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Impact of Low-Cost Dryland Interventions on Productivity of Oilseed Crops in Shiwalik Region of North-Western Himalayas

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ABSTRACT: The present study in the Shiwalik region of North-Western Himalayas revealed the status of organic carbon, N, P and K in soils and highlighted importance of soil test based application of the nutrients. The cultivation of the drought tolerant varieties of oilseeds with improved crop management practices resulted in 33.8% (sesame), 41.4% (raya) and 54.7% (taramira) additional yield of the crops under rainfed conditions compared to farmers' practices. The sowing of the oilseeds with seed drill in the drylands also gave 30.1% (raya) and 43.8% (taramira) additional seed yield over farmers' practice (broadcasting method). The setting up of the custom hiring centre for the agricultural machinery also improved the operational and economic efficiency of the farm operations and reduced the human labour. Hence, from the present study, it was concluded that adoption of low-cost interventions by small and marginal farmers can improve the crop productivity, increase the economic returns and enable them to cope with the weather aberrations in dryland regions.

Key words: Dryland, farm mechanization, frontline demonstrations, net returns, soil health

Introduction

In India, dryland ecosystems cover 83 mha of the area; contribute about 40% of the total food grain production and support two-thirds of the livestock population (CRIDA, 2011; Chander *et al.,* 2019). The greatest potential to increase the yield is in rainfed areas and management of water is the key to such increases. Shivalik region is sandwiched between Himalayas and Indo-Gangetic plains and lies in the states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Uttar Pradesh and union territory of Chandigarh at an elevation ranging from 217 to 2332 m above MSL and locally known as Kandi region (Yadav *et al*., 2015). The Kandi region of Punjab has been declared as backward area by Punjab Government because most of the population in the area depends on agriculture or work as agricultural labourers. The average size of land holdings is very small and fragmented (1-2 ha) (Bala, 2014). The area receives average annual rainfall of 800-1500 mm with a very high coefficient of variation. The agriculture in the region is mostly rain dependent and declining trend in the *kharif* rainfall over the years has been reported by Sharma *et al*., (2017).

Oilseeds have significant contribution in Indian agriculture and are second largest agricultural commodity in India after cereals. The productivity of oilseed crops is very low, because the majority of the oilseeds are cultivated under rainfed ecosystem (70%) having low soil fertility. The area under oilseeds is declining due to their relative lower profitability against competing crops like maize, cotton, chickpea etc. (Government of India, 2018). The lack of location specific improved agronomic practices such as high yielding varieties, nutrient management, weed management irrigation management, etc. are also responsible for the low productivity of oilseed crops in India. The extent of adoption of improved agricultural technologies is a crucial aspect under innovation diffusion process and important for enhancing agricultural production. The gap between recommendations made by the scientists and actual adoption by farmers is frequently encountered. The main objective of the frontline demonstration is to demonstrate newly released crop production and protection technologies and its management practices in the farmers' fields.

Hence, the present investigation was undertaken to demonstrate and transfer improved production technologies through frontline demonstrations in oilseeds under rainfed systems with the objectives of enhancing productivity and reducing yield gaps for sustainable production in lower Shiwalik (*Kandi*) region of North-western Himalayas.

Materials and Methods

The present study was conducted in Hoshiarpur district of Punjab, located at 31° 31′N latitude and 75° 55′ E longitude with an average elevation of 296 m above MSL. In district Hoshiarpur, villages namely Achalpur and Nainwan, block Garshankar, were selected as a typical rainfed ecosystem of Kandi region. The study area receives about 1100 mm of annual rainfall, 80% of it is received during two and half months of the South-West monsoon period (July-September). Early withdrawal of monsoon is common in this region, resulting in severe drought during the later part of *kharif* season. It also affects the stand establishment of the subsequent *rabi* crop as upper soil layer dries up by the sowing time. Sometimes, it becomes impossible to sow a *rabi* crop on residual moisture due to inadequate soil moisture in the seed zone (Sharma *et al*, 2014). The mean monthly minimum and maximum air temperature range from 5.2 to 25.0 and 19.3 to 38.5 °C during the year with their respective plateau in the month of January and May, respectively. The major soil type is silt loam (silty clay loam). The soils are generally non-saline (0.05-0.23 dS/m), neutral to slightly alkaline in reaction (pH 7.5-8.2), low in organic carbon (0.16-0.37%) and available N, low to medium in available P and medium in available K. Cation exchange capacity and calcium carbonate equivalent vary from 4.8 to 10.3 Cmol/kg and 2.6 to 5.6%, respectively (Kumar *et al*., 2019).

