

Dissemination of Fenugreek varieties through frontline demonstrations approach for sustainable fenugreek production in Pali district of Rajasthan, India

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Abstract

Front line demonstrations (FLDs) on fenugreek were laid down at 321 farmers' field to demonstrate production potential and economic benefits of improved production technologies comprising high yielding varieties namely RMT-305, RMT-143, AFG-3, GM-1 and RMT-1 in Pali district of arid zone of Rajasthan state during *Rabi* seasons from 2013 to 2019 in irrigated farming situation. The improved production technologies recorded an additional yield ranging from 2.4 to 5.0 q ha⁻¹ with a mean of 3.7 q ha⁻¹. The per cent increase yield under improved production technologies ranged from 18.2 to 39.8 (RMT-305), 20.5 to 46.1 (RMT-143), 29.7 to 38.5 (AFG-3), 24.0 to 31.9 (GM-1) and 30.8 (RMT-1) in respective years. The average extension gap, technology gap and technology index were 3.7 q ha⁻¹, 4.4 q ha⁻¹ and 21.8 per cent, respectively in different high yielding varieties of fenugreek. The improved production technologies gave higher benefit cost ratio ranging from 2.6 to 3.6 with a mean of 3.2 compared to local checks (2.5) being grown by farmers under locality. The result of the findings indicated that the maximum number of the respondents had medium level of knowledge and extent of adoption regarding recommended fenugreek production technology. The study reported lack of suitable HYV as major constraints faced by beneficiaries ranked first. Followed by low technical knowledge. The productivity of fenugreek per unit area could be increased by adopting feasible scientific and sustainable management practices with a suitable variety. Considering the above facts, frontline demonstrations were carried out in a systematic and scientific manner on farmer's field to show the potential of a new variety and convincing farming community about performance of improved production management technologies of fenugreek for further adoption.

Key words: Adoption, constraints, fenugreek, FLD, impact, knowledge, varieties.

Introduction

Indian spices and spicy food are popular across the world from ancient time. Traders from across the world had visited our sub-continent for spices; nearly 63 spices are being grown in India. Seed spices are annual crops whose seeds are consumed as spice, viz. coriander, cumin, fenugreek, fennel, ajwain, dill, anise, nigella, caraway celery etc. These seed spices make food tasty and palatable, and also bear medicinal value. Interestingly, these crops are predominantly grown in semi-arid and arid zone of the country having dry or wet cool weather conditions. Together the states of Rajasthan and Gujarat and parts of Madhya Pradesh can be called as the 'bowl of seed spices' contributing more than 80% of the country's annual production. Seed spices possess significant importance as domestic and export commodity. There has been a gradual rise in area and production of these crops, emphasizing more on the major crops like cumin, coriander, fennel and fenugreek

a clear enhancement is visible both in area and production including productivity in the last 25 years (Singh and Solanki 2015). Coriander and cumin covers nearly 80 % of the seed spice area and production. The global demands for Indian Spices are increasing day by day. In terms of export, there are increase of 29% in coriander, 70% in cumin, 58% in fennel and 49% in fenugreek. There is a huge demand for Indian spices all over the world.

Fenugreek (*Trigonella foenum-graecum* L.) is widely used as seed spices and cultivating for seed and leafy vegetable. Its fresh and tender leaves are rich in iron, calcium, protein, vitamin and essential amino acids. Besides, it has medicinal values as it prevents constipation, add in digestion and stimulates digestive process and metabolism. Seeds are used for the treatment of diabetes, dysentery, diarrhea and rickets. Fenugreek belongs to family Apiaceae, is one of the important major seed spice crops grown mainly in Rajasthan and Gujarat states of the country. Annually, it

is grown in about 124710 hectares area producing about 134100 tonnes (GOR, 2018-19). Average national productivity of this crop is low against potential yield due to low level of awareness among the farming community about area specific recommended package of practices, less availability of high yielding and resistant varieties, lower adoption of recommended plant production and protection technologies. Introduction of high yielding varieties tolerant to diseases can do the wonders in the growing area. Application of appropriate doses of fertilizers at right time with other recommended practices (irrigation and intercultural operations etc.) also play a crucial role with respect to the productivity of cumin (Lal, 2013).

Pali district is located between 24.45 to 26.75 degree N latitude and 72.48 to 74.20 degree E longitude at an altitude ranging between 212 m to about 220 m above mean sea level with a total geographical area of 12,387 square kilometers. In Pali district fenugreek traditionally grown as a *Rabi* crop. Fenugreek is most preferred seed spices crop in the arid region and is consumed by people of all ranks mainly in the form of green leaf, green seed and mature seed. Unfortunately use of local varieties and poor nutrient management results in very low yield.

