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PRODUCTIVITY AND PROFITABILITY OF BARLEY FLDS IN HYPER ARID PARTIALLY IRRIGATED ZONE OF RAJASTHAN

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SUMMARY

Barley (*Hordeum vulgare* L.) is an important nutritious cereal in India with growing demand for malt preparation, brewing and food industries. Over years, declining acreage along with distorted production becomes a major concern in spite of increasing yield. Whereas, feed for livestock invited crop acreage in the case of Madhya Pradesh and Uttar Pradesh. Around 71% perceived that barley is more suitable for cultivation under changing climate scenario owing to its high adaptability. Traditionally, barley is a poor man's cereal in India and its cultivation requires low input with better adaptability to different stresses like drought, salinity and alkalinity, and marginal lands. It has a wide range of utility such as cattle feed, human food and industrial raw material for malting and brewing. Under semi-arid conditions, it is also used for dual purpose *viz.*, green fodder and grain/ straw production from the crop re-growth. Seed is one of the crucial inputs for better farming and its availability and access influence largely the adoption of a variety. Farmers in the study region used mostly their own seed, either higher/ lower seed rate than the recommended (100 kg/ha) and if purchased, it was from seed dealers as they ensure timely availability. Apart from seed replacement rate, dose and source of purchase, time of sowing is more important for targeting better yield. A majority of the barley growers opted for timely/normal sowing and it was highest in Uttar Pradesh, followed by Madhya Pradesh, Haryana and Rajasthan. Interestingly, the association between time of sowing and yield shows that farmers opting for timely sowing harvests more than farmers who are undergoing either late sowing or early sowing. Arid region of Rajasthan is having recurrent drought owing to its harsh and frequent climatic aberrations. Consequently, limit the scope of sustainable crop production and encourage the degradation of natural resources. Therefore, majority of farming community is engaged in subsistence farming due lack of adequate resources and because of poor and instable crop production, socio-economic status of the farmers is very poor. This has necessitated improvement in agricultural production by imposing improved production technologies. Dual purpose barley provides nutrition rich green fodder for the livestock at the time of scarcity and at the same time also provides acceptable quality grain for human consumption. In addition to unfavorable climatic conditions, use of traditional practices is also important factor responsible for low yield. The present study was therefore conducted in Bikaner district of Rajasthan during 2014-15 and 2015-16 to study the impact of improved production technologies on the fodder, seed yield and economics. The data were collected from 52 farmers in 20.8 hectares area. The findings of the study results revealed that improved technology recorded a mean yield of 4100 kg/ha which was 19.65 per cent higher than obtained by farmers practices (3450 kg/ha). The higher net returns (Rs. 56561/ha) and benefit: cost ratio of 2.40 was obtained with improved technologies in comparison to farmer's practices (Rs. 41288 and 1.77).

Key words : Dual purpose barley, fodder, grain yield, front line demonstration, economics

