

# Assessing the Performance and Livelihood Impact of Fennel Variety, Rajasthan Fennel 125 (RF 125)

सौंफ किस्म, राजस्थान सौंफ 125 (आरएफ 125) के प्रदर्शन और  
आजीविका प्रभाव का आंकलन



**ICAR-All India Coordinated Research Project on Spices  
Department of Genetics and Plant Breeding**

**S.K.N. College of Agriculture**

**S.K.N. Agriculture University, Jobner, Rajasthan**

**and**

**ICAR-All India Coordinated Research Project on Spices**

**ICAR-Indian Institute of Spices Research**

**Kozhikode, Kerala**



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It is indeed a matter of great pride and contentment to note that the Principal Investigator, AICRP on Spices, Jobner Centre and his team have undertaken this important study on “Assessing the Performance and Livelihood Impact of Fennel Variety, Rajasthan Fennel 125 (RF 125) (सौंफ की किस्म राजस्थान सौंफ 125 (आरएफ 125) के पदर्शन और आजीविका प्रभाव का आकलन)” The present impact analysis effectively highlights its superior performance and its role in enhancing farmers’ income and productivity.

Fennel is an important seed spice crop of the semi-arid regions, valued for its high volatile oil content and increasing market demand. Assessing the impact of improved varieties is crucial to understand the tangible benefits of research interventions and their contributions to farmer’s livelihoods and the broader society.

The development and release of promising fennel variety *Rajasthan Fennel 125 (RF 125)* are the results of the concerted efforts of the ICAR–AICRP on Spices at Sri Karan Narendra Agriculture University, Jobner, Rajasthan. Through rigorous research, systematic evaluation and extensive dissemination, the team has successfully developed and popularized RF 125. This collaborative initiative has played a pivotal role in promoting the expansion and sustainability of fennel cultivation across India.

I believe this technical bulletin will serve as a valuable reference for farmers, researchers and the scientific community striving for sustainable growth and advancement of the seed spice sector.

  
(Dean, FC)

SKNCOA, Jobner

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## 1. Introduction

Fennel (*Foeniculum vulgare* Mill 2n = 22) belongs to the family Apiaceae (Umbelliferae). It popularly known as “Saunf”, is one of the most important seed spice crops of India due to its domestic consumption and export earnings. Two distinct sub-species are recognized in *Foeniculum vulgare*, one is piperitum which is wild type and the other one is capillaceum (Gillib) with three varieties namely var. vulgare, (Miller) Thellung -bitter fennel, var. dulce (Miller) Thellung-sweet fennel and var. ozoricum (Miller) Thellung - culinary florence fennel. The origin of fennel is South Europe and Mediterranean region.

Indian fennel is regarded as distinct variety of *Foeniculum vulgare* (Miller) Thellung var. panmorium. The bitter fennel oil is obtained from *Foeniculum vulgare*, which is cultivated in central Europe, India, Japan, Argentina and North America, whereas sweet fennel (*Foeniculum vulgare* Mill var. dulce) is mainly cultivated in South Europe (France and Italy). The essential oil is a yellowish green liquid with characteristic anise odour. Sweet fennel is also known as French or Roman fennel. It is found that oil of sweet fennel and common fennel differs significantly in hydrocarbon fractions. Limonene is the chief member in the oil of sweet fennel (*Foeniculum vulgare* Mill. Var. dulce) as against pinene in the oil of common fennel (*Foeniculum vulgare* Mill.Var. amara). Indian fennel contains about 70 per cent anethole and 6 per cent fenchone. However, European fennel contains up to 90 per cent anethole and absence of fenchone which is responsible for its delicate sweet odour and flavour.

Indian fennel is an annual, stout and aromatic herb of 100-180 cm height having slender, branched smooth stem which become hollow at maturity with distinct veins. Leaves are alternate, de-compounded and have sheathed petiole. The inflorescence is terminal bearing compound umbel subtended by involucre of bracts. Flowers are small, hermaphrodite, complete, regular and pentamerous. The fruits commonly known as seed is schizocarp of two mericarps attached to a dividing carpophore. A fully-grown fruit is four to eight mm long. The size and the colour of the fruit depend upon the stage of harvesting. The plant is pleasantly aromatic and each of the parts - leaves, stalks, bulbs and seeds, is edible. In India the seeds are also used for mastication and chewing either alone or with betel leaves. Fennel is known by different names in India (Table 1).

**Table 1. Indian Fennel is known by different names in the country**

S.No.	Name	Language State of India
1.	Saunf (Hindi)	Rajasthan, Haryana, Jammu and Kashmir
2.	Mauri, Panmouri (Bengali)	Bengal
3.	Hariyal, Variyali (Gujarati)	Gujarat
4.	Perumjeerakam ( Malayalam)	Kerala
5.	Badishep, Badisep, Shoap (Marathi)	Maharashtra
6.	Madhurika, Shatapushpa (Sanskrit)	Maharashtra
7.	Perunsiragum, Shombu (Tamil)	Tamil Nadu
8.	Peddajilakurra, Sopu (Telugu)	Andhra Pradesh
9.	Badisopu, Badisepu, Sabbasige, Doddasopu (Kannada)	Karnataka
10.	Badesoppu Gharwali	Uttarakhand

## 2. Botanical Description

*Foeniculum vulgare* is a perennial herb. The stem is hollow, erect, and glaucous green, and it can grow up to 2.1 m (7 feet) tall. The leaves grow up to 40 cm (16 inches) long. They are finely dissected, with the ultimate segments filiform (threadlike), about 0.5 mm (1/64 in) wide. Its leaves are similar to those of dill, but thinner.

The flowers are produced in terminal compound umbels 5–17.5 cm (2–7 in) wide, each umbel section having 20–50 tiny yellow flowers on short pedicels. The fruit is a dry schizocarp from 4–10 mm (3/16–3/8 in) long, half as wide or less, and grooved. Since the seed in the fruit is attached to the pericarp, the whole fruit is often mistakenly called "seed" (Fig. 1 and 2).



