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Impact of Frontline Demonstrations on Production and Productivity of Pulses in Arid Regions of Nagaur District of Rajasthan

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ABSTRACT

Background: Pulses are well known richest source of vegetable protein and is known as poor man's food because of its essential component in diet. The frontline demonstrations of pulses were carried out on 311.8 ha area with 694 demonstrations in different clusters of Nagaur district of Rajasthan.

Methods: Front line demonstrations on chickpea, mung bean and moth bean crop were conducted by Krishi Vigyan Kendra, Nagaur-I, Agriculture University, Jodhpur during *rabi* and *Kharif* season of 2011-12 to 2019-20.

Result: In demonstrations up to 29.43%, 30.29% and 35.22% yield increase of chickpea, mungbean and moth bean crop was observed over the farmer's practices in the year 2011-12, 2017 and 2016. The yield gap between improved technology and conventional farmer's practices was ranging from 1.98 to 4.54 q/ha, 0.61 to 2.55 q/ha and 0.6 to 1.68 q/ha, respectively. Whereas, the highest net returns of ₹ 71,881 ha^{-1}, ₹ 45,884 ha^{-1} and ₹ 14,315 ha^{-1} was observed in the year 2019-20, 2014 and 2016, respectively with the highest incremental cost benefit ratio of 1:3.71, 1:3.95 and 1:1.97 under demonstrations practices.

Key words: Arid regions, Chickpea, Front line demonstrations, Moth bean, Mung bean, Productivity.

INTRODUCTION

In terms of agricultural importance, pulses are next to cereal crops and are also known as excellent option for agriculture diversification and intensification in sustainable farming. India is the largest producer and consumer of pulses and contribute in about 35 per cent share in global area and production. The pulse production in India has been fluctuated widely leading to steady decline in the per capita availability over last 20 years (Gregory *et al.*, 2003). Over the last six years, the on-going National Food Security Mission (NFSM) has been converged with multi-pronged strategies to enhance the production and productivity of pulses in the country (Anonymous, 2018) which results in enhanced per hectare productivity. The year 2017-18 witnessed a record pulse production of 25.23 million tonnes (Anonymous, 2018), a grand success story and revolution in pulses self-sufficiency.

The country is now trying to meet the target of 35 million tonnes by 2030 with the challenging reasons like unavailability of quality seed, lack of technical guidance, ignorance of Integrated Pest Management techniques and non-adoption of integrated nutrient management (Kumar *et al.*, 2014; 2016). Besides this, major abiotic stress *i.e.* low organic content in soil, low moisture content in the soil, types of soils, seasonal drought due to low rainfall are also responsible for low productivity of the pulses crops (Dubey *et al.*, 2017). Among biotic stress, legume pod borer, *Helicoverpa armigera* (Hübner) is responsible for 50 to 60 per cent grain yield losses (Balikai *et al.*, 2001) and losses exceeded ₹ 12,000 million per year (Anonymous, 1996). Therefore, it is a great deal for extension scientists, policy makers and farming community to meet out the pulses availability demand over the country population in terms of household nutritional security.

To overcome the pulses hunger, government tried to improve pulses production and productivity in the country with Indian Council of Agricultural Research by taking major big step for the same by conducting Cluster Frontline Demonstrations nationwide through Krishi Vigyan Kendras with the mandate of out scaling of farm innovations through FLDs to highlight the specific benefits/ worth of technologies on farmer's fields. Besides this, various programmes like Technology Mission in 1986, National Pulse Development Project in 1990-91, Integrated Scheme of Oilseeds, Pulses, Oil palm and Maize in 2004, National Food Security Mission in 2007-08 and Accelerated Pulses Production Programme (A3P) has been started by the government (Kumar *et al.*, 2021) but gap between demand and supply is still bigger

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and this demand gap is tried to overcome through import of pulses.

The utmost objective of the frontline demonstrations is to large scale technological demonstrate latest technologies of crop production and management practices under diverse climatic conditions as well as farming situations to fill the per cent yield gap. Therefore, the effect of frontline demonstrations on production and productivity of pulses has been studied in rainfed areas of Nagaur district of Rajasthan.