Arid region of Rajasthan is having recurrent drought owing to its harsh and frequent climatic aberrations. Consequently, limit the scope of sustainable crop production and encourage the degradation of natural resources. Therefore, majority of farming community is engaged in subsistence farming due lack of adequate resources and because of poor and instable crop production, socio-economic status of the farmers is very poor. It is grown for several other purposes such as food and processed food products for human being. Barley grain is also valued for smothering and cooling effect on the body for easy digestion and as source of Vitamin B complex. Besides these conventional uses, it is an important industrial crop as it is used as raw material for beer, whisky and brewing industries. The small and marginal farmers of Rajasthan cut the green barley and feed it to farm and milch animals. It is generally grown in water scarcity areas or limited irrigation facilities, as it can tolerate moisture and salt stress (Yadav *et. al.*, 2003). This suggests very much scope for growing barley for better yield in Rajasthan. Growing of barley varieties with wider adaptability and responsive to inputs has opened a new avenue for exploiting higher grain yield potential. Thus identification of high yielding responsive varieties is considered to be the first and most important step for the development of production technology. The yield potentials of barley varieties are realized to the highest extent when they are grown under optimum agro-climatic environment (Singh *et al.*, 2009). Forage production for livestock is limited and costly due to erratic rainfall especially in Rajasthan. Barley is generally grown in areas where irrigation facilities are limited, as it can tolerate moisture and salt stress to a great extant. It possesses high total biomass, thus there has been an increasing interest in exploiting it as a dual purpose cereal which can permit forage production in early season in addition to the grain yield later on. In India, barley was cultivated on 0.66 million ha area during 2018-19 with 1.78 million tonnes of production at an average productivity status of 2693 kg/ha. In Rajasthan, barley was cultivated on 274 thousand hectare area during 2017-18 with 910 thousand tonnes of production at an average productivity status of 3324 kg/ha. In Bikaner district barley was cultivated on 4829 ha area during 2017-18 with 10661 tonnes of production at an average productivity status of 2208 kg/ha. (Anonymous, 2018-19). This suggests an ample scope for growing dual purpose barley for obtaining moderate yield of green fodder as well as grain. Growing of dual purpose barley genotypes having wider adaptability and responsive to inputs has opened a new avenue for exploiting higher green fodder and subsequent grain yield potential. It is grown during the *rabi* season in the northern plains of India, mostly under rainfed or limited irrigation condition on poor to marginal soils. In drier parts of Northern plains (Rajasthan, Madhya Pradesh, Southern Haryana, South West Punjab and Western U.P.) during November to January, farmers can grow dual purpose barley over other forage crops because of its dual utilization and less water requirement (Verma et al. 2007). In these regions, animal husbandry occupies an important role and there is a big gap between demand and supply of forage. Since both the green forage and grain can be utilized for animal fodder/ feed purposes, the crop can be advantageous over oats, because of its dual utilization, faster early growth as well as less water requirement. So barley can provide important nutrition to the livestock through its green fodder and grains harvested from regenerated crop. Considering these facts the front line demonstrations on dual purpose barley in hyper arid partial irrigated zone IC of Rajasthan:- (i) To find out production potential from dual purpose barley in Rajasthan (ii) To evaluate the productivity and economics of dual purpose barley.

MATERIALS AND METHODS

The study was carried out by Krishi Vigyan Kendra, Bikaner-II during 2014-15 to 2015-16 (two consecutive years) at farmers' fields in four blocks of Bikaner district in Rajasthan. During these two years of the study, an area of 20.8 ha was covered under front line demonstration. Before selection of farmers for FLDs, a comprehensive list of all barley growers were prepared. Out of list so prepared 32 in *rabi* 2014-15 and 20 in *rabi* 2015-16 were selected among four blocks (Lunkaransar, Chhatargarh, Khajuwala & Pugal) with the help of randomly sampling methods. During the selection procedure, repetition of farmers was completely avoided. Thus a total 52 farmers were included in the study. Intensive trainings were imparted to the selected farmers regarding different aspects of barley cultivation in each year. The differences between the demonstration package and existing farmers, practices are mentioned in Table 1. In demonstration plots, use of quality's seed of improved dual purpose cultivar (RD-2715), line sowing, seed treatment and timely weed control, as well as recommended dose of fertilizer (120 N kg/ha 40 P kg/ ha and 15 kg Zn (33%) were emphasized. In the demonstration, one control plot was also kept where farmers practices was carried out. All demonstrations were conducted under the supervision of Krishi Vigyan Kendra scientists. All the production and protection technology other than interventions were applied in similar manner in demonstrated as well as in farmers practices. The soil of demonstrations site was sandy loam in texture slightly alkaline in reaction, low in available nitrogen, phosphorus and high in available potassium status. Each demonstration was conducted on an area of 0.4 ha and adjacent plot (0.4 ha) to the demonstration plot was kept for assigning farmers practices. Before conducting FLDs, a list of farmers was prepared from group meeting and specific skill training on importance of dual purpose barley in the arid region of Rajasthan was given to the selected farmers regarding recommended practices of the crop.

TABLE 1
Comparison between demonstration and existing farmers practices of barley cultivation

S. No.	Interventions	Demonstration (Improved practices)	Farmers practices
1.	Farming situation	Irrigated	Irrigated
2.	Variety	RD-2715	Local
3.	Seed treatment	Seed treatment with mancozeb, Carbendazim @ 3 g/kg seed	No seed treatment
4.	Time of sowing	1-30 November	01-30 December
5.	Method of sowing	Line sowing proper crop geometry	Broadcasting
6.	Seed rate	120 kg/ha	150 kg/ha
7.	Fertilizer dose	120 kg N/ha 40 kg P/ha and 15 kg Zn (33%) (Half N before sowing , ¼ after fodder cutting and remaining ¼ after 1st irrigation after cutting	Negligible
8.	Plant protection measures	Need based application	Nil
9.	Weed management	One hand weeding followed by spray of 2,4 D sodium salt 1000 gm/ha 40-45 days after sowing	One hand weeding at 30 days after sowing (DAS)