Flower heads



Umbel



Fennel bulbs

Fig. 1 Flower heads, umbel and bulbs of fennel

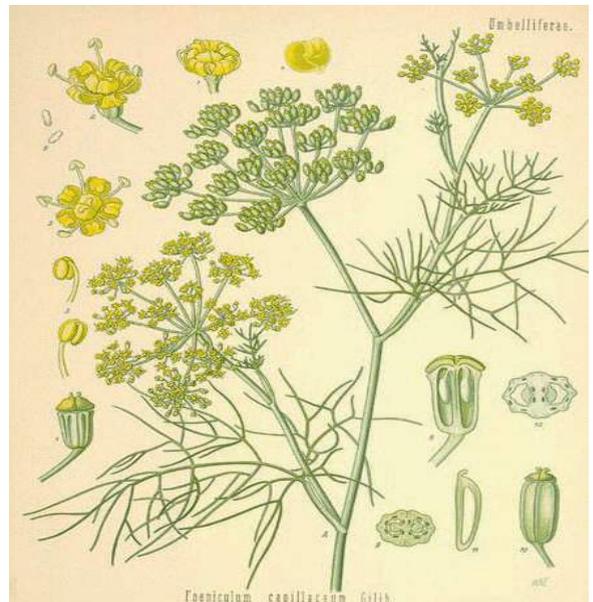


Fig. 2 Flower parts of fennel

### 3. Phytoconstituents

Fennel seeds contain about 0.7 to 6.0% volatile oil depending on the genotype or botanical type. Besides volatile oil, the seeds contain about 9.5% protein, 10.0% fat, 42.30% carbohydrates, 18.5% crude fibre and 13.40% minerals. The main constituents of the fennel oil are anethole and fenchone. The other constituents are methyl chavicol, alpha-pinene, comphane, alpha-phellandrene and dipentene. The essential oil extracted from seeds is used for scenting soaps and as flavouring material for cakes. Fennel oil and fennel oleoresins are used in pizza sauces, toppings, non-alcoholic beverages, liquors, ice creams and in seasoning of processed meats. The volatile oil is used in the manufacture of cordials and enters into the composition of fennel water, which is commonly given to infants as medicine. The volatile oil is primarily beneficial for digestive system and it also have vermifugal properties, antispasmodic and also helps in reducing flatulence.

### 4. Medicinal Properties and Uses

**Medicinal properties:** In fennel seeds (fruits), leaves, roots and volatile oil present in the seeds have medicinal values. Leaves are diuretic and roots are purgative. Seeds are aromatic, stimulant and carminative useful in diseases of chest, lungs, spleen, kidneys and used in diseases like cholera, bite, nervous disorders, cough and cold constipation, dysentery and diarrhoea.

**Medicinal uses:** Hot infusion of fruits is used in indigenous medicine to increase lacteal secretion and to stimulate sweating. The consumption of fennel seeds also aid to weight loss and longevity. Fennel oil is used in preparation of medicines for treatment of Post Menopausal.

Syndrome and regulates Menstrual periods; oil is also used in cosmetics and medicinal preparations like in infantile colic and flatulence. Local application of fennel is beneficial in giddiness, headache, especially in the summer season. A paste of seeds/ fruits is used in a cooling drink in fevers, burning micturition and scalding of urine.

### 5. Global area, production and productivity scenario of Fennel

Fennel (*Foeniculum vulgare*), a key aromatic and medicinal crop, is cultivated globally for its seeds, leaves and essential oils. It holds significant value in culinary, pharmaceutical and industrial sectors.

#### 1. Global area and production

As per the latest estimates (FAOSTAT and other sources, 2023):

- Total Area: Approximately 1.2 lakh hectares (120,000 ha) are under fennel cultivation worldwide.
- Global Production: Estimated around 2.2 to 2.5 lakh metric tonnes (220,000 – 250,000 MT) of fennel seed annually.
- Global average productivity: Approximately 1900–2100 kg/ha depending on the region, climate, variety and agronomic practices.

#### 2. Major Fennel Producing Countries

The major countries contributing to global fennel production includes India, China, Egypt, Iran, Turkey, Syria, Afghanistan, Italy etc. The area, production and productivity of fennel in these countries are given in Table 2.

**Table 2. Area, production and productivity of fennel in World**

Country	Area (ha)	Production (MT)	Productivity (kg/ha)	Remarks
India	~88,000	~150,000	...	Largest producer and exporter; mainly grown in Gujarat and Rajasthan
China	~15,000	~30,000	2000 – 2500	Used for traditional medicines and spices
Egypt	~6,000	~12,000	1800 – 2100	Focused on exports, especially to Europe
Iran	~4,000	~7,000	1600 – 2000	Local and export use
Turkey, Syria, Afghanistan, Italy	Minor producers	Varying outputs	1500 – 1800	Cultivated for culinary, essential oil and herbal use

**Note:** Data may vary due to lack of centralized reporting in some countries and intercropping practices.

Source: Spice Board of India (<https://www.indianspices.com>), APEDA (<https://agriexchange.apeda.gov.in>), DGCIS (<https://dgft.gov.in>/<https://www.dgciskol.gov.in>), <https://trendeconomy.com> (2022-23)

#### 4. India's Dominance

- India contributes more than 70% of global fennel production.
- Gujarat (Banaskantha, Mehsana, Surendranagar districts) and Rajasthan (Nagaur, Sikar, Tonk districts) are the leading production zones.
- India also leads in export of fennel seeds to countries like the USA, UAE, UK, Malaysia and Canada.

#### 5. Trends and Prospects

- Rising demand in health foods, herbal medicines and essential oils is boosting global interest in fennel cultivation.
- Export-oriented production is increasing in Egypt and India.
- Improved varieties (e.g., RF-125, RF-205, HF-143, Gujarat Fennel-2) and better agronomic practices are helping improve productivity and farmer incomes.

## 6. Area, production and productivity scenario of fennel in India

Over the past years, India has witnessed a consistent and significant growth in the area, production and productivity of fennel (*Foeniculum vulgare*), establishing itself as the world's largest producer and exporter of the crop. In the early 2000s, fennel was cultivated on approximately 50,000 hectares with a production of around 75,000 metric tonnes and average productivity of about 1,500 kg/ha. Since then, due to increasing domestic consumption, rising export demand and technological advancements in varieties and agronomic practices, the area under fennel cultivation expanded steadily. By 2010–11, the area reached around 60,000 hectares, producing approximately 95,000 metric tonnes. The momentum continued into the next decade, with major contributions from Gujarat and Rajasthan, the key fennel-producing states. As per estimates for 2019–20, the cultivated area increased to around 83,000 hectares with production reaching 142,000 metric tonnes and productivity improving to nearly 1,700 kg/ha. Recent estimates for 2023–24 suggest that fennel is grown on about 2,16,000 hectares with a production of 3,76,000 metric tonnes and productivity around 1,740 kg/ha (Table 3, Fig. 3). This upward trend is attributed to the introduction of high-yielding varieties such as RF-125, RF-205, HF-143, and Gujarat Fennel-2, improved irrigation practices and better pest and disease management. Despite occasional fluctuations due to climate variability, India has maintained a strong hold on the global fennel market, with over 70% of global production coming from the country.

