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Yield gap and economic analysis of seed spices in Arid Kachchh of Gujarat

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Abstract

Seed spices constitute an important segment of agriculture commodities that play a significant role in Indian economy. Frontline demonstration (FLD) aims to boost productivity by offering necessary inputs as well as enhanced production and good agricultural techniques that have been tested by the researchers. A study has conducted by ICAR-CAZRI, Krishi Vigyan Kendra, Kukma, Bhuj to know about the gaps in performance of high yielding varieties of seed spices in frontline demonstrations (FLDs) and farmer's practices. The demonstration were conducted on three major seed spices crops namely Fennel (Guj. Fennel-12), Fenugreek (AFg-3) and Isabgol (Guj. Isabgol-4) during 2019-20 to 2020-21. The results of 2 years FLDs indicated that improved varieties with improved package of practice recorded higher yield as compared to farmer's practice. The improved technologies recorded higher mean seed yield of 2175 kg ha^{-1}, 1055 kg ha^{-1} and 2305 kg ha^{-1} in fennel, isabgol and fenugreek respectively, than 1750, 945 and 2055 kg ha^{-1} under farmers practice. The Highest gross return (Rs. 115300 ha^{-1}), net return (Rs. 77800 ha^{-1}) and benefit cost ratio (3.07) was recorded in fennel crop followed by isabgol and lowest in fenugreek crop. The improved technologies gave higher gross return, net return with higher benefit cost ratio compared to farmer's practices. The results indicates that adoption of high yielding varieties have increased the production of the seed spices crops in the district. The economic return obtained from the high yielding varieties were also high that indicating the ample scope for the growers in the district. The extension gap is found to be higher in all the three varieties. There is also a need to bridge the extension gap through strengthening the extension activities to encourage the wider adoption of high yielding varieties so that the production and productivities of the seed spices in the district.

Keywords: Arid, frontline demonstration, gross return, seed spices, technology gap, technology index

Introduction

India is known as the "Land of Spices" across the world since a long. Among all the states of India, Gujarat and Rajasthan together contribute more than 80 per cent of the total seed spices production in the country and thus, both the states together are known as "seed spices bowl" of India. India is the largest producer, consumer as well as exporter of spices and spice products in the world. It account for nearly 51.79 per cent and 19.06 per cent of total area and production, respectively of total spices in the country. The area under seed spices in Gujarat state is 754785 hectare and production is 1199643 metric tons (Anon. 2021-22) [1]. Spices have a profound influence on the course of human civilization. They permeate our lives from birth to death. India is consistent source of seed spices for importing countries worldwide. Seed spices play a significant role in our national economy because of its large domestic consumption and growing demand for export. In the country, seed spices are mainly growing in the states of Gujarat, Rajasthan, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh and many more states in large and small areas. Gujarat is a leading producer of seed spices particularly Fennel, Coriander, Cumin, Isabgol and Dill. In the dry Kachchh region of Gujarat, it may grow successfully in salty soils with inadequate water quality because these crops require less water than traditional crops.

Seed replacement rate in seed spices are very low (15%) which is a major challenge for enhancing production and productivity of seed spices (Lal, 2018) [15]. Providing good quality seeds is one of the most important and easiest means to accelerate the productivity of seed spices in the country. Seed is a cheapest input in crop production and by adoption of improved varieties can contribute about 20-25 per cent increase in yield. Even while farmers are eager to accept improved varieties and technology, many seed spices growers continue to use local cultivars and traditional methods of cultivation. Poor adoption of high yielding varieties and technologies reduced the farmers' net profits. Many viable technologies have been developed by scientists with great efforts, but they have not yet reached the farming community at a sufficient rate. In general, there is a time lag between the emergence of new ideas and their implementation.