The productivity of fenugreek in the district is very low as compared to average national productivity (13.4 q ha⁻¹). Lack of suitable high yielding variety as well as poor knowledge about production practices are described as main reasons for low productivity in the district. The productivity of fenugreek per unit area could be increased by adopting recommended scientific and sustainable management production practices using suitable improved varieties. Frontline demonstration is the new concept of field demonstration evolved by the Indian Council of Agriculture Research (ICAR) with main objective to demonstrate newly released crop production and protection technologies and its management practices at farmers' fields under different agro-climatic regions of the country under different farming situations. Taking into account the above considerations, frontline demonstrations (FLDs) were carried out in a systematic manner on farmer's field to show the worth of a new variety and convincing farmers to adopt improved production management practices of fenugreek for enhancing productivity.

Materials and methods

The study was conducted at farmers' fields to demonstrate production potential and economic benefits of improved technologies in Pali district under arid zone

of Rajasthan state during *rabi* seasons from 2013 to 2019 in rainfed farming situation. To popularize the improved fenugreek production practices, constraints in fenugreek production were identified through participatory approach. Preferential ranking technique was utilized to identify the constraints faced by the respondent farmers in fenugreek production. Farmers were also asked to rank the constraints they perceive as limiting production factor for fenugreek cultivation in order of preference. Based on farmers problems identified, front line demonstrations were planned and conducted at the farmer's fields under ICAR and National Food Security Mission (NFSM). In all, 321 full package frontline demonstrations were conducted to convince them about potentialities of improved varieties of fenugreek viz., RMT-305, RMT-143, AFg-3, GM-1 and RMT-1 during *rabi* seasons from 2013 to 2019 under rainfed farming condition, in light to medium soils with low to medium fertility status under fenugreek-cumin cropping systems. Each demonstration was conducted in an area of 0.4 ha and adjacent to the farmer's fields in which the crop was cultivated with farmer's practice/local variety. The package of practices included were improved varieties, seed treatment, maintenance of optimum plant stand, recommended fertilizers dose, plant protection measures especially pod borer management. The spacing followed was at 30 cm x 10 cm sown between last week of October to first week of November with the seed rate of 20-25 kg ha⁻¹. All the participating farmers were trained on all aspects of fenugreek production management. To study the impact of front line demonstrations, out of 321 participating farmers, a total of 160 farmers were selected as respondent through proportionate sampling. Production and economic data for FLDs and local practices were collected and analyzed. The Extension gap, technology gap and technology index were calculated using the formula as suggested by (Dayanand, *et al.*, 2012).

Extension gap (q ha⁻¹) = Demonstration yield (q ha⁻¹) – Yield of local check (q ha⁻¹)

Technology gap (q ha⁻¹) = Potential yield (q ha⁻¹) – Demonstration yield (q ha⁻¹).

$$\text{Technology index (\%)} = \frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential yield}} \times 100$$

Knowledge level of the farmers about improved production practices of fenugreek before frontline demonstration implementation and after implementation was measured and compared by applying paired t-test at 5 per cent level of significance. Further, the satisfaction level of respondent farmers about extension services provided was also measured based on various dimensions like training of participating farmers, timeliness of services, supply of inputs, solving field problems and advisory services rendered, fairness of scientists, performance of variety demonstrated and overall impact of FLDs. The selected respondents were interviewed personally with the help of a pre-tested and well structured interview schedule. Client Satisfaction Index was calculated as developed by (Kumaran and Vijayaragavan, 2005). The individual obtained scores were calculated by the formula as:

$$\text{Client Satisfaction Index} = \frac{\text{Total individual obtained score}}{\text{Maximum score possible}}$$

The data thus collected were tabulated and statistically analyzed to interpret the FLDs results.

Results and discussion

Increase in knowledge

Knowledge level of respondent farmers on various aspects of improved fenugreek production technologies before conducting the frontline demonstration and after implementation was measured and compared by applying paired t-test. It could be seen from the Table 1 that farmers mean knowledge score had increased by 29.5 after implementation of frontline demonstrations. The increase in mean knowledge score of farmers was observed significantly higher. As the computed value of 't-test' (6.93*) was statistically significant at 5 % probability level. The results are at par with Lal (2014) on fenugreek crops, (Meena *et al.*, 2012) on cumin crop and (Chauhan *et al.*, 2020) on mustard crop. It means there was significant increase in knowledge level of the farmers due to frontline demonstration. This shows positive impact of frontline demonstration on knowledge of the farmers that have resulted in higher adoption of improved farm practices. The results so arrived might be due to the concentrated educational efforts made by the scientists. The findings are in conformation with the finding of (Dayanand, *et al.*, 2012).