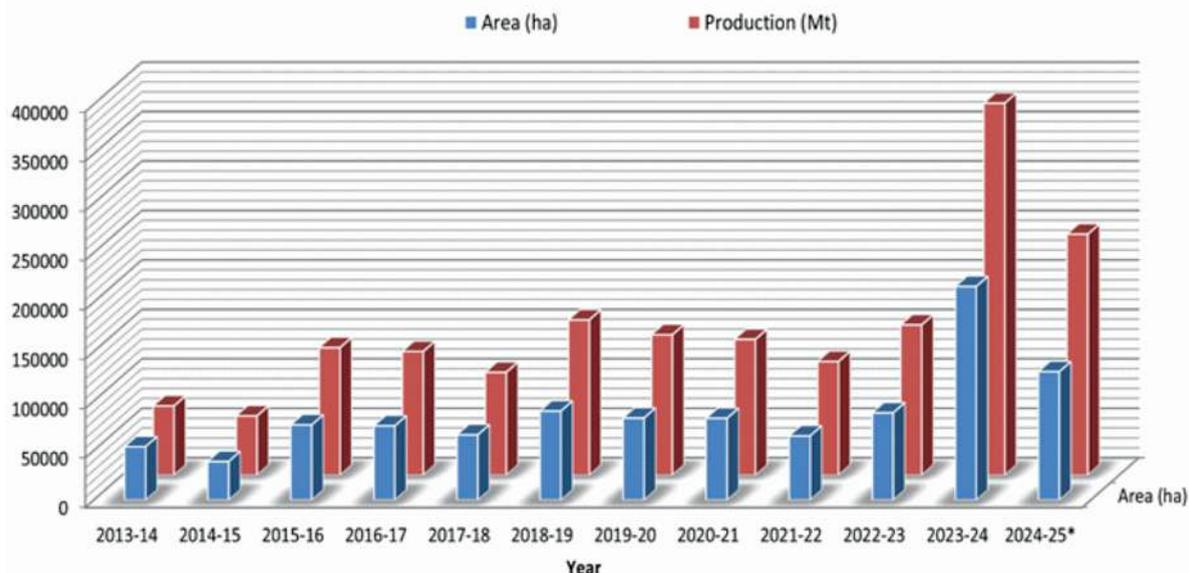
**Table 3. Area, production and productivity of fennel in India**

Year	Area (ha)	Production (Mt)	Productivity (kg/ha)
2013-14	54000	70000	1296
2014-15	39000	60000	1538
2015-16	76000	129000	1697
2016-17	75000	125000	1666
2017-18	66000	104000	1575
2018-19	90000	157000	1744
2019-20	83000	142000	1710
2020-21	82761	137388	1660
2021-22	64922	114971	1770
2022-23	88299	151937	1720
2023-24	216019	376049	1740
2024-25*	129858	243666	1876

\* Estimated value

Source: Department of Agriculture, Cooperation and Farmers Welfare GOI. <https://agriwelfare.gov.in/en/PublicationReports>. Spice Board of India (<https://www.indianspices.com>),

## Area and production of fennel in India



**Figure 3. Area and production of fennel in India**

### 7. Area, production and productivity scenario of fennel in Rajasthan

Rajasthan has emerged as the second-largest fennel-producing state in India, after Gujarat, with a steady rise in area, production, and productivity. In the early 2000s, fennel cultivation in Rajasthan was limited to around 4000 hectares, mainly concentrated in districts like Nagaur, Jodhpur and Sirohi, producing about 3,000–4,200 metric tonnes with an average productivity of 500–800 kg/ha. The state's favorable agro-climatic conditions, especially in semi-arid zones and increasing demand for fennel in local and export markets encouraged farmers to shift to this remunerative spice crop.

By 2010–11, the area under fennel increased to nearly 22,000–24,000 hectares, with production touching approximately 27,200 metric tonnes. Various government interventions, front-line demonstrations under AICRP on Spices and the introduction of improved varieties like RF-125, RF 205 and RF-178 further promoted its adoption. During 2015–16 to 2020–21, fennel cultivation gained momentum in districts such as Tonk, Ajmer and Barmer, with the area expanding to over 29,000 hectares and production reaching around 30,700 metric tonnes. The productivity during this period improved to approximately 1,100 kg/ha due to better irrigation facilities, use of certified seeds and integrated nutrient and pest management practices.

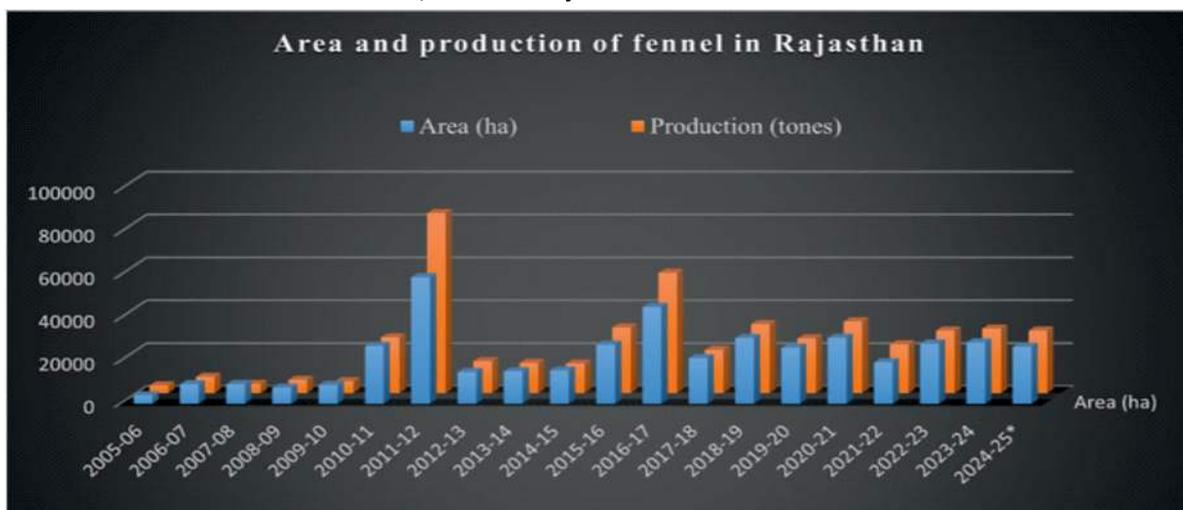
In recent years, especially by 2023–24, Rajasthan's fennel area is estimated at around 28,630 hectares, with total production exceeding 30,200 metric tonnes and average productivity nearing 1,055 kg/ha (Table 4, Fig. 4). The adoption of precision farming techniques, use of organic inputs and increasing awareness among farmers about post-harvest value addition have further boosted the crop's profitability. With continuous support from ICAR, state agricultural universities, research stations and spice boards, Rajasthan is playing a pivotal role in strengthening India's position in global fennel production and exports.

**Table 4. Area, production and productivity of fennel in Rajasthan**

Year	Area (ha)	Production (tonnes)	Productivity (kg/ha)
2005-06	3895	3657	939
2006-07	9095	7629	839
2007-08	9154	4365	477
2008-09	7500	6249	833
2009-10	8755	5601	640
2010-11	26973	26157	970
2011-12	59044	84070	1424
2012-13	14750	14978	1015
2013-14	15161	14277	942
2014-15	15561	13847	890
2015-16	27587	30717	1113
2016-17	45195	56238	1244
2017-18	21326	20274	951
2018-19	30678	32290	1053
2019-20	26250	25621	976
2020-21	30814	33563	1089
2021-22	19370	22832	1179
2022-23	28103	29308	1043
2023-24	28630	30209	1055
2024-25*	26622	29237	1098

\* Estimated value

Source: Directorate of Horticulture, Govt. of Rajasthan



**Figure 4. Area and production of fennel over the years in Rajasthan**

## 8. Status of fennel export from India

India has maintained its position as the largest exporter of fennel seeds in the world over the past 25 years, owing to its vast production, superior quality and cost competitiveness. The export scenario of fennel from India has shown a progressive growth trend, driven by rising global demand for spices, growing health consciousness, and the increasing popularity of traditional herbal remedies.