The main objective of FLDs is to demonstrate newly released crop production and protection technologies and their management in the farmers' field under different agro-climatic regions. Frontline demonstration (FLD) is one of these programmes, which focuses on increasing productivity by providing vital inputs as well as improved packages of practices that have been tested by scientists from ICAR Institutes and State Agricultural Universities (SAUs). The yields are higher when high-yielding variety seed, recommended seed rate, seed treatment, planting time, appropriate fertiliser dose, weed control, and integrated pest and disease management are used, as opposed to farmer's practices. Other key aspects of this initiative include promoting the farming of improved varieties, receiving feedback from farmers concerning barriers to the adoption of recommended improved technologies for further research, and maximising the technology diffusion process among farmers [22].

Keeping in mind these considerations, KVK conducted FLDs on the farmers' fields to encourage the adoption of the high-yielding varieties as well as an improved package of practices in the arid Kachchh, with the goal of increasing productivity and increasing net profit from these crops. The current study seeks to investigate the Yield Gap, Technological Gap, Extension Gap, Technology Index, and Yield Gap between FLD plots and farmers' practices as well as economics of the technology.

Materials and Methods

The yield gap analysis study was conducted by the ICAR-CAZRI, Krishi Vigyan Kendra, Bhuj-Kachchh-II (Gujarat) for two consecutive years i.e. 2019-20 and 2020-21 to find out the performance results of high yielding varieties of seed spices at farmer's fields. During this period a total of 60 frontline pro-tests were organised covering 24.0 ha area under these three seed spices crops in various villages in the Kachchh district's Anjar, Bhuj, and Nakhatrana talukas. The FLDs conducted area's soils were mostly saline to alkaline in nature, with a pH range of 8.5 to 9.2 and EC values ranges between 0.9 and 2.6 Dsm^{-1}. The soils were sandy to sandy loam in texture with low in organic carbon content.

The Kachchh district is bounded by 23º24' to 23º 46' North latitudes and 69º38'to 31º58' East longitudes. The total geographical area of Kachchh district is 45652 sq. km divided into ten talukas which is the largest district in Gujarat as well as in India. The average annual rainfall is registered at 250-340 mm and about 95 per cent of the total rainfall occurs during June-September. A number of rainy days are very few; the annual average is only 13 days. The variations in the timing and quantity of rainfall are very high having a co-efficient of the variability of about 60 per cent. This unreliability and uncertainty of rainfall have made Kachchh susceptible to droughts. Winds are generally moderate to high with an annual wind speed of 11.3 km per hour. Winter and summer temperatures range from 7- 48^{0}C with an average humidity of 63 per cent annually and increase to 80 per cent during the south-west monsoon. The practices adopted for the current study comprised high yielding improved varieties of Fennel (Gujarat Fennel-12), Isabgol (Gujarat Isabgol-4) and Fenugreek (AFg-3) with improved package of practices, where existing farming techniques and conventional varieties were viewed as a local check or farmer's practice (FP). The extension gap, technology index, and disparities between potential yield and demonstration yield were evaluated using the FLDs. In this impact study, yield data was obtained from FLD plots along with local farming practices widely used by farmers in this region, for comparative analysis.

During the off-campus training and field trips, KVK scientists assisted the demonstration farmers by demonstrating methods such as sowing in rows, spraying, weeding, and harvesting. Statistical tools such as frequency and percentage were used to collect, tabulate, and analyse the data. The extension gap, technology gap, and technology index were calculated using the Samui *et al*. (2000) [28] and Sagar and Chandra (2004) [27] equations.

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

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

Results and Discussion

Seed Yield

The yield gap analysis of seed spices varieties is given in the Table 1. The results indicates that yield in demonstration plot is higher compared to farmers field for all three seed spices varieties. The average yield of fennel (2175 kg ha^{-1}), isabgol (1055 kg ha^{-1}) and fenugreek (2305 kg ha^{-1}) were much higher as compared to average yield of farmer's practices 1750 kg ha^{-1}, 945 kg ha^{-1}and 2055 kg ha^{-1} respectively. The average percentage increased in the yield over farmer's practices was 24.29, 11.64 and 12.17 per cent in fennel, isabgol and fenugreek. The results indicated that frontline demonstrations have given a good impact over the farming community of Kachchh district as they were motivated for adoption of new agriculture technology applied in the demo plot. The similar results of increasing yield under FLDs in different seed spices crops were reported by Choudhary *et al.*(2018) [5], Dhaka *et al.*(2015) [8], Garwal and Arora (2013) [9], Lal *et al.*(2016) [17], Meena *et al.*(2016) [20], Poonia *et al.*(2017) [23], Ramniwas *et al.* (2022a) [25], Tamboli *et al.* (2020) [30] and Verma *et al.* (2016) [31].