MATERIALS AND METHODS

Front line demonstrations on chickpea, mung bean and moth bean were conducted by Krishi Vigyan Kendra, Nagaur-I, Agriculture University, Jodhpur during *rabi* and *Kharif* season from 2011-12 to 2019-20. Total 311.8 ha area was covered with 694 demonstrations in different clusters in Nagaur district. Nagaur district is situated between 260.25" to 270.40" North latitude and 730.18" to 750.15" East longitude. The average rainfall of the zone is 360 mm. In general, soils of the area under study were sandy to sandy loam in texture with average pH 7.8, organic carbon 0.32, low in nitrogen and medium in phosphorus and potash.

Cluster selections, farmer selection, problem diagnosis, layout of demonstration were carried out as suggested by Choudhary (1999). Assessment of gap in adoption of recommended technology was done before laying out FLD's through personal discussion with selected farmers (Table 1). Trainings were organized about detailed technological intervention with improved package and practice for successful cultivation of pulses. In the demonstrated FLDs the recommended package of practices were followed for crop cultivation and compared with the farmer's practices (Table 1). In case of farmers practice plots, existing practices being used by farmers were followed.

Scientists visited regularly demonstration fields and farmer's fields. The feedback information from the farmers was also recorded for further improvement in research and extension programmes. The extension activities *i.e.* trainings, interaction with farmers and field days were organized at the cluster frontline demonstration sites. The basic information were recorded from the farmer's field and analyzed to comparative performance of demonstrated plot and local check.

Data on yield parameters from demonstrated plots and farmers practices was collected by random crop cutting method and the cost of cultivation, gross return, net return and benefit cost ratio etc. were analyzed by simple statistical analysis. Observations on grain yield (qt/ha), straw yield (qt/ha) and harvest index (%), yield increase over farmers practices (%), technology gap (q/ha), technology index (%) and extension gap (q/ha) *etc*. were also worked out by methods suggested by Samui *et al.* (2000):

Extension gap (q/ha) =
Demonstrations yield (q/ha) - Yield under farmer's practices (q/ha)

Technology gap (q/ha) =
Potential yield (q/ha) - Demonstrations yield (q/ha)

$$\text{Technology index (\%)} = \frac{\text{Technology gap (q/ha)}}{\text{Potential yield (q/ha)}} \times 100$$

RESULTS AND DISCUSSION

The performance of pulse crops owing to the adoption of improved technologies was assessed over a period of nine years from 2011-12 to 2019-20 and is presented in Fig 1,2,3 and Table 2. The economics of cost of cultivation, gross return, net return, additional cost, additional return and benefit: cost ratio were analyzed and presented in Table 3.

Economic yield (q/ha)

Data of 694 demonstration results from the Table 2 represents the average seed yield of the pulses crops. Under demonstration technology, the average seed yield of chickpea, mung bean and moth bean crops was 18.02, 8.36 and 5.37 q/ha, respectively. Whereas, the same was 14.51, 6.97 and 4.17 q/ha, respectively under farmer's practices. The average per cent yield increase of respective crops over farmer's practices was 24.18%, 19.59% and 28.36%, respectively. From the results, it is witnessed that the performance of improved varieties with proper practices found better than the conventional farmer's practices. Possible reasons for variations in the seed yield range could be low quality seed as well as unpredictable rainfall.

Similarly, Kumar *et al.* (2019) also reported 0.83 to 14 q/ha grain yield of different pulse crops under demonstrations as compared to 0.72 to 8.40 q/ha in farmer's practices. The per cent yield increase of chickpea crop was 28.57 to 30.28% in the similar dry areas (Kumar *et al.*, 2021).

Extension gap (q/ha)

The extension yield gap ranged from 0.6 to 4.54 q/ha was observed between demonstrations technology and farmers practices in the respective crops (Fig 1, 2, 3). The maximum extension yield gap of 4.54 q/ha was observed in chickpea variety GNG-1581, whereas, the lowest (0.61 q/ha) was in mung bean variety Satya. Extension yield gaps can be changed through creating awareness among farming community about improved technology.

Avoiding the adoption of improved crop production technology by the farmers for better production results in extension yield gaps (Kumari *et al.*, 2007). According to Parihar *et al.* (2018), the average extension yield gap in lentil crop was 1.83 q/ha under demonstrations which resulted in higher grain yield as compared to farmer's practices.

