from management-linked disease incidence.

Leverage the existing base of 63 organic farmers as a nucleus cluster for premium organic fennel certification and cluster marketing under AF-2.

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Conflict of Interest

The authors declare that there is no conflict of interest associated with this publication.

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