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Ashok Rai
ICAR-IIVR-Krishi Vigyan Kendra, Kushinagar, Uttar Pradesh, India

Ajay Kumar Rai
ICAR-IIVR-Krishi Vigyan Kendra, Kushinagar, Uttar Pradesh, India

Rajneesh Srivastva
ICAR-IIVR-Krishi Vigyan Kendra, Deoria, Uttar Pradesh, India

Shamsher Singh
ICAR-IIVR-Krishi Vigyan Kendra, Kushinagar, Uttar Pradesh, India

Ajay Tiwari
ICAR-IIVR-Krishi Vigyan Kendra, Deoria, Uttar Pradesh, India

Neeraj Singh
ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh, India

Corresponding Author:
Ajay Kumar Rai
ICAR-IIVR-Krishi Vigyan Kendra, Kushinagar, Uttar Pradesh, India

Yield and economic analysis of front line demonstration on lentil (*Lens culinaris*) under north eastern plain zone of Uttar Pradesh

Ashok Rai, Ajay Kumar Rai, Rajneesh Srivastva, Shamsher Singh, Ajay Tiwari and Neeraj Singh

Abstract
ICAR-IIVR - Krishi Vigyan Kendra, Kushinagar conducted trials for four years in a row from 2019-20 to 2022-23 in the farmers' fields in various areas of the Kushinagar district under front line demonstration. A total of 365 demonstrations in an area of nearly 50.0 hectares took place in farmer's fields throughout the course of the investigation. Each trial component was demonstrated in an area of 0.4 ha of land corresponding 0.1 ha adjacent area for the comparative farmer's practice (control). Survey based selected farmer received particular training on improved lentil cultivation. Data accumulated under the investigation indicates that lentil yield range from 12.6-17.3 q ha^{-1} under demonstration and from 5.5-8.5 q ha^{-1} in farmer's practice. Demonstration plots exhibited an average yield of 10.38 q ha^{-1} as compared to 5.53 q ha^{-1} in Farmer's practice. BCR of lentil demo ranged from 2.40-3.10 with corresponding BCR of 1.31 to 2.30 in farmer's practice plots. The average BCR of 2.16 under demonstration and 1.42 under farmer's practices was finally observed over the period of four years under the study. The FLD had a positive impact on productivity and economics critical to the farmers. The horizontal spread technology as assessed over the years under this investigation is bound to have a significant impact on motivating farmers to undertake lentil production without a second thought.

Keywords: Lentil, front line demonstration, yield, economic, technology gap

Introduction
India ranks as number one in pulse production and contributes about 25 percent to the total pulse production of the world NHB Database, (2020). Due to this India called as "house of pulses". Pulses (Poor man's meat) are the most cost effective and concentrated source to dietary amino acid necessary to fulfill protein demand of the vegetarian population (Adsule *et al.*, 1989) [1]. Besides pulses are good for nature (environment), pulses provide sustainability in crop production system by incorporation of crop residue, fix the atmospheric N. Lentil comes from the Fabaceae family and is regarded as one of the foremost crop grown since ancient times. The FLD had a good influence on production and economics, which were important to farmers. The horizontal spread technique that has been evaluated throughout the years as part of this inquiry is sure to have a substantial influence on inspiring farmers to begin lentil production without hesitation.

Materials and Methods
The trial was undertaken by ICAR-IIVR - Krishi Vigyan Kendra, Kushinagar for four years in a row from 2019-2023 in the farmers' fields in various areas of the Kushinagar district using front line demonstration. Average temperature in this region is 31.4°C, with a corresponding rainfall of 1145 mm per year. Over the course of the investigation's four years, a total of 365 demonstrations were held at farmer fields on 50.0 ha of land. Each frontline demonstration was set up on 0.4 ha of land, with the nearby 0.1 ha serving as control. Based on a survey, farmers were chosen, and those selected received specialized training on enhanced Lentil farming. Table-1 lists the distinctions between the demonstration package and current farmer practices (control/ traditional cultivation methods). KVK scientists gathered information on yield, production costs and returns from control as well as démonstration plots and subsequently field days were organised to create awareness and further horizontally propagate the technology. Finally, the formulas proposed by and Dayanand and Mehta (2012) [2] were used to calculate extension gap, technology gap, and technology index, as shown below.

Percent yield increase = Demo Yield - Control yield X 100/ Control yield

Technology gap = Yield potential of variety -Demo Yield

Extension gap = Demo Yield - Control Yield

Technology index = Potential yield of variety - Demo Yield X 100 /Potential yield of variety

Table 1: Distinctive features of demonstration and farmer's practices

Agronomical Practices	Demonstration	Farmers practices
Variety	IPL316	Local
Seed rate	30 kg ha^{-1}	40 kg
Chemical / biological treatment of seed	Seed treated with Carbendazim @ 2 gm/ kg + Rhizobium culture @ 20 gm kg^{-1} seed	Not in practice
Sowing method	Line sowing	Broadcasting
Field placement Spacing of seeds	Row to Row 30 cm and Plant to Plant 10 cm	No standard parameters set
Sowing time	Second week of October to November first week	Fourth week of November until December
Nutrients supply Dosage	Fertiliser @ 20 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}	Imbalance application/ No use of Fertilizer
Weedicide Application/ dose	Pendimethalin @ 2.0 liter ha^{-1} was applied within 48 hrs of Sowing.	No weeding/Hand weeding
Pesticide Application/ dose	Need base use of pestiticide application at recommended dose	No application of pesticides
Harvesting	First fortnight of March	Second fortnight of March

Results and Discussion

Yield and Economic Interpretations

Data as compiled under Table 3 of the investigation indicates that lentil yield range from 12.6 - 17.3 q ha^{-1} under demonstration and from 5.5-8.5 q ha^{-1} in farmer's practice. Demonstration plots exhibited an average yield of 10.38 q ha^{-1} as compared to 5.53 q ha^{-1} in check. BCR of lentil demo ranged from 2.40-3.10 with corresponding BCR of 1.31 to 2.30 in farmer's practice plots. The average BCR of 2.16 under demonstration and 1.42 under farmer's practices was finally observed over the period of four years under the study. This can be attributed to the incorporation and successful integration of recommended package and practices for lentil in on-field demo plots whereas there was lack of these practices in control plots.