### Early 2000s (2000–2005):

- Fennel exports were modest, averaging around 5,000–7,000 metric tonnes annually.
- Major export destinations included UAE, USA, UK, Malaysia and Sri Lanka.
- Export value remained under Rs. 25–30 crore, due to low global awareness and limited processing infrastructure.

### Mid 2000s to Early 2010s (2006–2012):

- Exports increased to 10,000–14,000 metric tonnes annually.
- The global popularity of Indian spices and Ayurveda boosted fennel demand.
- Export value rose to Rs. 50–70 crore and India captured over 60–65% of global fennel exports.
- Improved cleaning, grading and packaging practices enhanced marketability.

### Late 2013–2020:

- A sharp rise in demand from Southeast Asia, Europe and the USA led to export quantities increasing to 18,000–22,000 metric tonnes annually.
- Value crossed Rs.120–160 crore, especially during 2017–2019.
- Processed fennel products like essential oils and extracts began contributing to export value.
- India consistently exported fennel to more than 40 countries, maintaining over 70% share in global fennel exports.

### Recent Years (2021–2024):

- Annual exports ranged between 22,000–26,000 metric tonnes.
- Export value reached Rs. 250–280 crore, with spikes due to pandemic-related demand for immunity-boosting products.
- Major importing countries in this period include: USA, UAE, Nepal, Bangladesh, Malaysia, UK and Saudi Arabia
- Value-added fennel products (powdered form, organic fennel, and oil) contributed significantly to revenue.

India's Spices Board, APEDA, ICAR and state agriculture departments have played key roles in export promotion. Over the last 25 years, fennel exports from India have grown five-fold in volume and over ten-fold in value. This growth is driven by consistent production, varietal improvement, export-friendly policies and rising international demand for healthy and natural products. India is likely to remain a global leader in fennel exports, with ongoing efforts toward value addition promising further gains.

**Table 5. Quantity and value of fennel exports from India (2019-20 to 2024-25)**

Years	Qty. in Tonnes	Value in Rs. Lakhs
2019-20	24,220	23,162
2020-21	33,742	29,396
2021-22	40,139	41,197
2022-23	21,201	31,437
2023-24	39,565	66,961
2024-25	76,586	76,544

Source: Spices Board, 2025

Fennel exports from India have shown fluctuations over the past five years, both in quantity and value. Major export destinations include the USA, Malaysia, Pakistan, Saudi Arabia, the UK, UAE, Sri Lanka, Morocco, Bangladesh and Brazil. The highest export quantity was recorded in 2021–22 at 40,139 tonnes, while the maximum export value was achieved in 2024-25 at Rs. 76544 lakhs (Table 5). The unit value of exported commodity was highest during 2023-24, reflecting improved demand and resultant price scenario in global markets. Notably, the export quantity dipped in 2022–23 to 21,201 tonnes but recovered strongly the following year, highlighting the dynamic nature of the fennel export trade.

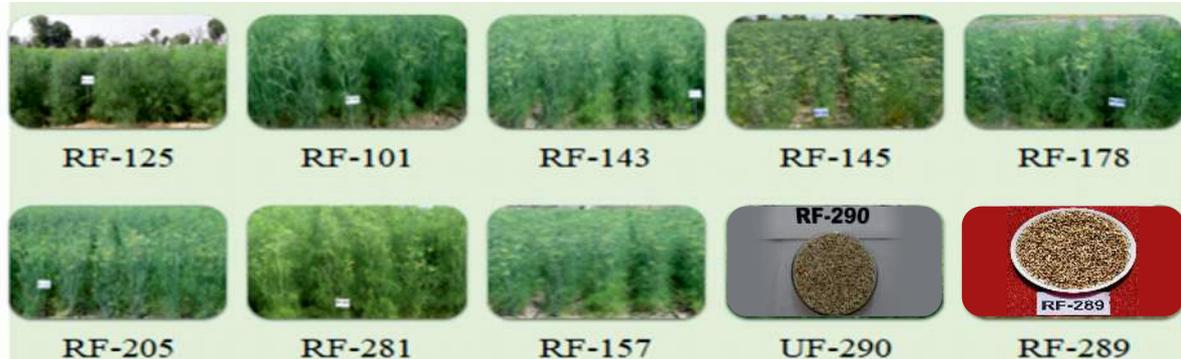
## 9. Varietal status in fennel

To survive and thrive, Indian fennel farmers need higher yields and lower production costs, as well as tolerance to diseases. ICAR-AICRP on Spices has identified several high yielding fennel varieties, often with additional desirable features like disease resistance and adaptability to specific regions / agro-climatic conditions. Our next challenge is to further improve yield while maintaining or improving disease resistance and quality to ensure that the industry remains sustainable. The fennel breeding programme in the country is mainly carried out by public funded institutions like ICAR and SAUs. Five major centres working on fennel varietal improvement are SKN Agriculture University, Jobner, Jaipur, Rajasthan; SardarkrushinagarDantiwada Agricultural University, Jagudan, Gujarat; ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan; G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand and ChaudhararyaCharan Singh Haryana Agricultural University, Hisar, Haryana. These centres under AICRP Spices have been developing fennel varieties (Table 6). Till date, 25 fennel varieties have been released for cultivation in India.

**Table 6. Fennel varieties developed in India**

Variety	Features	Yield (q/ha)	Quality Attributes
RF 101 (2002)	Erect, medium tall nature, medium duration type (150 -160 days) with long bold grains, most suitable for loamy and black cotton soil	15.50	1.4% volatile oil content
RF 125 (2004)	Plants are short statured with compact umbels and long bold seeds when presence, denser view of plants green, maturity type (110-130 days)	17-20	1.90 % volatile oil content
RF 143 (2007)	Medium tall and recommended for loamy and black cotton soils	12.00	1.87 % volatile oil content
RF 178 (2006)	Seeds long bold and attractive	16.00	2.13% volatile oil content
RF 205 (2010)	High yield potential. Better seed quality.	10-12	2.48 % volatile oil content