Technology gap (q/ha)

The results of frontline demonstrations yield and potential yield of pulses crops was compared to estimate the yield gaps, technology gap and technology index (Fig 1, 2, 3). The technology gap of pulses crops ranged from 0.67 to 8.57 q/ha. It results that higher the value of technology gap more is the feasibility of the improved technology at the farmer's field. The variation in technology gap is common

Table 1: Technologies demonstrated under front line demonstrations *vs* farmer's practices.

Crop	Components	Demonstration of recommended technology	Farmer's practices	Gap analysis (%)
Chickpea	*Variety(s)	GNG-1581, RSG-974, GNG-1958	Local/old variety (RSG 896)	50-60
	*Seed rate	75 kg/ha	90-95 kg/ha	50-55
	*Seed treatment	*Trichoderma viride* @ 6-8 gm/Carbendazim 50WP @ 2 gm/kg seed, PSB+Rhizobium culture@ 500 gm/ha	30-40% farmers do seed treatment with Carbendazim	60-70
	Sowing method	Line sowing (30 × 10 cm)	Broadcasting/ line sowing	50-60
	Irrigation	At 60 DAS as a life saving irrigation with sprinkler	No irrigation	65-75
	*Nutrients	N-18 kg/ha; P-46 kg/ha, FYM @ 2.5 tones/ha	Improper use of fertilizers	70-80
	*IPM measures	Pendimethalin @ 0.6 kg/ha as pre-emergence, manual weeding @ 30-35 DAS, Emamectin Benzoate 5 SG @ 250 gm/ha for pod borer management.	40-50% farmers use irrelevant IPM measures	50-60
	Trainings	Audio-video On and Off campus training	No training	100
Mung bean	*Variety(s)	SML-668, GM-4, GAM-5	Old variety IPM 02-3	40-50
	*Seed rate	15 kg/ha	10 kg/ha	40-50
	*Seed treatment	*Trichoderma viride* @ 4 gm/ Carbendazim 50WP @ 2 gm/kg seed, Imidacloprid 600FS @ 5 ml/kg seed, PSB+Rhizobium @ 500 gm/ha	45-50% farmers do seed treatment with Carbendazim	50-55
	Sowing method	Line sowing (30 x 10 cm) (RxP)	Broadcasting/ line sowing	40-50
	*Nutrient	N:P:S:Zn=15:40:3.75:5.25 kg/ha, foliar spray of 2% NPK 18:18:18 at flowering	5-10 kg N+15-20 kg P_2O_5/ha	50-55
	*IPM measures	Weed management by Imazethapyr 10SL @ 50 gm/ha/ manual weeding @ 35-40 DAS, Disease management by spray of Carbendazim @ 500 g/ha or Sucking pest management by Imidacloprid 17.8SL @ 150 ml/ha.	50-60% farmers use irrelevant IPM measures	40-50
	Trainings	Audio-video On and Off campus training	No training	100
Moth bean	*Variety(s)	RMO-435, RMO-257, CZM-2	Local/ RMO-40, RMO-225	40-50
	*Seed rate	10-12 kg/ha	15 kg/ha	40-45
	*Seed treatment	*Trichoderma viride* @ 4 gm, Carbendazim 50WP @ 2 gm/kg seed, Imidacloprid 600FS @ 5 ml/l water, PSB+Rhizobium @ 500 gm/ha	45-50% farmers do seed treatment with Carbendazim	50-60
	Sowing method	Line sowing (45 x 15-20 cm) (RxP)	Only broadcasting	40-50
	*Nutrient	N:P:S:Zn=10:30:3.75:5.25 kg/ha, foliar spray of 2% NPK 18:18:18 at flowering	N:P = 5:2.5 kg/ha	70-75
	*IPM measures	Weed management by Imazethapyr 10SL @ 50 gm/ha/ manual weeding @ 35-40 DAS, Disease management by spray of Carbendazim @ 500 g/ha or Sucking pest management by Imidacloprid 17.8SL @ 150 ml/ha.	50-60% farmers use irrelevant IPM measures	40-50
	Trainings	Audio-video On and Off campus training	No training	100

*Demonstrate the technology/ input provided.

and it appears even the LFDs are conducted under the strict supervision of scientist. The reasons may be lack of irrigation facility, low rainfall distribution, variation in soil fertility, local crop management practices *etc*. problems to get the yield potential of cultivars under demonstrations (Sagar and Chandra, 2004).

