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RESEARCH ARTICLE

Berseem seed and fodder production for Punjab's dairy sector- A comparative economic analysis

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Abstract: The current study examines the on-farm profitability of berseem seed and fodder production in Indian Punjab from an innovative informal strategy for building a village-based forage seed enterprise for berseem (*Trifolium alexandrinum*). A comparative economic analysis of berseem seed, fodder, and wheat production in *rabi* season, 2019-20 found that berseem (as seed and fodder) was more profitable than wheat. Thus, there is a need to shift some area to berseem, particularly its seed production, which will not only help dairy producers increase their income but will also provide nutritious fodder for milch animals to reach their full potential. Quality seed production of improved varieties of berseem will also address the issue of recommended high-yielding varieties being unavailable during the peak sowing season. Berseem seed disposal patterns suggested that practically all seed produced by farmers was sold in the same year (without any certification) due to its high demand. Around 90% of growers reported that the primary challenge they faced during the production and marketing of berseem seed was high price volatility and losses during cleaning and grading, followed by an insufficient supply of high-quality seed (85%), a lack of an appropriate marketing channel (80%), and an inadequate price for the produce (80%). The primary challenge for berseem fodder growers was high labour costs (28%). Creating awareness among farmers/livestock keepers/policymakers about new berseem varieties, providing incentives, and ensuring a market for seed production will all contribute to increasing demand for quality fodder and, thus, seed production of berseem. The government should stabilize input and output prices, which can contribute significantly to sustaining higher productivity and the livelihoods of Punjab's dairy farmers, resulting in more effective rural development and poverty reduction.

Keywords: Berseem seed, cultivation, dairy, fodder, returns, wheat

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Introduction

Dairy farming has been an indispensable activity throughout the history of human civilization. It is not only economically significant but also nutritionally significant as a source of alternative food for the world's ever-growing population. Nutritious feed is critical for milch animals to reach their full potential. Among all fodder crops, berseem is the most effective at increasing milk production in lactating animals and crossbred cattle. The cost of feeding milch animals can be reduced by using berseem in place of mineral concentrate (Kumar et al. 2021; Akila and Lakshmi, 2020). An all-berseem ration is adequate for milch animals yielding up to 6-7 litres of milk daily (PAU, 2021). Berseem is the highly beneficial winter forage crop in India, which is known as 'King of Fodders' due to its highest tonnage capacity with no toxic effects. It is the most palatable fodder, due to its succulence and high nutritious value for livestock. Being a leguminous crop, berseem fodder has higher protein content than non-leguminous fodders.

Though it is not possible to easily increase the area under fodder crops, various steps can be taken to enhance their productivity and hence, production. Out of different inputs, the cultivation of fodder crops for the production of seed particularly the quality seed by replacing the area with other crops can play an important role to increase the fodder production in the country. Seed yield in forage crops is generally low due to more vegetative growth as well as reduced seed setting. Lack of quality seed availability results in less fodder production which affects livestock

production. In developing countries, fodder production has many folds restricted by land dearth, the inadequacy of standard seed (Tufail et al.2019), and unawareness about fodder production technology and usage (Kamanzi and Mapiye, 2012).

In India, small farmers follow a mixed crop-livestock farming system which constitutes the major part of agricultural productivity. The livestock sector plays a fundamental role in the Indian economy by employing about nine percent of the population (Bhardwaj et al. 2020). The timely availability of seed to the farmers helps in timely sowing and realization of its full potential as fodder (Canbolat et al. 2006) and thus enhancing the income from dairying. With an attainable seed yield of (0.4 t/ha) and the seed multiplication ratio (SMR) of 20, only 6.4 percent of the total seed requirements of berseem can be met at the national level. During 2015-16, 10,375 MT berseem seed was imported to fill the gap in production and demand (Chauhan et al. 2017). Among the forage crops, berseem seed import is highest with 0.03-0.04 percent share of total imports into India which turns out to be around 20 million US dollars. To reduce the loss to the exchequer in the form of foreign exchange, there is a need to reduce the seed import from abroad. Thus, suitable technological and appropriate action points are needed to increase berseem seed production. Because of its high-yielding nature, huge demand for berseem seed exists in the market. During the peak sowing period, there is a shortage of berseem seed in the market, and farmers are obliged to buy unrecommended low-yielding varieties.