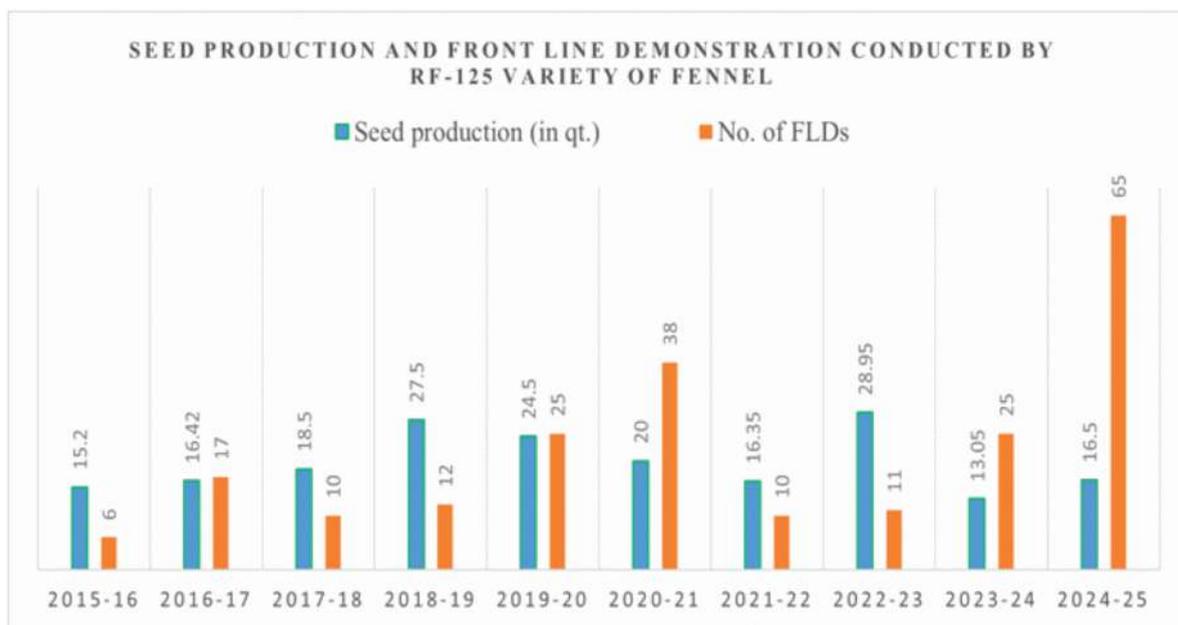
RF 145 (2010)	The plants are erect and medium tall with bold and attractive seeds. It matures in 130 - 140 days.	21.87	2.48 % volatile oil content
RF 281 (2012)	Bold, attractive seeds. Matures in 130 - 140days.	18.25	2.58% volatile oil content
RF-157 (2015)	Long, attractive, bold seeds	21.67	1.95 % volatile oil content
RF-290 (2024)	High yielding with long and bold seeds, more umbellets and seeds per umbel	20.65	1.85 % volatile oil content
RF-289 (2024)	High yielding and high oil type fennel. Moderately resistant to Ramularia blight	17.43	2.1% volatile oil
Gujarat Fennel-2 (2004)	Plants bushy, bold grains. Suitable for both rainfed and irrigated condition.	19.40	Rich in volatile oil (2.4%)
Gujarat Fennel-11 (2008)	Seeds are medium bold	24.87	1.80 %volatile oil
Pant Madhurika (2019)	Tall robust erect plant with big umbels, bold sweet seeds with green fine ridges, medium duration	12-15	Sweet in taste
HisarSwarup	Plants grow upright, spreading, gives a bushy appearance. A late maturity type (175-185 days), grain long and bold, resistant to lodging, no shattering of grains	16.00	1.6% volatile oil
Ajmer Fennel-2 (2018)	Fennel variety with moderate resistance to Ramularia blight.	17.9	1.9% volatile oil
Ajmer Fennel-3	High yielding and high oil type fennel. Resistant to Ramularia blight	21.43	1.9% volatile oil



## 10. Rajasthan Fennel 125 (RF-125)

Rajasthan Fennel-125 (RF-125) is a high-yielding fennel variety developed through recurrent half-sib selection from an exotic collection (EC-243380) sourced from Italy. It was released and notified by Central Varietal Release committee (CVRC) through Gazette notification No.S.O.597 (E) 25.04.2006. The variety is characterized by its medium maturity (130–140 days), short-statured plants, compact umbels and long bold seeds. When in the vegetative stage, RF-125 presents a dense green canopy, making it visually distinctive. Notably, it has a high volatile oil content, which makes it especially suitable for markets. With an average seed yield of 17-20 quintals per hectare, RF-125 has become a preferred choice among fennel growers in arid and semi-arid regions. The development and release of this promising variety is the result of coordinated efforts by ICAR-AICRP on Spices at SKN Agriculture University, Jobner, Rajasthan, who conducted rigorous research and systematic evaluation leading to the release of the variety and also spearheaded widespread dissemination of the variety. This collaborative initiative has significantly contributed to the expansion and sustainability of fennel cultivation in India.

## 11. Varietal dissemination



Source: Annual report of MIDH, Directorate of Arecanut and Spices Development (DASD) and ICAR-AICRP on Spices (2015-16 to 2024-25)

Figure 5. Seed production and front-line demonstration of RF-125 variety of fennel

The variety RF-125 of fennel, developed by ICAR-AICRP on Spices, Jobner center has witnessed widespread dissemination across Rajasthan through a combination of seed production initiatives and Front-Line Demonstrations (FLDs). Over a span of ten years, from 2015–16 to 2024–25, a total of approximately 196.97 quintals of quality seed has been produced to meet the growing demand from farmers. The seed production efforts gained significant momentum in the years 2018–19 (27.50 q) and 2022–23 (28.95 q), indicating focused interventions during these periods to enhance the

availability of certified seed of RF-125.

Alongside seed multiplication, FLDs have been instrumental in showcasing the potential of RF-125 in farmer's field. These demonstrations not only validated the performance of the variety but also helped in building confidence among farmers regarding its yield potential, export suitability and resilience under semi-arid conditions. A total of 220 FLDs were conducted during the 10-year period, with a notable increase in numbers in 2020–21 (38 FLDs) and 2024–25 (65 FLDs) (Fig. 5), reflecting strengthened extension activities and farmer outreach.

This integrated approach of varietal dissemination has significantly contributed to the adoption of RF-125 by farmers, leading to expansion in area under fennel cultivation and improvement in farm incomes. The strategic production of quality seed coupled with on-field demonstrations has created a ripple effect, making RF-125 a popular and preferred choice among fennel growers, particularly in Rajasthan's key seed spice-producing zones.

Quality seed production plays vital role in the popularization and dissemination of varieties. The seed production programme at Jobner centre is limited to multiplication of nucleus seed. The breeder/TL seed production programme is taken up by ADR (Seeds), Sri Karan Narendra Agriculture University, Jobner under the supervision and close coordination of Sr. Breeder (Spices) and Sr. Agronomist (Spices). The details of the seed production of fennel variety RF-125 are given Table-7.

Table 7. Breeder, Foundation and Certified Seed production of fennel variety RF-125

Year	Breeder seed (quintals)	Foundation seed (quintals)	Certified seed (quintals)	Area covered (ha)	Contribution (%)
2015-16	4.1	320	1495	3740	13.6
2016-17	5.5	385	1585	4290	9.5
2017-18	6.4	390	1405	2720	12.8
2018-19	4.5	200	1402	3200	10.4
2019-20	5.5	346	1680	3840	14.6
2020-21	5.1	330	1741	2870	9.3
2021-22	6.4	423	1160	3080	15.9
2022-23	8.9	474	1923	3460	12.3
2023-24	9.1	482	1056	3520	12.3
2024-25	9.6	512	1134	3560	13.4

Source : Annual report of MIDH, Directorate of Arecanut and Spices Development (DASD) and ICAR-AICRP on Spices (2015-16 to 2024-25)

## 12. Impact of fennel variety RF-125

Development and release of the high-yielding and adaptable fennel variety RF 125 by the ICAR-AICRP on Spices, Jobner center has made a significant impact on fennel cultivation, especially in the state of Rajasthan.

