The Pharma Innovation Journal 2021; SP-10(9): 841-844

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(9): 841-844

www.thepharmajournal.com
Received: 08-07-2021
Accepted: 12-08-2021

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Effect of cluster frontline demonstrations (CFLDs) on production and profitability of Lentil (*Lens culinaris*) for nutritional security in Eastern Ladakh

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Abstract
Lentil (*Lens culinaris*) is an important crop in the highland cropping systems of Ladakh because of its contribution to human food and soil health improvement. It is also gaining popularity in the eastern Ladakh and has been included as a component of crop diversification of eastern Ladakh. Cluster front line demonstrations on lentil crop were conducted by Krishi Vigyan Kendra, Nyoma across the 5 villages (Liktsey, Tukla, Hemiya, Kungyam and Teri) of Eastern Ladakh during summer season of 2018-19 to 2019-20. The data were collected personally and collected data were classified, tabulated and analyzed by using appropriate statistical tools. The findings of the study revealed that an average yield of demonstration plots was obtained 6.6 q/ha as compared to local check 5.7 q/ha which was 13.6 per cent higher as compared to local check. Further, mean results of the study revealed that average additional yield (0.9 q/ha), additional returns (Rs. 7324), effective gain (Rs. 5724) and benefit: cost ratio (1.75) from one hectare was obtained under demonstration as compared to farmer practices. The overall adoption of lentil production technology by the partner farmers was 65.00 percent. The study indicated that practical implications and usability of CFLDs is increasing the production and productivity of lentil crop at the farmers' fields.

Keywords: CFLDs, Lentil, benefit cost Ratio, Adoption, Eastern Ladakh

Introduction
India being an agrarian country is the largest producer, consumer and importer of pulses in world (Singh *et al.*, 2020) [7]. Apart from good returns pulses are major source of plant protein and carbohydrates. Other nutrients like Phosphorus, Minerals, Vitamin C, Riboflavin and essential Amino acids are also major constituent and because of its rich protein content 22-34.6% it is also called "Poor man's meat" (Adsule *et al.*, 1989) [1]. Pulses can grow in rain-fed as well as partially irrigated agriculture by improving physical, chemical and biological properties of soil and are considered excellent crops for natural resource management, environmental security, crop diversification and consequently for viable agriculture (Ali and Kumar, 2006) [2].

Lentil (*Lens culinaris*) is a small annual legume of the pea family (Fabaceae) and seed is edible. It is a valuable human food, mostly consumed as dry seeds (whole decorticated, seed decorticated and split). Around the world, lentil is grown in India, Persia, Syria, Egypt, Nubia and North Africa and in Europe, along the coast of the Mediterranean and as far north as Germany, Holland and France. India ranked first in the lentil area and second in the production with 43 and 37 percent of world area and production, respectively (Yadav *et al.* 2020) [9]. In Leh-Ladakh, lentil is cultivated mainly in Nimmu, Saspol, Khaltse, Skurbuchan, Wanla, Diskit, Turtuk, Panamic, Chushot and Kharu blocks. Lentil (*Lens culinaris*) is an important crop in the highland cropping systems of Ladakh because of its contribution to human food and soil health improvement. It is also gaining popularity in the eastern Ladakh and has been included as a component of crop diversification of eastern Ladakh. Lentil has been grown in the central and western region of Ladakh and covered an area of 265 hectares in year 2016-17 (Anonymous, 2017) [3]. As per the data, lentil was rarely grown in the eastern Ladakh but this crop was undertaken in the CFLDs programme by the Krishi Vigyan Kendra Nyoma, especially in the lower elevated region of the eastern Ladakh. In Ladakh, lentil is mainly grown in summer season because of severe cold winter and the crop productivity is very low, whereas in other parts of India, lentil is primarily a *rabi* season pulse crop.

The concept of front line demonstrations was put forth under "Technology Mission on Pulses" in the year 1991-92 with the objective to enhance the pulse production and productivity.

These demonstrations are conducted under the close supervision of scientists of Krishi Vigyan Kendras, SAUs and their Regional Research Stations. The FLD is an important tool for transfer of latest package of practices in totality to farmers and the main objective of this programme is to demonstrate newly released crop production and protection technologies and management practices at the farmers' field under real farming situation along with capacity building of partner farmers. Through this practice, the newly improved innovative technology having higher production potential under the specific cropping system can be popularized and simultaneously feedback from the farmers may be generated on the demonstrated technology (Singh *et al*., 2012) [8]. The aim of study was conducted to increase the lentil production, net cropped area and also to improve the nutritional security of the *Changpas*. The cluster frontline demonstrations will boost good yield and economical advantages in the eastern Ladakh.