Table 1. Comparison between knowledge levels of the respondents farmers about improved farming practices of fenugreek (N=160)

Mean score		Mean difference	Calculated "t" value
Before FLD implementation	After FLD implementation		
41.8	71.3	29.5	6.93*

*Significant at 5 % probability level

Farmer's satisfaction:

The extent of satisfaction level of respondent farmers over extension services and performance of demonstrated variety was measured by Client Satisfaction Index (CSI) and results presented in Table 2. It is observed that majority of the respondent farmers expressed medium (63.1%) to the high (26.3%) level of satisfaction for extension services and performance of technology under demonstrations whereas, very few 10.6 per cent of respondents expressed lower level of satisfaction. The results are in close conformity with the results of (Meena and Singh, 2017) on greengram crop and (Lal, 2013) on fenugreek crop. The medium to higher level of satisfaction with respect to services rendered, linkage with farmer's and technologies demonstrated

etc. indicate stronger conviction, physical and mental involvement in the frontline demonstration which in turn would lead to higher adoption. This shows that the relevance of frontline demonstrations. It indicates that fenugreek grown with low yield are identified by low knowledge, un-favorable attitude towards high yielding varieties, low risk bearers with negative perception of fenugreek production technology. In other wards it may also due to then socio-economic status, lower holdings and unavailability of inputs and credit facilities and to some extent supply and marketing problems. This is a point of concern for research and extension functionaries to disseminate improved fenugreek production technologies for raising the productivity of fenugreek at all the levels.

Table 2. Extent of farmers satisfaction of extension services rendered (N=160)

Satisfaction level	Number	Percent
Low	17	10.6
Medium	101	63.1
High	42	26.3
Total	160	100.0

Constraints in fenugreek production

Farmer's fenugreek production problems were documented in this study. Preferential ranking technique was utilized to identify the constraints faced by the respondent farmers in fenugreek production. The ranking given by the different farmers are given in Table 3. A perusal of table indicates that lack of suitable high

yielding variety (HYV) (89.8%) was given the top most rank followed by low technical knowledge (81.2%), termite infestation (76.4%), vagaries of weather (71.8%). Based on the ranks given by the respondent farmers for the different constraints revealed that lack of suitable HYV, low technical knowledge, termite infestation are the major constraints to fenugreek production and followed by wild animals. Other constraints such low or erratic rainfall, low soil fertility post, blight disease infestation, stem rot, weed infestation, water logging, marketing and were found to reduce fenugreek production. Among all the constraints, harvest management got least concerns. Other studies (Meena and Gupta, 2013; Rathore, *et al.*, 2016; Singh and Sharam, 2018; Singh and Solanki, 2015) have reported similar problems in fenugreek production.

Table 3. Ranking given by farmers for different constraints (N=160)

S.No.	Constraints	Percentage	Ranks
1	Lack of suitable high yielding variety	89.8	I
2	Powdery mildew diseases	33.6	VII
3	Pod borer infestation	44.7	VI
4	Low soil fertility	23.3	X
5	Low technical knowledge	81.2	II
6	Wild animals (Blue bulls and wild pigs)	55.3	V
7	Vagaries of weather (low rainfall, high frost, high temperature)	71.8	IV
8	Weed infestation	28.8	VIII
9	Termite infestations	76.4	III
10	Water lodging	25.1	IX
11	Marketing	20.4	XI
12	Post harvest management	18.6	XII

Performance of FLD

A comparison of productivity levels between demonstrated varieties and local checks is shown in Table 4. During the period under study, it was observed that the productivity of fenugreek in Pali district under improved production technologies ranged between 13.6 to 18.8 q ha⁻¹ with a mean yield of 16.5 q ha⁻¹. The productivity under improved technologies varied from 14.6 to 18.0, 14.9 to 16.9, 17.7 to 18.8, 15.9 to 17.8 and 13.6 q ha⁻¹ for the varieties RMt-305, RMt-143, AFg-3, GM-1 and RMt-1, respectively as against the yield range between 10.2 to 14.5 with a mean of 12.8 q ha⁻¹ under farmers local practices and varieties during study period. The additional yield of different varieties under improved production technologies over local practices ranged from 2.4 to 5.0 q ha⁻¹ with a mean of 3.7 q ha⁻¹ in

comparison to local practice and varieties. The per cent increase yield under improved production technologies ranged from 18.2 to 39.8 (RMt-305), 20.5 to 46.1 (RMt-143), 29.7 to 38.5 (AFg-3), 24.0 to 31.9 (GM-1) and 30.8 (RMt-1) in respective years. This increased grain yield with improved production technologies was mainly because of high potential yielding varieties.