### Key Features of RF 125 (Fig. 6):

- Higher Yield Potential: RF 125 records a seed yield potential of 17–20 quintals/ha, which is significantly higher than local varieties.
- Medium maturity: Matures in about 130–140 days, allowing better crop scheduling and reducing the risk of terminal heat stress.
- Bold seed size and attractive color: Preferred in domestic and export markets, enhancing marketability.
- Tolerant to lodging and moderate resistance to diseases: Reduces the need for frequent pesticide sprays and lowers production costs.
- Suitable for irrigated and semi-arid conditions: Ideal for the agro-climatic conditions of Rajasthan, Gujarat, and parts of Madhya Pradesh.

### Adoption and Area Expansion:

- RF 125 has been adopted by a large number of farmers in Nagaur, Sikar, Ajmer, and Jodhpur districts.
- The performance of the variety in Front Line Demonstrations under AICRP has demonstrated consistent superiority over other varieties/local cultivars.
- Rajasthan state seed corporation and private agencies have started producing and distributing certified seed, boosting seed replacement rate.

### Economic Impact:

The economic impact of a variety depends on several factors. This includes variables like yield advantage over other varieties, adoption rate and spread of the variety, price and market preference for the variety, seed replacement rate, etc. The quantification of economic impact of the variety requires extensive data, spread over a significant period of time. Farmers cultivating RF-125 have reported 15–20% increase in yield compared to traditional/local varieties. Further, due to better seed quality and uniform maturity, the produce from RF 125 fetches 10–15% higher market price, improving net income per hectare. A quick glance at the data on certified seed production and other secondary data on crop spread clearly indicates that the adoption of RF 125 has led to enhanced profitability and crop diversification in regions traditionally dominated by wheat and mustard.

A quick estimate of the magnitude of economic impact of the variety RF-125 in Rajasthan can be gauged from the data on crop spread in the state and expected relative yield advantage of the variety. Conservative estimates of yield advantage (10 %) and price premium for the produce (5%) were assigned to the variety RF-125 to estimate the value of output from the variety in Rajasthan during the period 2015-16 to 2024-25. An estimate of net impact accounting for a counterfactual situation (RF 125 not available for cultivation) for the same period has also been developed. Though assumptions on crop economy and counterfactual situation have been used to develop simplified crop scenarios,

these estimates indicate the economic potential of the variety and highlights the substantial returns to investment from crop varietal development efforts.

S. No.	Particulars	Value
1	Total output from RF-125 (2015-16 to 2024-25)	40,425 tonnes
2	Total value of output from RF-125 (2015-16 to 2024-25)	64,603 Rs Lakhs
3	Average value of output from RF-125 per year	6,460 Rs Lakhs
4	Average share of RF-125 in fennel output of Rajasthan	14.98 %
5	Incremental fennel output due to RF-125 (2015-16 to 2024-25)	3,675 tonnes
6	Incremental value of output due to RF-125 (2015-16 to 2024-25)	6,167 Rs lakhs
7	Average incremental value of output from RF-125 per year	617 Rs lakhs
8	Impact on national average yield of fennel due to RF-125	13.2 kg/ha

**Notes: 1.** The spread of the variety outside Rajasthan has not been considered in the estimation of value of output from the variety and impact on national average yield of fennel. **2.** The value of output and other monetary values are in expressed in 2024-25 prices.

Table 8 provides a quantitative summary of the estimated economic impact of RF-125 in Rajasthan over the ten-year period from 2015-16 to 2024-25. The variety contributed a total output of 40,425 tonnes of fennel, translating into a value of ₹64,603 lakhs, with an average annual contribution of about ₹6,460 lakhs. Importantly, RF-125 accounted for nearly 15% of the state’s fennel output. The incremental gains attributable to the variety—arising cumulatively from its yield advantage and price premium—amounted to 3,675 tonnes of additional output, worth ₹6,167 lakhs over the period, or ₹617 lakhs annually. The variety RF-125 also improved the national average fennel yield by 13.2 kg/ha, highlighting its role in strengthening productivity. Overall, the estimates reinforce that RF-125 has generated substantial economic benefits, validating the investment in varietal development and dissemination. The stream of benefits from the variety can be expected to continue in the medium term till varietal development efforts negate the relative yield advantage and new varieties replace RF-125.





Figure 6. Field view, flowers and seeds of fennel variety RF-125

### 13. Success Stories: Income enhancement through seed production and FLDs in Fennel

The adoption of high-yielding fennel variety RF 125, developed by ICAR-AICRP on Spices, Jobner, has significantly contributed to income enhancement and crop diversification in

Rajasthan, particularly through seed production and Front Line Demonstrations (FLDs).

The introduction of RF 125, along with scientific advisory practices (SAPs), has led to remarkable area expansion and yield improvements in key districts like Bharatpur and Nagaur.

In Bharatpur, the area under fennel cultivation increased gradually but showed a steep rise after 2013-14, reaching over 200 hectares by 2016-17, with a parallel increase in production. Similarly, in Nagaur, fennel area expansion surged dramatically post-2010, with production jumping from negligible levels to nearly 30,000 MT during peak years. This trend reflects strong farmer adoption, driven by the higher economic returns from RF 125 (Fig. 8).

The impact of FLDs (Front Line Demonstrations) has been transformative. Before 2010-11, only 5 FLDs were conducted in Rajasthan, but after 2010-11, this number surged to 123, promoting awareness and confidence among farmers regarding HYVs and best practices. The average area under fennel cultivation in Rajasthan increased from a mere 4,620 ha to 33,328 ha, marking a 620% rise (Fig. 7). Nationally too, the area increased from 55,284 ha (2010-11) to more than 1,00,000 ha (post 2010-11), confirming Rajasthan's major contribution to India's fennel production.