Materials and Methods

The present study was carried out in eastern Ladakh under the Krishi Vigyan Kendra-Nyoma, which is highest altitude KVK in India, during 2018-2019 and 2019-20 for two consecutive years in the farmer's field in lower elevated areas of Nyoma subdivision in Rong-Chumathang block under the guideline of Cluster Front Line Demonstration by ICAR-ATARI (Zone-I), Ludhiana to selected KVKs. Accordingly CFLDs on pulses under lentil (Masoor) crop laid out in villages namely-Liktsey, Tukla, Hemiya, Kungyam and Teri. In this study, a total area of the two years under CFLDs programme on lentil was 1.26 hectares and a total of 48 beneficiary/partner farmers were involved from above mentioned villages. Beneficiary/partner farmers were identified through their participation and feedback received during the survey, awareness programme and training also. All the participating farmers were trained to follow the improved practices of lentil cultivation. In the selected area for CFLDs programme on lentil cultivation, seed sowing was done in both the year in summer between second week of May to last week of May month with a seed rate of 80 kg /ha in line sowing with row to row spacing of 25 cm and 10 cm between plants in the row. In context to nutrient management, 125 to 150 qtls per hectare farm yard manure (FYM) was applied at the time of field preparation. One hand weeding was done about 30-35 days after sowing and approximately 6 to 7 irrigations were applied as per the crop requirement due to high evapotranspiration rate. The crop was harvested up to 15 September after the leaves turn yellow.

Field day was conducted with active participation of demonstration holding farmers, other farmers, KVK Scientists, officials from state line departments and local extension functionaries to demonstrate the superiority of technology and to create awareness among the farmers. The basic information was recorded from the demonstration plots and control plots then analyzed for comparative performance of CFLDs and Farmer's practice. Further, the data of extent of adoption of lentil production technologies were collected from the partner farmers by personal interview method with the help of interview schedule. The collected data were classified, tabulated and analyzed by using suitable statistical tools.

The data on seed yield, cost of cultivation, gross and net return were collected from demonstration plots from the farmers. The benefit cost (B: C) ratio was calculated based on gross return.

The extension gap was worked out (Katare *et al*., 2011[4]; Samui *et. al*., 2000 [6]) as given below:

Extension gap = Demonstration yield- Farmers yield
Net return = Gross Return - Cost of cultivation

$$\text{Percent increased yield} = \frac{\text{Demonstration yield - Farmers yield}}{\text{Farmers yield}} \times 100$$

Additional cost (₹/ha.) = Improved technology cost (₹/ha.) - Farmer practice cost (₹/ha.)
Additional return (₹/ha.) = Improved technology (₹/ha.) - Farmer practice return (₹/ha.)
Effective gain (₹/ha.) = Additional return (₹/ha.) - Additional cost (₹/ha.)

Results and discussion

Before conducting cluster frontline demonstrations in the farmer's field, on the basis of survey data, major gap were observed between technological interventions and farmer' s practice with respect to lentil cultivation in eastern Ladakh. Under the demonstrated plots, improved seed of local selection of lentil was given to the farmers by the KVK and all other package of practices (Table 1) were timely performed by the farmers itself under the guidance and supervision of KVK scientists. Similar trends have also been observed by Singh *et al.* (2012) [8] and Meena *et al.* (2020) [5].

Gap analysis

The data in Table 1 revealed that the highest gap 70% was recorded in case of method of sowing and spacing followed by weed management (67%), nutrient management (52%), irrigation management (45%), variety (34%), harvesting and threshing (28%), seed rate (25%) and sowing time (22%), respectively. From the above data, it can be deduced that major gap was found in method of sowing and spacing of lentil crop due to the lack of proper knowledge and as most of the famers were having very less size of land holding, so they faced difficulty to use modern farm machinery for seed sowing. Further, gap was observed in weed management practice due to poor awareness and untimely and less availability of labour during the crop season. Likewise, next gap was observed in nutrient management because either mostly farmers were devoted to the organic cultivation practices or they were not acquainted about the proper organic nutrient management in the lentil cultivation.