The variation in the productivity was also caused unusual delay in sowing in some of the farmer's fields. The late sowing crop was subjected to relatively less time span available for plant growth and development. Similar yield enhancement in different crops in front line demonstration has amply been documented by (Singh, *et al.*, 2018; Singh, *et al.*, 2007; Mahadik and Talithi, 2016; Meharya and Ramesh, 2018; Narappa, *et al.*, 2018; Meena and Singh, 2013; Morwal *et al.*, 2018; Kaur,

et al., 2019 and Lal, 2014). From these results it is evident that performance of improved varieties was found better than the local check under local conditions. Farmers were motivated by results of agro technologies applied in the FLDs trials and it is expected that they would adopt these technologies in the coming years also. Yield of the frontline demonstration trials and potential yield of the different varieties of crop was compared to estimate the yield gaps which were further categorized into technology index. The technology gap shows the gap in the demonstration yield over potential yield and it was 3.4 q ha⁻¹. The observed technology gap

may be attributed to dissimilarities in soil fertility, salinity and erratic rainfall and other vagaries of weather conditions in the area. Hence, to narrow down the gap between the yields of different varieties, location specific recommendation appears to be necessary. Technology index shows the feasibility of the variety at the farmer's field. The lower the value of technology index more is the feasibility. Table 4 revealed that the technology index value was 21.8. The findings of the present study are in line with the findings of (Meena and Singh, 2016; Chauhan, *et al.*, 2020 and Morwal *et al.*, 2018).

Table 4. Yield of fenugreek as influenced by improved production technologies and improved varieties over local practices in farmer's fields (2013-2019)

Year	Variety	Area (ha)	No. of Demo.	Yield (q ha ⁻¹)		Add. Yield over farmer practice (q ha ⁻¹)	% increase over farmer practice	EG (q ha ⁻¹)	TG (q ha ⁻¹)	TI (%)
				IP	FP					
2013	RMt-305	10	25	15.6	13.2	2.4	18.2	2.4	4.9	23.9
	RMt-143	08	20	16.2	13.5	2.7	20.0	2.7	4.3	20.9
2014	RMt-305	10	25	16.9	13.0	3.9	30.0	3.9	3.6	17.6
	AFg-3	15	36	17.7	13.6	4.1	30.1	4.1	4.8	21.3
2015	AFg-3	04	10	18.8	14.5	4.3	29.7	4.3	3.7	16.4
	RMt-143	08	20	15.6	12.0	3.6	30.0	3.6	4.9	23.9
	RMt-1	06	15	13.6	10.4	3.2	30.8	3.2	4.9	26.5
	GM-1	06	15	16.0	12.9	3.1	24.0	3.1	5.5	25.6
2016	AFg-3	04	10	18.0	13.0	5.0	38.5	5.0	4.5	20.0
	RMt-305	08	20	14.6	10.6	4.0	37.7	4.0	5.9	28.8
2017	RMt-305	06	15	16.5	11.8	4.7	39.8	4.7	4.0	19.5
	RMt-143	08	20	14.9	10.2	4.7	46.1	4.7	5.6	37.6
	GM-1	04	10	16.8	12.8	4.0	31.3	4.0	4.7	21.9
2018	RMt-305	08	20	17.4	14.5	2.9	20.0	2.9	3.1	15.2
	RMt-143	08	20	16.9	12.7	4.2	33.1	4.2	3.6	17.6
	GM-1	04	10	17.8	13.5	4.3	31.9	4.3	3.7	17.2
2019	RMt-305	08	20	18.0	14.0	4.0	28.6	4.0	2.5	12.2
	GM-1	04	10	15.9	13.9	2.0	14.4	2.0	5.6	26.0
Average		129	321	16.5	12.8	3.7	29.7	3.7	4.4	21.8

The economic feasibility of improved technologies over traditional farmer's practices was calculated depending on the prevailing prices of inputs and output costs (Table 5). It was found that operational cost of cultivation of fenugreek under improved technologies varied from ₹ 19550 to ₹ 21520 ha⁻¹ in case of RMt-305, ₹ 19550 to ₹ 20900 ha⁻¹ for RMt-143, ₹ 20200 to ₹ 21520 ha⁻¹ for AFg-3, ₹ 19650 to ₹ 20500 ha⁻¹ for GM-1 and ₹ 19800 ha⁻¹ in case of RMt-1 with an average of ₹ 20251 ha⁻¹ of improved technologies and with an average of ₹ 19128 ha⁻¹ in local practice. The additional cost incurred in the improved technologies was mainly due to more costs involved in the cost of improved seed only. Front line demonstrations recorded higher mean gross returns (₹ 64634 ha⁻¹) and mean net return (₹ 44383 ha⁻¹) with higher benefit ratio (3.2) under improved technologies of different improved varieties of fenugreek as compared to local checks. These results are in line with the findings of