Improved varieties of sesame (*Sesamum indicum*), Raya (*Brassica juncea*) and taramira (*Eruca sativa*) were demonstrated on the farmers' field and compared with the varieties being grown by the farmers (Table 1). The other interventions were fertilizer application and weeding/hoeing after 3 weeks of sowing. The crop management practices as recommended by Punjab Agricultural University were followed (Table 1). Farm mechanization was promoted by the establishment of the custom hiring centre under the NICRA scheme in the selected villages. Mechanized sowing with seed drills was evaluated during the year 2012-2016 in the fields of farmers. One-way analysis of variance (ANOVA) of the data collected on improved and farmers' practice was done and a least significant difference (LSD) was computed using Fisher's method to statistically compare the difference between mean yields of improved and farmers' practice.

Table 1: Details of interventions under FLD and farmers' practices

S. No.	Technology	Farmers Practice	Improved practices
1.	Variety	Local/unknown variety	Sesame: Punjab Til No. 2, RT 346 Raya: RLC 1, RLM 619 & PBR 97 Taramira: TMLC 2
2.	Spacing	Broadcasting of seed	Spacing was 30 cm between rows and 10-15 cm between plants in the row.
3.	Seed Rate	5.0 - 6.0 kg/ha	Sesame: 2.5 kg/ha Raya & Taramira: 3.75 kg/ha
4.	Fertilizer application	No fertilizer application	Sesame: 52.5 kg N/ha as basal dose Raya: 37.5 kg N and 20 kg P_2O_5/ha as basal application Taramira: 30 kg N/ha as basal application
5.	Crop production and protection	All other crop management practices as per the package of practices for *kharif* crops & *rabi* crops by Punjab Agricultural University, Ludhiana were followed for raising the crops.	

Results and Discussion

The demonstrations on improved dryland crop management practices gave an average yield of 348 kg/ha, 940 kg/ha and 612 kg/ha compared to 260 kg/ha, 680 kg/ha and 402 kg/ha as farmers' practices, (Table 2), respectively for sesame, raya and taramira with an average increase of 33.8%, 41.4% and 54.7% for the respective crop. The average net returns with improved practices for sesame were ₹18,266/ha, for raya ₹19,372/ha and for taramira ₹14,679/ha; and net returns varied from ₹ 12,786 to ₹24,133/ha, ₹11,306 to ₹ 27,974/ha and ₹ 7,487 to ₹ 31,233/ha, for the respective crop. The farmers realized additional returns to the tune of ₹ 9,206, ₹9049 and ₹ 8758/ha, respectively for sesame, raya and taramira. From the results it is clear that the improved varieties performed better than the local cultivars of farmers. Similar impact of improved varieties of oilseed crops on yield was also reported by Kumar *et al*. (2014) and Sharma *et al*. (2016). Fertilizer application as basal dose at the time of sowing also resulted in better initial growth, which contributed in terms of higher seed yield. Also, the weeding/hoeing operation after 3 weeks of sowing reduced the crop-weed competition, which helped in better crop growth. These factors combined might have contributed for better yields realized under the FLDs for improved management practices compared to farmers' practice.

Sowing of raya with seed drill gave an average yield of 935 kg/ha and net returns ₹ 19839/ha compared to 730 kg/ha and ₹ 12580/ha with broadcasting method. The average additional returns of ₹7260/ha were also realized with additional cost of cultivation of ₹1800/ha required for hiring of tractor and seed drill. The average increase in yield was 30.1% over broadcasting method (Table 3). In case of taramira, average yield over the years with drill sowing was 602 kg/ha with net returns of ₹14565/ha compared to 420 kg/ha with net returns of ₹6819 from farmers' practice. The additional returns of ₹ 7,746/ha was realized from sowing with seed drill. The sowing with seed-cum-fertilizer drill places the seed in a deeper layer of soil having sufficient moisture, which results in higher seed germination, better crop stand and ultimately higher yield (Sharma *et al*., 2016). Also yield advantage through mechanization was apparently due to

Table 2: Effect of improved crop management practices on yield, economics and water-use efficiency in oilseed crops under rainfed conditions