The results are in accordance to the findings of Parihar *et al.* (2018) and Kumar *et al.* (2019), according to them the technology gap in chickpea, mung bean and lentil crop was 9.5 to 13.0, 6.62 to 12.40, 5.25 to 10.50 and 3.61 to 4.42 q/ha, respectively.

Table 2: Grain yield and per cent yield increase of pulse crops under FLDs.

Year/ season	Area of demo.	No. of demo.	Variety (s)	Potential yield (q/ha)	Demo. yield (q/ha)	FP yield (q/ha)	% yield increase over FP
Chickpea (*Rabi*)							
2011-12	10	13	RSG-888	25.0	17.35	13.49	28.61
2011-12	10	12	RSG-963	22.0	17.28	13.35	29.43
2014-15	12.5	25	GNG-1581	24.0	21.38	17.79	20.17
2015-16	16	47	GNG-1581	24.0	16.50	13.30	24.06
2016-17	20	40	GNG-1581	24.0	17.89	15.00	19.27
2017-18	50	125	RSG-974	23.0	14.24	12.26	16.15
2018-19	40	70	GNG-1958	26.8	19.31	15.24	26.71
2019-20	20	50	GNG-1581	24.0	20.19	15.65	29.01
Total	178.5	382	Average	24.1	18.02	14.51	24.18
Mung bean (*Kharif*)							
2011	12	30	RMG-62	10.0	9.33	7.27	28.33
2013	10	20	SML-668	14.0	11.25	8.7	29.31
2014	10	20	SML-668	14.0	11.16	9.27	20.39
2015	5	10	GM-4	14.0	7.50	6.19	21.16
2016	10	25	SML-668	14.0	10.32	9.33	10.61
2017	10	20	GM-4	14.0	6.14	5.41	13.49
2017	7.6	19	Satya	14.0	6.00	5.39	11.32
2018	30	75	GAM-5	15.0	6.43	5.57	15.44
2019	10	25	GAM-5	15.0	7.12	5.64	26.24
Total	104.6	244	Average	13.78	8.36	6.97	19.59
Moth bean (*Kharif*)							
2013	5	10	RMO-435	7.0	5.93	4.36	36.00
2014	5	10	RMO-435	7.0	5.05	4.18	20.81
2016	22	73	RMO-257	8.0	6.45	4.77	35.22
2017	11.2	28	CZM-2	7.0	4.37	3.63	20.39
2018	30	70	RMO-435	7.0	5.25	4.08	28.68
2019	20	50	RMO-435	7.0	5.15	3.99	29.07
Total	93.2	241	Average	7.17	5.37	4.17	28.36

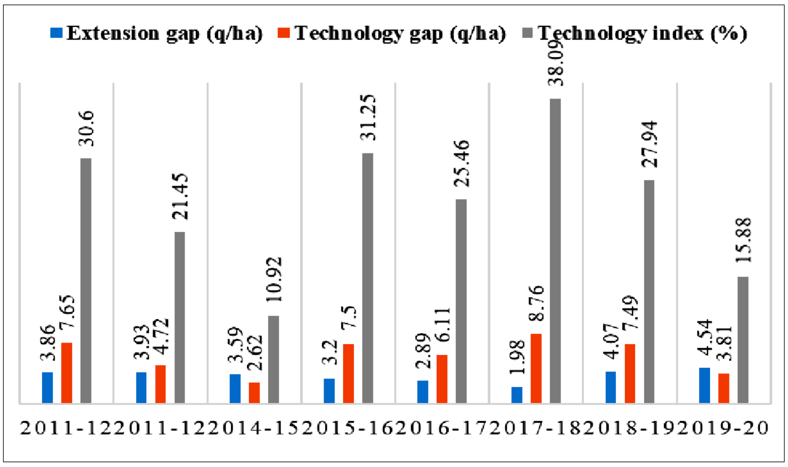

Fig 1: Extension gap, technology gap and technology index of chickpea crop.