This expansion has led to significant income enhancement for farmers, particularly those involved in quality seed production of RF 125, which fetches better prices and ensures timely marketability. The average fennel area per farmer increased from 8% to 44% (Fig. 7) post-intervention, underlining the success of integrated efforts through HYVs, FLDs, and focused extension strategies. These interventions have not only improved farmer incomes but also created a scalable model for other seed spices in arid and semi-arid regions

#### Impact of FLDs on increase in area of fennel in Rajasthan through HYV and SAP

No. of FLDs conducted in new area in Rajasthan:

Before 2010-11 = 5 and after 2010-11 = 123

**Av. Area=8% (before 2010-11) and Av. Area=44% (After 2010-11)**

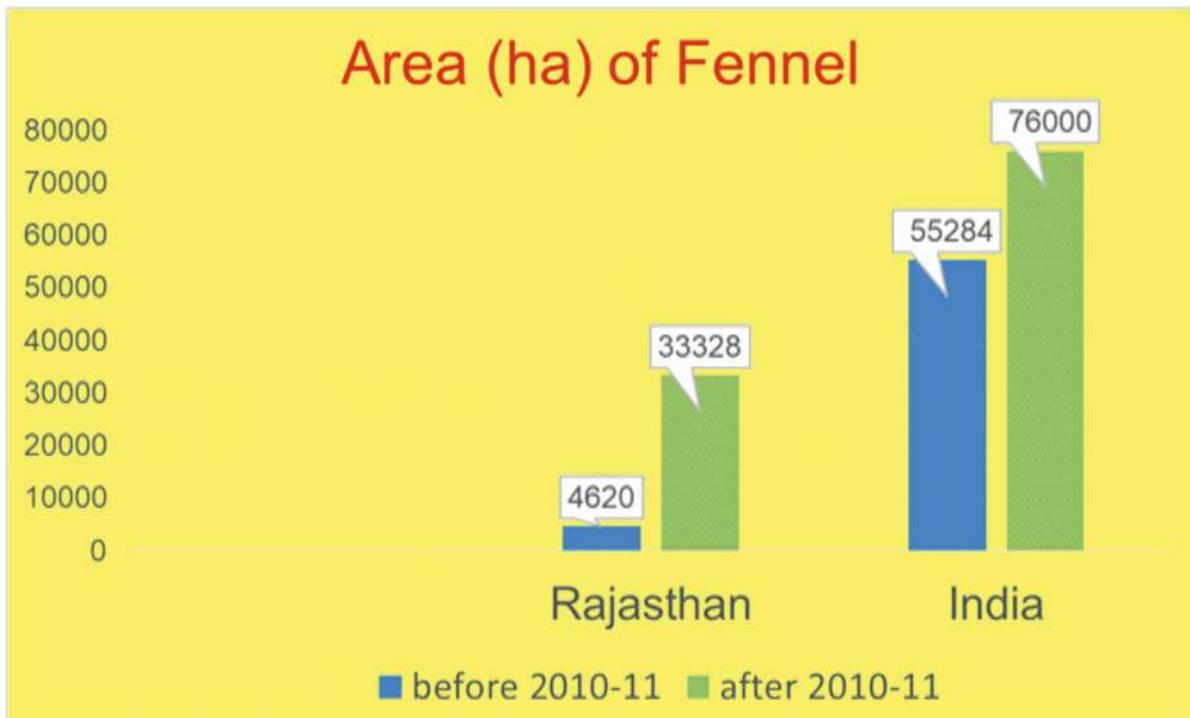
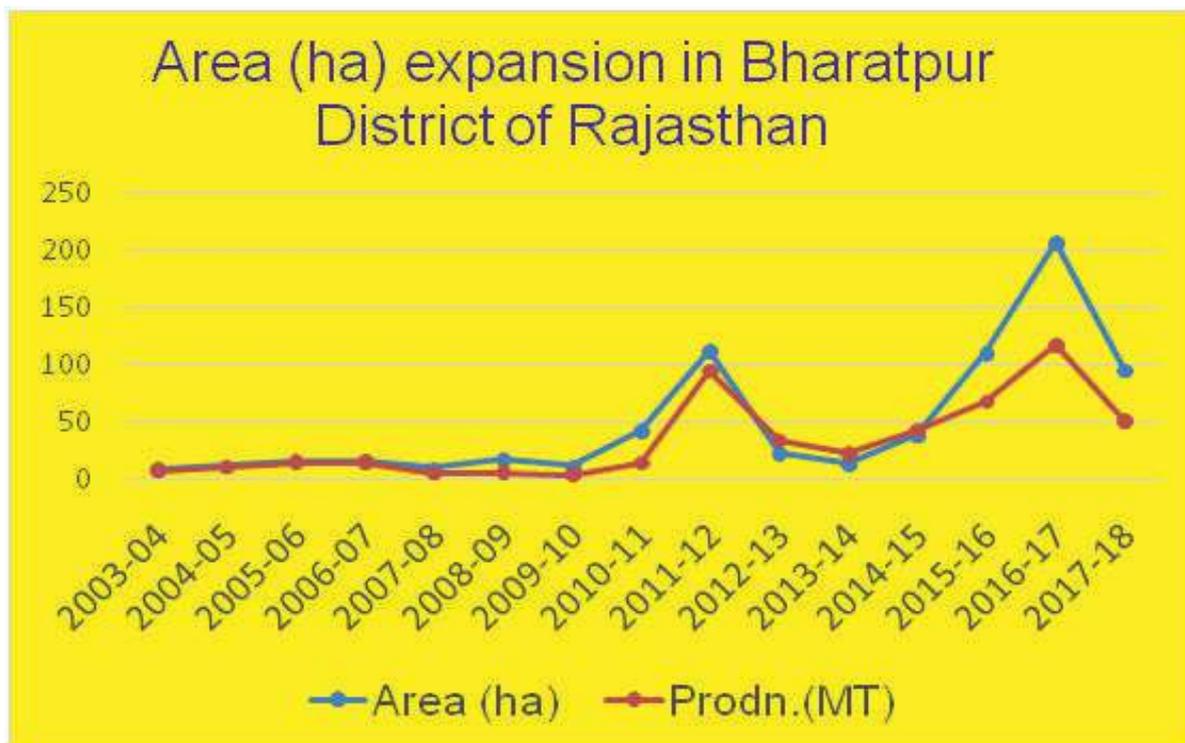