Year	Yield (kg/ha)		CD (5%)	% increase in yield	RWUE (kg/ha-mm)		Net returns (₹/ha)		Additional returns (₹/ha)
	Improved practices	Farmers' practice			Improved practices	Farmers' practice	Improved practices	Farmers' practice	
Sesame									
2012-13	306	244	45.5	25.4	0.74	0.59	12786	7838	4948
2013-14	300	217	68.7	38.2	0.57	0.41	14482	7376	7106
2014-15	348	264	65.8	31.8	0.72	0.55	18845	8826	10019
2015-16	370	270	84.9	37.0	0.74	0.54	21082	9422	11660
2016-17	416	305	96.8	36.4	0.70	0.51	24133	11840	12293
Mean	348	260	72.3	33.8	0.69	0.52	18266	9060	9206
Raya									
2012-13	957	742	154.6	29.0	6.13	4.76	19492	12102	7390
2013-14	1070	711	204.8	50.5	3.79	2.52	22478	10030	12448
2014-15	735	530	187.9	38.7	1.72	1.23	11306	5316	5990
2015-16	810	550	168.8	47.3	9.1	6.17	15611	6720	8891
2016-17	1130	865	198.7	30.6	6.05	4.64	27974	17399	10575
Mean	940	680	183.0	41.4	5.36	3.86	19372	10313	9059
Taramira									
2012-13	610	360	182.8	69.4	3.91	2.31	9714	1772	7942
2013-14	606	334	126.4	81.4	6.09	3.36	8699	-26	8725
2014-15	450	345	85.4	30.4	1.05	0.93	7487	3287	4200
2015-16	727	430	224.8	69.1	8.17	4.83	31223	13800	17423
2016-17	665	540	98.6	23.2	3.6	2.89	16270	10770	5500
Mean	612	402	143.6	54.7	4.56	2.86	14679	5921	8758

Table 3: Effect of on-farm mechanization (drill sowing) on productivity, economics and water-use efficiency in oilseed crops under rainfed conditions

Year	Yield (kg/ha)		CD (5%)	% increase in yield	RWUE (kg/ha-mm)		Net returns (₹/ha)		Additional returns (₹/ha)
	Sowing with drill	Broad casting			Sowing with drill	Broad casting	Sowing with drill	Broad casting	
Raya									
2012-13	893	607	144.2	47.1	5.73	3.89	19356	9657	9699
2013-14	1040	825	168.4	26.1	3.69	2.92	23296	16082	7214
2014-15	758	600	112.9	26.3	1.77	1.4	12199	6176	6023
2015-16	945	782	118.7	20.8	2.21	1.82	19946	14784	5162
2016-17	1040	835	187.4	24.8	5.59	4.48	24399	16199	8200
Mean	935	730	146.3	30.1	3.80	2.90	19839	12580	7260
Taramira									
2012-13	560	400	108.7	40	3.59	2.57	8114	2994	5120
2013-14	615	425	112.6	44.7	2.18	1.51	10919	4269	6650
2014-15	456	381	142.8	19.5	1.05	0.89	7687	4747	2940
2015-16	675	395	189.7	70.9	7.58	4.43	28073	13075	14998
2016-17	705	500	157.9	41.0	3.80	2.68	18030	9010	9020
Mean	602	420	142.3	43.8	3.64	2.4	14565	6819	7746

uniform spacing and implementation of line sowing (Chander *et al*., 2019).

Mean total annual rainfall during the study period was 1081 mm; with 903.7 mm during *kharif* season (June-September) and remaining during the *rabi* season. Water-use efficiency (WUE) in oilseeds varied between 0.57-0.74 kg/ha-mm in sesame, 1.72-9.1 kg/ha-mm in raya and 1.05-8.17 kg/ha-mm in taramira, in case of the cultivation of improved varieties with an average of 0.69, 5.36 and 4.56 kg/ha-mm for the respective crops. Whereas, in case of sowing with drill, the water use efficiency varied from 1.77-5.73 kg/ha-mm in raya and 1.05-7.58 kg/ha-mm in taramira with an average of 3.80 and 3.64 kg/ha-mm respectively. From the present study, it is evident that the use of improved technologies greatly improved the WUE in oilseed crops over farmers' practices. This can be attributed mainly to improved yields of oilseeds in demonstrations due to adoption of the better crop management practices, resulting in higher WUE with the same amount of water (Chaudhary and Suri, 2014).

Conclusions

It is evident from the present investigation that cultivation of oilseeds with recommended improved practices resulted in higher productivity of oilseeds under rainfed conditions. The farm mechanization also helped in yield enhancement and also realization of higher net returns to the farmers. Hence it is evident from the present study that there is need of the concerted efforts from the extension functionaries of KVKs, SAUs and state departments for better dissemination of the technologies developed by the researchers.

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