Punjab state is among the leading states producing berseem with wheat being the main competing *rabi* season crop. The state has about one-fourth of the total area of fodder crops and livestock contributes approximately forty percent (40%) to the annual income of small farmers. The current livestock population of the state is 81.2 lakh (62.4 lakh adult) with a fodder supply of 31.4 kg per animal per day which is far from satisfactory. Based on 40 kg green fodder per adult animal per day, approximately 911 lakh tonnes of fodder is required (PAU, 2021). In this backdrop, the present study was carried out to study the comparative cost of production of Berseem seed and wheat crop to study the share of different inputs involved along with measures to promote berseem seed production in the state.

Materials and Methods

The present study was conducted in the Punjab state during the year 2019-20. A widely distributed and representative sample was drawn by using multistage sampling technique with selection of district at the first stage (Ludhiana and Gurdaspur), followed by selection of one block from each selected district at the second stage (Dehlon from Ludhiana and Dina Nagar from Gurdaspur district), villages at third stage and farmers at the fourth stage of sampling. A sample of 80 berseem fodder-cum-wheat growers (40 from each district) was randomly selected without replacement representing different farm size categories to study the economics of berseem fodder and wheat cultivation (Table 1). In addition, to study the economics of berseem seed production, 20 berseem seed producers were also taken from the selected districts as very few farmers follow the practice of fodder seed production. From the selected 20 seed growers, 17 were large (>10 ha) and medium farmers (4-10 ha); three respondents were small farmers (1-2 ha) and none was from the semi-medium and marginal farm size category. Thus, for comparative economic analysis of berseem fodder, berseem seed and wheat crop cultivation, a total of 100 respondents were selected for the study.

The data were collected by personal interview method on a well-structured and pre-tested survey schedules regarding different inputs used, returns obtained, seed marketing pattern and problems faced by the growers. To study the trend in the area under fodder crops especially berseem, the time series secondary data on the area under fodder crops in Punjab was also taken from the Department of Animal Husbandry, Punjab. The compound annual growth rates (CAGRs) of total cropped area, the area under fodder crops, and area under berseem crop were estimated for Punjab for the five periods viz. Period I: 1981-1990, Period II: 1991-2000, Period III: 2001- 2010, Period IV: 2011-2019, and Period V: 1981-2019. The growth model adopted is as under:

$$Y_t = AB^t$$

Where,

Y_t = Total cropped area/area under fodder crops/area under berseem crop for the year 't'.

t = Time variable (1,2…, n) for each period.

A = Constant

Log transformation of the above function is:

Table 1 Sampling design of berseem seed, berseem fodder, and wheat growers in Punjab

(No. of farmers)

Particulars	Farm size category					Total
	Marginal (<1ha)	Small (1-2 ha)	Semi-medium (2-4 ha)	Medium (4-10 ha)	Large (>10 ha)	
Berseem fodder and wheat growers	12	19	26	19	4	80
Berseem seed producers	0	3	5	5	7	20
Total	12	22	31	24	11	100