Technology index (%)

Similarly, the per cent technology index of chickpea, mung bean and moth bean ranged from 10.92 to 38.09%, 6.70 to 57.14% and 15.29 to 37.57%, respectively (Fig 1,2,3). Per cent technology index represents technology gap and is the result of poor transfer of improved technology among farmers. Higher technology index for two varieties of mung bean crop during 2017 may be due to poor extension services or non-transferring of proven technology to the farmers.

The hypothesis proposed by Ram *et al.* (2014) and Dayanand *et al.* (2014) are in conformity with the present findings. According to them, the technology index of chickpea and urdbean crop was 25.20 % and 50.33%.

Table 3: Economic analysis of different pulse crops under front line demonstrations.

Year/ season	Variety	Cost of cultivation (₹/ha)		Gross return (₹/ha)		Net return (₹/ha)		Benefit cost ratio	
		Demo	FP	Demo	FP	Demo	FP	Demo	FP
Chickpea (*Rabi*)									
2011-12	RSG-888	11,108	8,872	32,880	25,551	21,772	16,679	1:2.96	1:2.88
2011-12	RSG-963	11,002	8,823	32,677	25,145	21,675	16,322	1:2.97	1:2.85
2014-15	GNG-1581	23,740	22,100	36,124	27,712	12,384	5,612	1:1.52	1:1.25
2015-16	GNG-1581	24,500	22,250	57,750	46,550	33,250	24,300	1:2.36	1:2.09
2016-17	GNG-1581	24,800	23,600	71,560	60,000	46,760	36,400	1:2.89	1:2.54
2017-18	RSG-974	25,500	24,600	62,656	53,944	37,156	29,344	1:2.50	1:2.20
2018-19	GNG-1958	27,853	26,000	89,212	70,409	58,829	41,964	1:3.20	1:2.71
2019-20	GNG-1581	26,545	25,495	98,426	76,294	71,881	50,799	1:3.71	1:2.99
Mung bean (*Kharif*)									
2011	RMG-62	9,196	7,412	22,991	16,307	13,795	8,895	1:2.50	1:2.20
2013	SML-668	14,550	13,700	43,400	28,800	28,850	15,100	1:2.98	1:2.10
2014	SML-668	15,560	14,650	61,444	49,313	45,884	34,663	1:3.95	1:3.37
2015	GM-4	15,700	14,800	48,050	37,815	32,350	23,015	1:3.06	1:2.56
2016	SML-668	18,462	17,615	53,922	48,749	35,460	31,134	1:2.92	1:2.77
2017	GM-4	13,250	12,900	34,231	30,161	20,981	17,261	1:2.58	1:2.34
2017	Satya	13,250	12,900	33,450	30,049	20,200	17,149	1:2.52	1:2.33
2018	GAM-5	18,575	16,725	44,849	38,851	26,274	22,126	1:2.41	1:2.32
2019	GAM-5	19,675	17,750	50,196	39,762	30,521	22,012	1:2.55	1:2.24
Moth bean (*Kharif*)									
2013	RMO-435	12,750	12,200	22,831	16,786	10,081	4,586	1:1.79	1:1.38
2014	RMO-435	15,200	14,220	20,200	16,720	5,000	2,500	1:1.33	1:1.18
2016	RMO-257	14,710	12,900	29,025	21,465	14,315	8,565	1:1.97	1:1.66
2017	CZM-2	10,900	10,000	22,069	18,332	11,169	8,332	1:2.02	1:1.83
2018	RMO-435	14,250	12,850	27,300	21,216	13,050	8,366	1:1.92	1:1.65
2019	RMO-435	15,775	13,650	28,325	21,945	12,550	8,295	1:1.80	1:1.61