Table 1: Year-wise details and yield performance of frontline demonstrations (Average of two years)

Year	Crop	Variety	No. of Demo	Area (ha)	Yield (kg ha^{-1}) Demo Yield (IP)*	Check Yield (FP)	Increased yield over local check (%)
2019-20	Fennel	Gujarat Fennel-12	10	4.0	2300	1850	24.32
	Isabgol	Gujarat Isabgol-4	20	8.0	1050	940	11.70
	Fenugreek	Ajmer Fenugreek-3	5	2.0	2270	2060	10.19
2020-21	Fennel	Gujarat Fennel-12	30	12.0	2050	1650	24.24
	Isabgol	Gujarat Isabgol-4	20	8.0	1060	950	11.58
	Fenugreek	Ajmer Fenugreek-3	05	2.0	2340	2050	14.15
Av. Mean of Fennel (2019-20 to 2020-21)			15	8.0	2175	1750	24.29
Av. Mean of Isabgol (2019-20 to 2020-21)			20	8.0	1055	945	11.64
Av. Mean of Fenugreek (2019-20 to 2020-21)			5	2.0	2305	2055	12.17

*IP=Improved Practice; FP= Farmers Practice

Table 2: Extension gap, technology gap and technology index of seed spices under FLDs

Year	Technologies (2019-20 to 2020-21)	Potential Yield	Extension Gap (kg ha^{-1})	Technology Gap (kg ha^{-1})	Technology Index (%)
2019-20	Gujarat Fennel-12	2400	450	100	04.17
	Gujarat Isabgol-4	1300	110	150	11.54
	AFg-3	2400	210	130	05.42
2020-21	Gujarat Fennel-12	2400	400	350	14.58
	Gujarat Isabgol-4	1300	110	140	10.77
	AFg-3	2400	290	60	02.50
Av. Mean of Fennel (2019-20 to 2020-21)		2400	425	225.00	09.38
Av. Mean of Isabgol (2019-20 to 2020-21)		1300	110	145.00	11.15
Av. Mean of Fenugreek (2019-20 to 2020-21)		2400	250	095.00	03.96

Technology Gap Analysis

The technology gap is of great significance than other cultivation parameters as it indicates the constraints in implementation and drawbacks in our package of practices concerning to environmental or varietal change. The technology gap is the difference between demonstration yields over potential yields. The mean average technology gaps were 225 kg ha^{-1}for fennel, 145 kg ha^{-1} for isabgol and 95 kg ha^{-1} for fenugreek. The technology gap might be attributed to the dissimilarity in the soil fertility, quality of irrigation water, surrounding microclimate, insect-pests and disease risk, level of crop management by farmer's and others are responsible for the changes in this gap. Similar results were also observed by many researchers such as Kumar *et al.* (2021) [14], Mitra and Samajadar (2010) [19] and Mukherjee (2003) [21].

Extension Gap Analysis

Before the study period, it was discovered that the most farmers did not use high-yielding variety seeds and optimised packages of practices for seed spices cultivation, resulting in an extension gap between demonstrated technology and farmers' exercise. To bridge that gap, KVK demonstrated improved technologies on various farmers' fields as FLDs, which resulted in increased seed yield over the farmer's practice. The data presented in the Table 2 showed that the highest mean extension gap of 425 kg ha^{-1} was recorded in fennel followed by 250 kg ha^{-1} for fenugreek and 110 kg for isabgol. This large extension gap emphasized that there was a need to raise awareness about the use of high-yielding varieties in conjunction with a better package of techniques to reverse this trend of wide extension gap. The result findings of Bhoraniya *et al.* (2017) [3], Lal *et al.* (2013) [16] Ramniwas *et al.* (2022b) [26] supported the conclusions of these results.