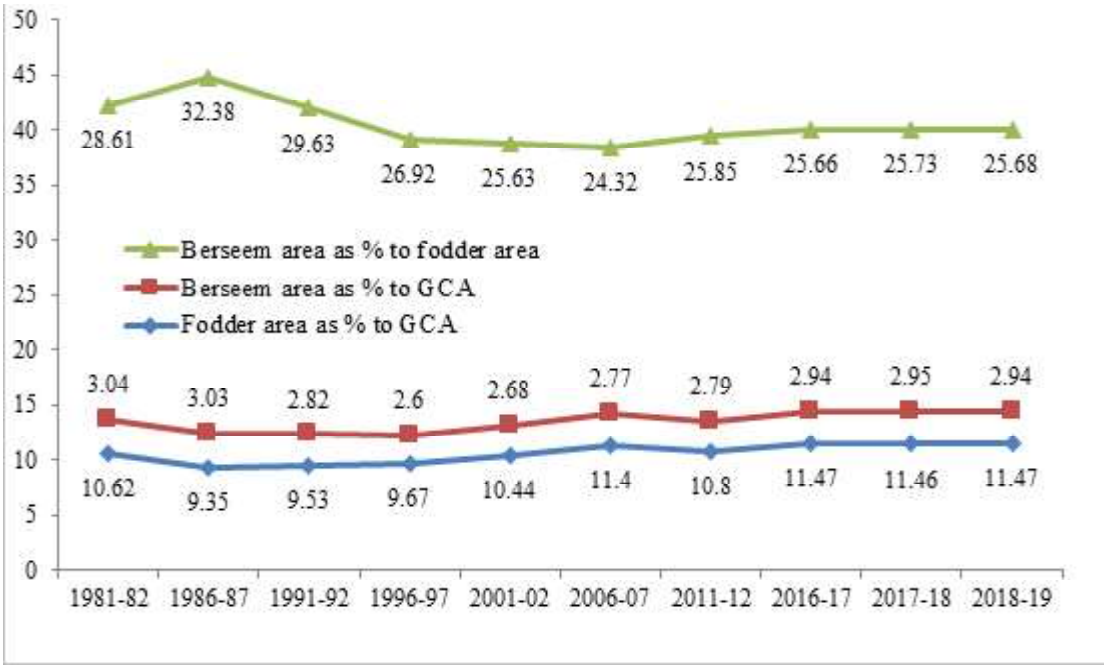


Fig. 1 Trends in area under fodder crops in Punjab

$\ln Y_t = \ln A + t (\ln B)$.

Where,

$\ln B = \ln (1+r)$, and

$r = [\text{antilog} (\ln B) - 1]$

CAGR (%) $= [\text{antilog} (\ln B) - 1] \times 100$

The student's t-test was used to test the significance of CGRs.

Results and Discussion

Berseem is one of the major *rabi* forage crops in Punjab state and occupies the maximum area among forage crops during the winter season. Though the area under different fodder crops increased from 10.62 percent of total cropped area (TCA) in 1981-82 to 11.47 percent in 2018-19, the percent share of berseem in the TCA decreased from 3.04 to 2.94 during this period, according to the analysis (Figure 1). Despite its benefits to animal nutrition, berseem's percentage in total fodder fell from 28.61 to 25.68 percent, owing to a rise in the area under key cereal crops such as rice and wheat. Another major factor was the extensive mechanization of state agriculture, which resulted in a significant decrease in the number of draught animals. Due to the introduction of high yielding quality cultivars, the area under berseem crop as a percentage of TCA increased somewhat in 1986-87 but then began to decline. The compound annual growth rates (CAGRs) of TCA and area under fodder crops were calculated to be 0.34 and 0.60 percent, respectively, from 1981-82 to 2018-19, but the area under berseem crop grew at a negligible rate (Table 2). The CAGR of the berseem crop was highest from 1981-82 to 1990-91, after which it began to decline. Thus, from 1981-82 to 2018-19, the area under berseem crop stayed nearly constant. TCA, fodder crop area, and berseem crop area all increased, although not in the same way. Due to insufficient area

Table 2 Growth in area under total crops, fodder crops and berseem crop in Punjab