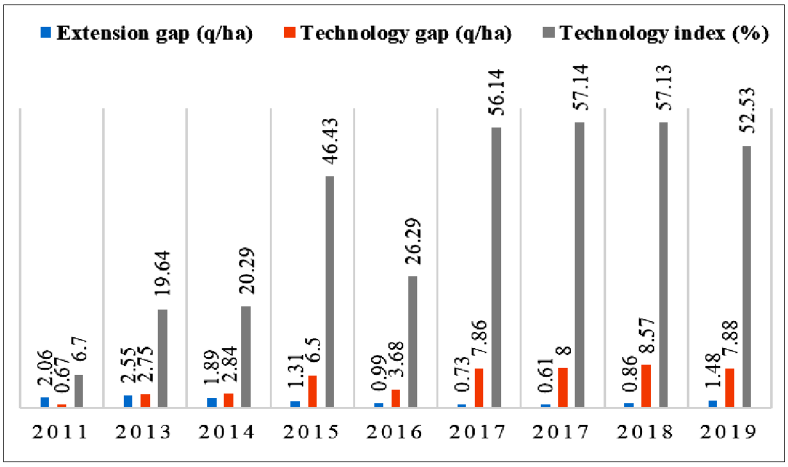

Fig 2: Extension gap, technology gap and technology index of mung bean crop.

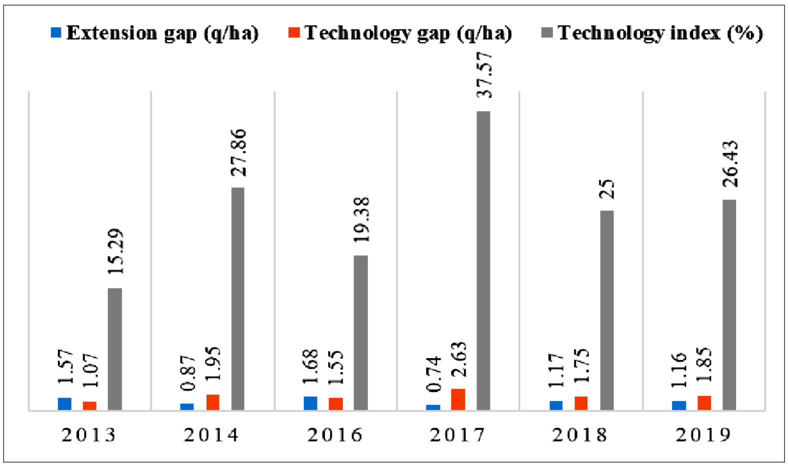

Fig 3: Extension gap, technology gap and technology index of moth bean crop.

Monetary return analysis of frontline demonstrations

The highest gross return (₹98,426 ha^{-1}) and net return (₹ 71,881 ha^{-1}) under demonstrations was in chickpea variety GNG-1581 over the farmers practices (Table 3). Similarly, in mung bean (var. SML-668) and moth bean (var. RMO-257), the same was ₹ 61,444 and ₹ 45,884 ha^{-1} and ₹ 29,025 and ₹ 14,315 ha^{-1}, respectively. The benefit cost ratio was also highest (1:3.71) in chickpea variety GNG-1581 in demonstration plots as compared to farmer's practices (1:2.99). Similar trend was also observed in mung bean crop, in which the benefit cost ratio was 1:3.95 as compared to farmer's practices (1:3.37). However, in moth bean crop, the highest benefit cost ratio (1:2.02) was in variety CZM-2. Result data are the supportive evidences of improved interventions/ technologies under demonstrations practices. Farmers can adopt the demonstrated technology to improve his monetary returns from their fields and leads to improve socio economic status and livelihood under the unpredictable drought conditions of the district.

Increasing in monetary returns and benefit cost ratio in pulses crops have been also reported by earlier workers (Ram *et al.*, 2014; Dayanand *et al.*, 2014; Lathwal, 2010). Similarly, demonstrations of improved technologies at farmer's field proven best to a great extent in enhancing the production and productivity of chickpea crop (Singh *et al.*, 2017; Tomar, 2010).

CONCLUSION

The severe to moderate drought conditions have been noticed frequently in western regions of Rajasthan. Even though up to 35% yield increase of pulses crops over farmer's practices are witnessed of creating confidence and friendly relationships between farm scientists and village community. In Nagaur district of Rajasthan, the production and productivity of pulses was quite low earlier. Now, National Food Security Mission a government initiative tried to bridges a connection to enhance the same due to popularization of improved technologies at farmer's field. But, there is still a wide gap between potential and demo yield which needs more extension service among farming community for better crop production, productivity and net monetary returns of pulses with more emphasis.

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