To popularize the dual purpose barley production. The improved technologies selected for FLDs were dual purpose barley *cultivar.* RD-2715, supplemental irrigation and drill sowing. The other management practices like seed rate, seed treatment, sowing time and methods, time of first fodder cutting, irrigation scheduling, recommended fertilizers dose and plant protection etc. were applied for demonstrations as per the recommendation. The crop was sown in last week of October to second week of November during both the years with the seed rate of 120 kg/ha. So, keeping this in view, demonstrations was conducted to evaluate production potential and economics from the dual purpose cultivar RD-2715 to get maximum yield of fodder and grain. The data for fodder yield, grain yield and grain equivalent yield and economic was recorded, compared with farmer practice and analyzed. Fodder yield of barley was converted into barley grain equivalent yield as computed by multiplying the fodder yield of with their respective per unit price. The calculated total return (Rs./ha) was divided by the price of barley grain and was added to the barley grain yield. The extension yield gap, technology yield gap and technology index were calculated using the formula as suggested by Samui *et al.* (2000).

$$\text{Extension gap (kg/ha)} = \frac{\text{Demonstration yield (kg/ha)}}{\text{Yield of farmers practice (kg/ha)}}$$

$$\text{Technology gap (kg/ha)} = \frac{\text{Potential yield (kg/ha)}}{\text{Demonstration yield (kg/ha)}}$$

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

RESULTS AND DISCUSSION

Impact of improved production technologies on Fodder and grain yield

A comparison of productivity levels between demonstrated varieties and local check is shown in Table 2 and Fig 1. During the period under study, it was observed that in front line demonstration, the improved barley varieties recorded the average higher seed yield (4100 kg/ha) as compared to local check (3450 kg/ha). The percentage increase in yield over local check was 19.65. The data indicated that the FLDs given a good impact on the farming community of Bikaner district as they were motivated by the new agricultural technologies adopted in the demonstrations. Average fodder yield during second year under front line demonstrations was observed as 8000 kg/ha which was higher by 50.94% over the prevailing farmers practice (5300 kg/ha). The results clearly show the positive effects of FLD over the existing practices words enhancing the yield of barley in the study area with its positives effect on yield attributes *viz* plant height in cm, tillers/ear, grain/ear and 1000 grain weight. Higher value of grain yield, yield attributes obtained under demonstration plots might be due to improved varieties and recommended practices and better managements. Similar yield enhancement in different crops in front line demonstration has amply been documented by Jeengar *et al.*(2006), Dhaka *et al.* (2010) and Patel

TABLE 2
Fodder, grain yield and barley equivalent yield of cultivar RD-2715 under demonstration and farmers practice

Year	Variety	No.	Area (ha)	Average Fodder yield (q/ha)		% Increase in fodder yield over	Average Grain yield (kg/ha)		% Increase in grain yield over	Barley grain equivalent yield (kg/ha)		% Increase in barley grain equivalent over FP
				Demo	FP		Demo	FP		Demo	FP	
2014-15	RD-2715	32	12.8	-	-	-	5200	4450	16.85	5200	4450	16.85
2015-16	RD-2715	20	8.0	140	90	55.56	3000	2450	22.45	4667	3531	32.17
Average		52	20.8	80	53	50.94	4100	3450	19.65	5122	4127	24.11

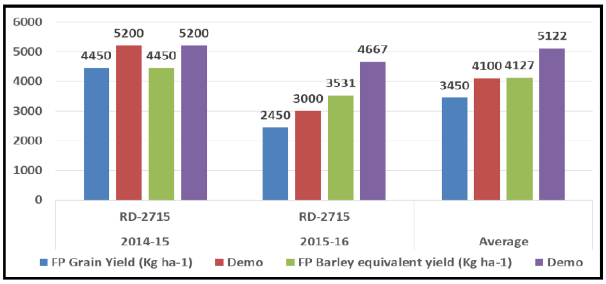

Fig. 1. Grain yield and equivalent yield of barley under demonstration and farmers practice.

et al. (2013). From these results it is evident that the performance of improved variety as found better than the local check under same environment conditions. Farmers were motivated by results of agro technologies applied in the FLDs trials and it is expected that they would adopt these technologies in the coming years.