Technology Index Analysis

The technology index shows the feasibility of the evolved technology at the farmer's field and the lower the value of technology index more is the feasibility of the technology (Jeengar, *et al.*, 2006) [12]. According to the data presented in the Table 2 showed that the average mean technology index for fennel was 9.38 per cent, for isabgol 11.15 per cent and for fenugreek was 3.96 per cent. During the study period, the lowest technology index in fenugreek may be due to better monitoring of the grower's field as the numbers of FLDs are lesser. The technology index showed that the intervened technology was widely accepted and viable by the farmers. The findings of Choudhary *et al.* (2018) [5], Chauhan *et al.* (2020) [4], Dayanand *et al.* (2012) [6], Mishra *et al.* (2009) [18] and Raj *et al.* (2013) [24] on the impact of FLDs in different crops are in agreement with the current studies.

Economic Analysis

It is essential to assess the economical yardstick of the demonstrated technology as compared to existing farmer's technology. The inputs and outputs prices of commodities prevailed during the study of demonstrations were taken for calculating cost of cultivation, gross return, the net return, additional income, and the benefit-cost (B:C) ratio. The outcomes of the economic analysis (Table 3) of seed spices revealed that the cultivation of fennel, isabgol and fenugreek under improved technologies gave higher gross (Rs. 115300, Rs. 97575 and Rs. 94540ha^{-1}) and net returns (Rs. 77800, Rs. 63325, Rs. 60490ha^{-1}) compared to farmers' practice. Furthermore, the demonstration plots get an average additional return of Rs. 22150, Rs. 9935 and Rs. 9740 ha^{-1}, respectively in fennel, isabgol and fenugreek. The benefit cost ratio of fennel, isabgol and fenugreek under improved technologies were 3.07, 2.85 and 2.78 as compared to 2.50, 2.58 and 2.53 under farmers practice. This may be due to higher yields obtained under improved technologies compared to farmers practice. The results of the economic study point to the shown technology's increased profitability and economic feasibility found similar results in seed spices. Bhargav *et al.* (2015) [2] and Dhaka *et al.* (2010) [7] also reported similar findings in chickpea and maize.

Table 3: Economic analysis of front-line demonstrations in seed spices

Year	Technologies	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
2019-20	GF-12	36500	36075	103500	83250	67000	47175	19825	2.84	2.31
2019-20	GI-4	34000	33760	99750	89300	65750	55540	10210	2.93	2.65
2019-20	AFg-3	33700	33300	90800	82000	57100	48700	8400	2.69	2.46
2020-21	GF-12	38500	38125	127100	102300	88600	64175	24425	3.30	2.68
2020-21	GI-4	34500	34260	95400	85500	60900	51240	9660	2.77	2.50
2020-21	AFg-3	34400	33300	98280	86100	63880	52800	11080	2.86	2.59
Av. mean of GF-12		37500	37100	115300	92775	77800	55675	22150	3.07	2.50
Av. mean of GI-4		34250	34010	97575	87400	63325	53390	9935	2.85	2.58
Av. mean of AFg-3		34050	33300	94540	84050	60490	50750	9740	2.78	2.53

*IP=Improved Practice; FP= Farmers Practice

Conclusions

The front line pro-tests conducted by the KVK revealed that adoption of higher yielding varieties of seed spices have resulted in higher production and higher return with recommended package of practices. The extension methodologies have to apply in the district to encourage the farmers for the adoption of the cultivation of improved varieties of seed spices. This also led to improve the relationship between farmers and scientists. The beneficiary farmers always play an important role as a source of information and dissemination of the high-yielding varieties of seed spices for other nearby farmers. This will help in the removal of the cross-sectional barriers among the farming community. FLDs are critical role in pushing farmers to adopt modern agricultural technology, resulting in increased output and income.

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