Yield

The data in Table 2 revealed that the maximum average yield of lentil through demonstrations was recorded (6.83 q/ha) during year 2019-20 and minimum average yield was recorded in year 2018-19 (6.35 q/ha) and the average yield of two years was recorded 6.6 q/ha over local check (5.7 q/ha). The average increase in yield was 13.6 per cent recorded in two years of study. The higher yield of lentil could be attributed to selection of improved variety with improved production practices of lentil. These results corroborate the findings of Meena *et al.* (2020) [5] in green gram.

Extension gap

Analysis of data (Table 2) stated that on an average basis the extension gap was 0.9 q/ha. Such gap might be attributed to adoption of improved technology especially improved local

selection variety grown with the proper method with balanced nutrition, weed management and proper irrigation management in demonstrations. During the study period, emphasis was given to educate the farmers through various means for adoption of improved production technologies to reverse the trend of wide extension gap. Similar findings were recorded by Yadav *et al*. (2020) [9].

Economic analysis

Different variables like seed and manure were considered for the demonstration as well as farmer practice and inputs and outputs prices of commodities prevailed during the study period of demonstration were taken for calculating the cost of cultivation, gross return, net return and benefit: cost ratio (Table 3). On an average additional investment of Rs. 1600 per ha was made under demonstration. Cultivation of lentil under demonstrations gave net return (Rs. 22431/ha.) due to higher grain yield under demonstrations. The higher additional returns and effective gain obtained under demonstration could be due to improved technology and non-monetary factors, timely operations of crop cultivation and scientific monitoring. The lowest and highest benefit: cost ratio of 1.61 and 1.89 in 2019-20 and 2018-19, respectively (Table 3) depends on produced grain yield and market sale rates. Overall average benefit: cost ratio was obtained 1.75. The results confirm with the findings of Meena *et al*. (2020) [5].

Extent of adoption of lentil production technology by the partner farmers

The extent of adoption of different technological parameters of lentil cultivation for enhancing the production of lentil in the eastern region of Ladakh was analyzed separately such as seed rate, variety, sowing time, method of sowing and spacing, nutrient management, weed management, irrigation management and harvesting and threshing. The relative importance of extent of adoption of all eight technological parameters of the lentil cultivation was highlighted by ranking them in descending order on the basis of their percentage of adoption and data have been presented in Table 4.

The data revealed that the partner farmers had maximum adoption in 'sowing time' (79.25 percent) and assigned rank first. The second rank was accorded to the 'seed rate' as it was adopted to the extent of 75.37 percent and the third rank was assigned to the 'variety' with extent of adoption of 72.34 percent. Likewise 'irrigation management' (66.35 percent), 'method of sowing and spacing' (63.21 percent), 'harvesting and threshing' (58.24 percent), 'nutrient management' (56.15 percent) and 'weed management' (49.09 percent) were assigned ranked IV, V, VI, VII and VIII, respectively. Further, the data in Table 4 also indicated that overall extent of adoption of technological parameters by the partner farmers in lentil cultivation was 65.00 percent.

From the extent of adoption of individual technological parameters of lentil cultivation, it can be concluded that the partner farmers had more adopted to the 'sowing time'. The results seemed to be quite natural because of the fact that the farmers were more acquainted to the 'sowing time' due to their past experience of the climatic conditions of particular area, whereas less adopted to the 'weed management' practice. This might be due to fact that the farmers had more focus on lentil cultivation organically, so they were not applying weedicide for weed control. In case of manual weeding, they had faced labour scarcity during the crop season. Therefore, in order to convert low adoption to higher adoption, extension agencies should give more emphasis on the methodologies of weed management for transfer of technologies in acceptable manner. The results of the study are in accordance with the findings of Singh *et al.* (2020) [7] who reported that 100 percent respondents were adopted to the timely sowing in adoption of recommended lentil cultivation practices.

Reason of Low Yield of Lentil at Farmer's Field

In the cold-prone highlands, lentil is traditionally grown in summer to avoid harsh cold climates in winter months. However, it has been identified three major elements of constraints of lentil production in the highlands: lack of short duration and high-yielding varieties, insufficient weed control and little use of proper agronomic practices. The farmers in these areas are not acquainted with scientific lentil production technology. Proper agronomic management from land preparation up to maturity, weed control, disease management is the key factors for higher and stable yield. Farmers need to be trained to implement these productions.