Extension and technological yield gap and technological index analysis

Data pertaining to extension gap depicted in Table 3 and Fig 2 showed that demonstration plot resulted in highest extension gap. Extension gap ranged from 750 to 1136 kg/ha with average of 995 kg/ha during the period of the study emphasizes the need to educate the farmers through various means *viz*. training programmes, kisan gosthies, distribution of literatures for the wider adoption of improved agricultural production.

The technology gap (Table 3 and Fig 2) shows that the gap in the demonstration yield over the potential yield and it was maximum in the year 2015-16 (1333 kg/ha) and lowest in the year 2014-15 (800 kg/ha). However, overall average technology gap in the study was 878 kg/ha (Table 3). The technological gap obtained may be attributed to dissimilarity in soil fertility status and weather conditions. This shows tremendous scope of increasing crop productivity through adoption of improved production technologies and recommended package of practices with due consideration of agro-climatic condition, soil fertility and other factors.

The technology index (Table 3 and Fig 2) indicates the feasibility of the evolved technology at the farmer's fields. The lower the value of technology index more is the feasibility of the technology. The data (Table-3) showed that technology index value 13.33 % was noticed in the year 2014-15 while in the year 2015-16 the value was 22.22%, whereas the average value of technology index was recorded 14.63%, it may be due to uneven and erratic rainfall and weather conditions of the area. Lower difference in technological index due to improved varieties coupled with seed treatment compared to farmer's practice exhibits almost similar feasibility of adoption of both improved. Technology index shows the

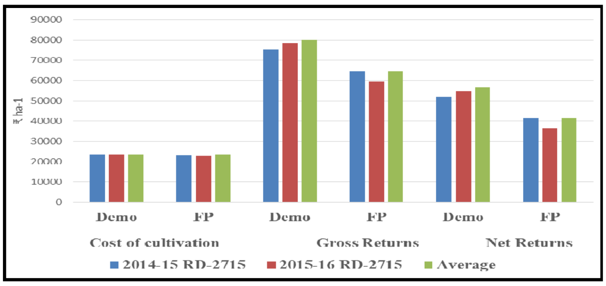

Fig. 2. Economics of barley demonstrations

TABLE 3
Yield gap analysis in the barley grain equivalent productivity under front line demonstrations and farmers practice

Year	Variety	Technology Yield Gap (kg/ha)	Extension Yield Gap (kg/ha)	Technology Index (%)	Potential Yield (kg/ha)
2014-15	RD-2715	800	750	13.33	6000
2015-16	RD-2715	1333	1136	22.22	6000
Average	878	995	14.63	6000	

TABLE 4
Total cost of cultivation, Gross returns & Net returns (Rs./ha) and benefit cost ratio of barley grain equivalent yield

Year	Variety	Demonstration				Farmers practice				Additional	Additional	Rs. per
		Gross	Gross	Net	B : C	Gross	Gross	Net	B : C			
2014-15	RD-2715	23596	75400	51804	2.20	23100	64525	41425	1.79	496	10379	3.20
2015-16	RD-2715	23600	78406	54806	2.32	22950	59321	36371	1.58	650	18435	3.32
	Average	23598	80159	56561	2.40	23300	64588	41288	1.77	298	15274	3.40

feasibility of improved technology at the farmer's field. The lower the value of the technology index more is the feasibility of technology (Jeengar *et al*. 2006).These findings are similar to the findings of Sharma and Sharma (2004) and Patel *et al.* (2013).

Economics of demonstration

The economic analysis ((Table 4) indicated that net returns, benefit: cost ratio and economic efficiency were also markedly influenced by improved production technologies as compared to farmer's practice. Highest average net returns (Rs. 56561), benefit: cost ratio (2.40) and additional return (Rs. 15274) was observed with demonstrations plot as compare to farmers practice where net returns (Rs. 41288) with low benefit: cost ratio (1.77) recorded. This could be ascribed to the high yield potential of varieties and effect of favorable growth environment. Similar findings were also reported by Sharma and Sharma (2014), Rao *et al* (2011) and Patel *et al.* (2013).

CONCLUSION

The findings of the study revealed that wide gap existed in potential and demonstration yield in high yielding barley varieties due to technology and extension gap in arid zone. By conducting front line demonstrations proven technologies, yield potential of barley can be increased to a great extent. This will substantially increase the income as well as the livelihoods of the farming community. The study emphasizes that the needs to educate the farmers in adoption of improved technology to narrow the extension gap through various technology transfer center. Therefore it is suggested that these factors may be taken for consideration to increase the scientific temperament of the farmers.

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