Table 2: Economics of Lentil production (2019-23)

Year	Economic of Demonstration (INR)				Economic of FP (INR)			
	Gross Cost	Gross Return	Net Return	B:C	Gross Cost	Gross Return	Net Return	B:C
2019-20	18500.00	46000.00	27500.00	2.48	16700.00	21850.00	5150.00	1.31
2020-21	19750.00	47250.00	27500.00	2.40	17885.00	24750.00	6865.00	1.38
2021-22	19450.00	62000.00	42550.00	3.10	18350.00	42500.00	24150.00	2.30
2022-23	23400.00	65520.00	42120.00	2.80	19562.00	41080.00	21518.00	2.10
Average	16220.00	44154.00	27934.00	2.16	14499.40	26036.00	11536.60	1.42

The average yield of lentil under demonstration package was 32.08 per cent higher than control. Increase in lentil production can be attributed to successful deployment of improved variety with good agricultural package of practices for lentil cultivation. Increase in yield ranged between 47.60 - 20.0 and peaked during 2020-21. Yield fluctuations as observed in during different years might be due to a.) Available soil moisture, b.) rainfall and irrigation timing, c.) climatic aberration such as cold wave etc., d.) Change of demo plots every consequent year.

Variations in production cost of lentil under demonstration were in the range of INR 18500.00 - 23400.00 ha^{-1} with an average of INR 16220.00 with a corresponding range of INR 16700.00-19562.00 and average INR 14499.40 under control. The additional cost incurred under demo plots was mainly due to use of balanced fertiliser, procurement of excellent qualitative seed with higher yield potential and timely, judicious use of agrochemicals etc.

In the years 2019-20, 2020-21, 2021-22, and 2022-23, respectively, lentil production under demonstration resulted in better net returns per hectare of INR 27,500.00, 27,500.00, 42,120.00, and 42,550.00. The average net gain of INR 27934.00 ha^{-1} obtained was more than double under farmer's practice INR 11536.00. The net BCR ranged from 2.40 - 3.10 and 1.31- 2.30 from démonstration and farmer's plots respectively with a corresponding net BCR of 2.16 in demonstration and 1.42 under farmer's practices (Table 2). The enhanced BCR is probably due to higher yield accrued. These findings are similar to the findings of Yadav *et al*. (2020) [9] in lentil and Meena *et al*. (2020) [3]; Srivastava *et al*. (2022) [7] and Meena *et al*. (2022) [4] as cases reported from other crops.

Table 3: Yield and gap parametric data for lentil under demonstration

Year	Area (ha)	No. of farmers	Yield (q ha^{-1})			Extension gap (q ha^{-1})	Technology gap (q ha^{-1})	Technology Index (%)
			Potential	FLD	FP			
2019-20	10	109	18	11.5	5.75	5.75	6.50	9.89
2020-21	10	52	18	10.5	5.5	5.00	7.50	11.42
2021-22	10	65	18	17.3	8.5	8.80	0.70	1.07
2022-23	20	139	18	12.6	7.9	4.70	5.40	8.22
Total/Average	50	365	18	10.38	5.53	4.85	4.02	6.12

Extension gap

The extension gap 5.75, 5.0, 8.80 and 4.70 q ha^{-1} were recorded through 2019-20, 2020-21, 2021-22 and 2022-23, respectively. On an average extension gap was 4.85 q ha^{-1} (Table 3). This significant yield extension gap emphasises the need to create awareness among the masses through all available means to promote adoption of improved agricultural production technologies. More and more successful integration of latest production technologies into practice will assist in reversal of the trend i.e. reducing the yield extension gap.

Technology gap

Technology gap is assumed to be difference between potential yield of crop and actual yield. The average technology gap under the FLD programme was 5.40 q ha^{-1} with yield variations corresponding to 6.50, 7.50, 0.70 and 5.40 q ha^{-1} from 2019-20, 2020-21, 2021-22 and 2022-23, respectively. Similar findings have been reported earlier by Singh *et al*. (2020) [8] and Mishra *et al*. (2014) [5]. These variations can be surmised to be caused by changes in microclimatic condition of the demo plots under consideration, skill status and readiness of the farmers to practice spot solutions when available. So there is a further need to carefully implement and document the integrated approach to crop management subject to location specificity in order the bridge the technological gap.

Technology Index

Average technology index of 6.12 percent ranging from 1.07 to 11.42 (Table 3) was observed during the study which shows the effectiveness of technical interventions.

Conclusion

The investigation demonstrated the productivity potential and profitability of the applied technology under multi-location trials within the district. Target oriented training programme on integrated approach to lentil production and large scale démonstrations are desired to supplement and strengthen the existing level of knowledge and belief of the farming community. This may be possible with first hand close encounter and liable to reform lentil production in the district.

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