Table 1: Gap analysis between technological interventions and farmer's practice of lentil growers

S. No.	Particulars	Technological interventions	Farmer's practice	Gap (%)
1	Seed rate	80 Kg/ha	100 kg/ha	25
2	Variety	Local selection (KGML)	Local	34
3	Sowing Time	Month of May	Improper sowing time	22
4	Method of sowing and spacing	Line sowing, 25cm x10cm	Broad casting, uneven plant population	70
5	Nutrient management	FYM 125-150 qtls/ha	60-100 qtls/ha	52
6	Weed management	One hand weeding after 30-35 DAS	Partially weeding	67
7	Irrigation management	6-7 Irrigations	Improper irrigations	45
8	Harvesting and threshing	First fortnight in month of September	Less-follow proper time of harvesting and threshing	28

Table 2: Yield and extension gap analysis between Cluster Front Line Demonstrations (CFLDs) plots and farmer's Practice in Lentil crop

Year	No. of CFLDs	Demo. Avg. Yield (q/ha)	Yield of local Check (q/ha)	(%) Increase over local check	Extension gap (q/ha)
2018-19	20	6.35	5.45	14.17	0.9
2019-20	28	6.83	5.94	13.03	0.89
Average	48 (Total)	6.6	5.7	13.6	0.9

Table 3: Economical comparison of lentil growers in Cluster Front Line Demonstrations (CFLDs) and farmers Practice

Crop	Season and year	Average Cost of cultivation (Rs./ha)		Additional cost in demo. (Rs/ha.)	Average Gross Return (Rs./ha)		Additional return in demo. (Rs./ha.)	Average Net Return (Rs./ha)		Effective Gain (Rs./ha)	Benefit-Cost Ratio	
		Demo.	Local Check		Demo.	Local Check		Demo	Local Check		Demon	Local Check
Lentil	Summer 2018-19	25550	23950	1600	48190	41275	6915	22640	17325	5315	1.89	1.72
	Summer 2019-20	36450	34850	1600	58673	50940	7733	22223	16090	6133	1.61	1.46
Average		31000	29400	1600	53432	46108	7324	22431	16707	5724	1.75	1.59

Table 4: Extent of adoption of Lentil production technology by the partner farmers (PF = 48)

S. No.	Technological parameters	Partner farmers	
		Extent of adoption (%)	Rank
1	Seed rate	75.37	II
2	Variety	72.34	III
3	Sowing time	79.25	I
4	Method of sowing and spacing	63.21	V
5	Nutrient management	56.15	VII
6	Weed management	49.09	VIII
7	Irrigation management	66.35	IV
8	Harvesting and threshing	58.24	VI
Overall adoption		65.00	

PF = Number of partner farmers

Conclusion

Cluster frontline demonstrations on lentil was conducted in different villages of Nyoma subdivision of Leh-Ladakh and it can be concluded that average highest yield 6.6q/ha found in demonstration plots against 5.7 q/ha in control plots. There was 13.6 per cent yield increase in demonstration plots over local check. It was observed that potential yield can be achieved by imparting scientific knowledge to the farmers, providing the quality need based inputs and proper management. The main issue reported by the lentil growers was non-availability of short duration varieties for the area and non-availability of good quality seed. In respect of adoption, the technological parameters of the lentil cultivation *i.e.* 'sowing time' was widely adopted by the farmers because they were more acquainted to the 'sowing time' due to past experience of the climatic conditions. Whereas, less adopted the 'weed management' practice due to inclination towards organic lentil cultivation practices thereby not applying weedicide and resorted to manual weeding, facing labour scarcity during crop season. Hence, it is advised that the extension agencies should give more emphasis on the methodologies for transfer of technologies in acceptable manner. Wider dissemination and horizontal spread of improved technologies may be achieved by the successful implementation of frontline demonstrations and various extensions activities like training programme, field days and exposure visits. However, front line demonstration is an effective method for increasing the acreage, production and productivity of lentil and changing the knowledge, attitude and skills of farmers.

Acknowledgement

Authors are highly thankful to the Director, ICAR-ATARI (Zone-I), Ludhiana for providing funds to conducting the CFLDs and farmers who always show faith in the Krishi Vigyan Kendra, Nyoma.

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