Figure 7. Impact of FLDs on area expansion in Rajasthan

### Adoption of new crop (Fennel) by farmers



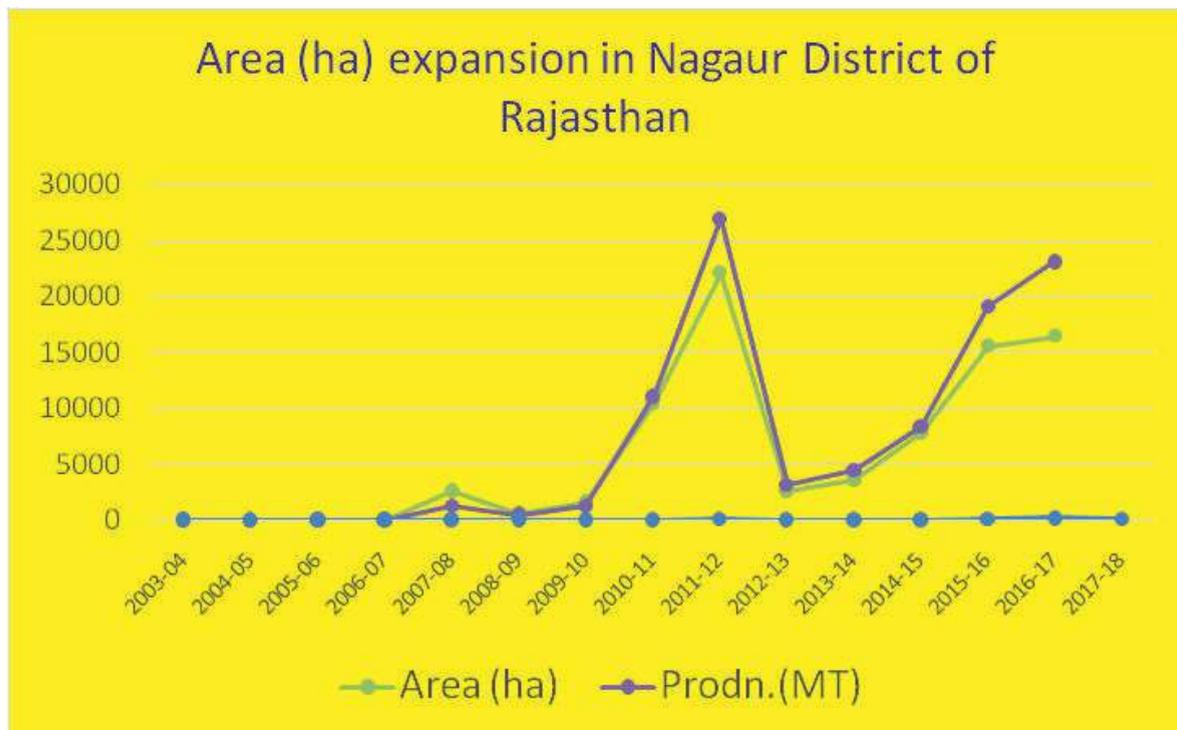


Figure 8. Impact of FLDs on area expansion in different districts of Rajasthan

The adoption of fennel as a new crop by farmers in Rajasthan, particularly in the districts of Bharatpur and Nagaur, reflects a significant success story in agricultural diversification and income enhancement. The graphical data indicates a notable expansion in the area under fennel cultivation and corresponding increases in production over the years. In Bharatpur district, from 2003–04 to 2017–18, fennel cultivation remained relatively low until around 2011–12, after which there was a marked rise in both area and production. The area increased sharply from below 50 hectares to over 200 hectares by 2016–17, indicating growing farmer interest, likely due to the profitability and market potential of the crop.

A more dramatic trend is observed in Nagaur district, where fennel area and production remained minimal until 2009–10. However, with the introduction of high-yielding varieties like RF 125 and extension activities such as FLDs, there was a massive surge in adoption. By 2010–11, both area and production spiked steeply, with production touching nearly 30,000 metric tons at its peak. Although slight fluctuations followed, the overall trend continued upward, confirming the crop's long-term viability and profitability in the region.

This shift highlights the success of interventions by ICAR-AICRP on Spices, Jobner, in promoting fennel through improved varieties and scientific farming practices. The results not only emphasize increased productivity but also point to the growing economic value of fennel as a sustainable cash crop for farmers in semi-arid regions.



RF-125 in Bloom: Advancing Fennel Cultivation through Field Trials at Bharatpur

**Table 9. Details of Fennel demonstrations on Variety RF-125**

S. No.	Variety	Location	Year	Number of FLDs	Area (ha)	FLD Yield (q/ha)	Local Check/ Practices Yield (q/ha)	% Increase over check
1	RF-125	Bharatpur, Dausa, Jobner	2018-19	30	15.0	20.5	17.5	17.14
2	RF-125	Bharatpur, Dausa,	2019-20	24	12.0	12.0	9.5	26.32
3	RF-125	Bharatpur Dausa, Lalsot	2020-21	30	15.0	17.0	14.5	17.24
4	RF-125	Bharatpur Dausa, Dholpur	2021-22	40	20.0	18.5	15	23.33
5	RF-125	Bharatpur, Alwar	2022-23	11	11.0	19.7	16.9	16.57
6	RF-125	Lalsot, Dausa, Kum bher	2023-24	25	12.0	23.4	20.3	15.27
7	RF-125	Tonk, Dausa, Lalsot	2024-25	60	30.0	20.90	17.83	17.31
<b>Total</b>				<b>220</b>	<b>115</b>	<b>18.52</b>	<b>15.62</b>	<b>19.31</b>

Front Line Demonstrations (FLDs) on fennel variety RF-125 were conducted in districts of Rajasthan including Bharatpur, Dausa, Jobner, Lalsot, Dholpur, Alwar, Kumbher and Tonk from 2018-19 to 2024-25. Over this period, a total of 220 demonstrations were carried out covering 115 hectares. The average yield recorded under demonstrations was 18.52 q/ha, which was significantly higher than the average yield of local practices (15.62 q/ha), reflecting an overall yield increase of 19.31%.

Year-wise analysis shows consistent yield advantages with RF-125, with the highest percent increase (26.32%) observed during 2019-20, followed by 23.33% in 2021-22. Even in recent demonstrations (2023-24 and 2024-25), the variety maintained superior performance with 15–17% yield gains. These results highlight the varietal superiority and adaptability of RF-125 under farmers' field conditions across diverse agro-climatic zones.

The adoption of RF-125 by farmers in different districts demonstrates growing confidence in its performance, especially in terms of higher productivity and better adaptability. The consistent yield advantage over local checks indicates the variety's potential to enhance income and productivity in seed spice-based farming systems. The increase in number of demonstrations over the years, peaking at 60 in 2024-25, also reflects successful extension efforts and rising farmer interest.

Furthermore, the widespread geographical coverage from eastern Rajasthan (Bharatpur, Dholpur) to central zones (Dausa, Tonk, Lalsot), suggests that RF-125 performs well across varied soil and climatic conditions. The average yield of 23.4 q/ha achieved in 2023-24 at Lalsot, Dausa, and Kumher is particularly encouraging, indicating further scope for scaling out this variety through quality seed distribution and farmer training programs (Table 7 and Table 8).



**Demonstrating the Potential of RF-125 Fennel Variety**



**Fennel Variety RF-125: Field Demonstration for Productivity & Adaptability**



**On-Farm Performance of RF-125: A Promising Fennel Variety**



**Showcasing RF-125: A Step Towards Enhanced Fennel Productivity**



**Fennel Demonstration of RF-125 at Dausa District**



**Empowering Farmers with RF-125: On-Field Demonstration**

#### **14. Conclusion:**

The development of RF 125 by ICAR-AICRP on Spices, Jobner has made a tangible contribution to enhancing the productivity, profitability and sustainability of fennel cultivation in Rajasthan. Its success has encouraged further varietal improvement programs and reaffirmed the role of public research institutions in meeting the regional agricultural demands.

#### **15. A way forward**

- Develop suitable varieties with improved yield and quality parameters to sustain the yield growth rate in fennel and to generate exportable surplus.
- Area expansion using quality enhanced seeds.
- Identify farmers groups and farming clusters for focused technology dissemination efforts.
- Develop specialized seed spice export zones based on the agro-climatic conditions.
- Organize training programs and farmers exposure visit in fennel growing areas to enhance pace of technology dissemination and Sustainable Agricultural Production practices.
- Establish processing units adopting Good Manufacturing practices (GMP) in identified zones.
- Promote research on developing packaging and storage of fennel.
- Promote research on, product development, value addition and organic production for export purposes

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