(Morwal, *et al.* 2018; Meena, *et al.* 2012; Singh and Sharma, 2018; Singh, *et al.*, 2007; Lal, 2013 and Kaur *et al.* 2019). Further, additional cost of ₹ 372 ha⁻¹ in demonstration has yielded additional net returns of ₹ 10841 ha⁻¹ with incremental benefit cost ratio 3.9 suggesting its higher profitability and economic viability of the demonstration. Similar results were also reported by (Meena and Singh 2016; Meena and Gupta, 2013; Mahadik and Talathi 2016; Rathore *et al.*, 2016; Meena and Singh, 2017; Morwal *et al.*, 2018; Shakthi *et al.*, 2020; Lal *et al.*, 2020; Mehrya, *et al.*, 2020 and Meena, *et al.*, 2020) in different crops. The results from the present study clearly brought out the potential of improved production technologies in enhancing fenugreek production and economic gains in rainfed farming situations conditions of this region of Rajasthan. Hence, fenugreek production technologies have broad scope for increasing the area and productivity at each and every

Table 5. Cost of cultivation net return (₹ ha⁻¹) and benefit cost ratio of fenugreek as affected by improved production technologies over local practices

Year	Variety	Total cost of cultivation		Gross return (₹ ha ⁻¹)		Net return (₹ ha ⁻¹)		B:C ratio		Add. Cost of cultivation	Add. Net returns (₹ ha ⁻¹)
		IP	FP	IP	FP	IP	FP	IP	FP		
2013	RMt-305	19550	18405	59280	50160	39730	31755	3.0	2.7	1145	7975
	RMt-143	19550	18520	61560	51300	42010	32780	3.1	2.6	1030	9230
2014	RMt-305	20200	19850	64220	49400	44020	29550	3.2	2.4	350	14470
	AFg-3	20200	19650	67260	51680	47060	32030	3.3	2.6	550	15030
2015	AFg-3	20500	19560	72380	55100	51880	35540	3.5	2.8	940	16340
	RMt-143	20500	19970	60840	45600	40340	25630	2.9	2.2	530	14710
	RMt-1	19800	18630	53040	39520	33240	20890	2.6	2.1	1170	12350
	GM-1	19800	18560	62400	49665	42600	31105	3.2	2.6	1240	11495
2016	AFg-3	21520	19400	70200	51350	48680	31950	3.3	2.6	2120	16730
	RMt-305	21520	19780	56940	41870	35420	22090	2.6	2.1	1740	13330
2017	RMt-305	19780	18650	64350	46610	44570	27960	3.3	2.4	1130	16610
	RMt-143	19780	18450	65175	40290	45395	21840	3.2	2.1	1330	23555
	GM-1	19650	18900	59600	50560	39950	31660	3.0	2.6	750	7890
2018	RMt-305	19870	18660	67200	57275	47330	33615	3.4	2.8	1210	13715
	RMt-143	20900	19870	69600	50165	48700	30295	3.3	2.5	1030	18405
	GM-1	20400	19400	72090	54000	51690	34600	3.5	2.7	1000	17090
2019	RMt-305	20500	19050	72900	56000	52400	36950	3.6	2.9	1450	15450
	GM-1	20500	19000	64375	55600	43875	36600	3.1	2.7	1500	7275
Average		20251	19128	64634	49786	44383	30380	3.2	2.5	1123	13981

Conclusion

On the basis of the result obtained in present study it can be concluded that the yield gap between conventional practices and improved production technologies was perceptibly high. There is urgent need to make stronger extension services for educating the cultivators in the implementation of improved production technology. However, the yield level under FLD was better than the local varieties and performance of these varieties could be further improved by adopting recommended production technologies. Hence, it can be observed that increased yield was due to adoption of high yielding varieties and conducting front line demonstration of proven technologies. Yield potentials of crop can be increased to greater extent. This will subsequently increase the income as well as the livelihood of the farming community. From the above research findings it can be also concluded that the maximum number of the respondents had medium level of knowledge and extent of adoption regarding recommended fenugreek production technology. The study reported lack of suitable HYV as major constraint by the beneficiaries and is ranked first followed by low technical knowledge.

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