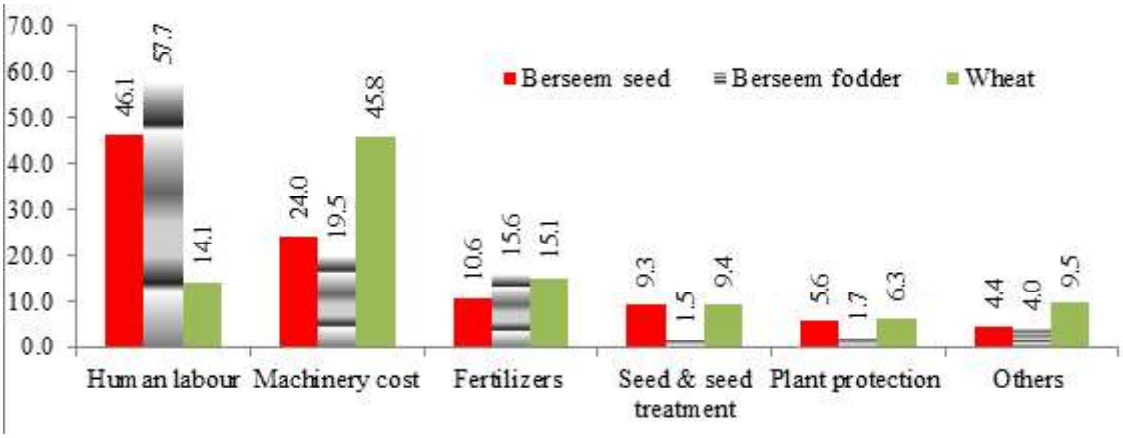
Period	Total cropped area		Area under total fodder crops		Area under berseem crop	
	CAGR	R^2	CAGR	R^2	CAGR	R^2
1981-82 to 1990-91	1.01***	0.97**	0.55NS	0.04NS	2.06*	0.27NS
1991-92 to 2000-01	0.64^{***}	0.94^{**}	-0.04^{NS}	0.001^{NS}	-1.56^{NS}	0.62^{**}
2001-02 to 2010-11	-0.04^{NS}	0.03^{NS}	-0.269^{NS}	0.01^{NS}	0.02^{NS}	0.001^{NS}
2011-12 to 2018-19	-0.11^{NS}	0.60^{**}	0.82^{***}	0.98^{NS}	0.87^{***}	0.91^{**}
1981-82 to 2018-19	0.34^{***}	0.70^{**}	0.60^{***}	0.48^{**}	0.04^{NS}	0.004^{NS}

Source: Department of Animal Husbandry, Punjab

***, ** and * Significant at 1, 5 and 10percent level of significance; NS: Non-significant

CAGR: Compound annual growth rate (percent per annum)

Fig 2 Percent share of different inputs in total variable costs



Note: Others include cost of irrigation, marketing, transportation etc.

Table 3 General characteristics of the selected respondents

Category	Berseem fodder and wheat growers (n=80)	% to total	Berseem seed producers (n=20)	% to total
		Age (Years)		
Up to 40	29	36.25	3	15.00
40-50	36	45.00	10	50.00
>50	15	18.75	7	35.00
Total	80	100.00	20	100.00
		Education level		
Illiterate	6	7.50	-	-
Up to middle	11	13.75	-	-
Matric	34	42.50	2	10.00
10+2	17	21.25	11	55.00
Graduate	12	15.00	4	20.00
Postgraduate	-	-	3	15.00
Total	80	100.00	20	100.00

under fodder crops, there is a demand-supply mismatch for fodder. As a result, there is a pressing need to expand the area under fodder and berseem crops.

General information about the respondents

According to the survey, 50 percent of the berseem seed growers were between the ages of 40 and 50, with 35 percent being over 50 and the remaining 15 percent being the age of up to 40 years (Table 3). Similarly, the majority of berseem fodder and wheat growers, 45.00 percent, were in the age category of 40 to 50 years, with about 36 percent belonging to a younger age group of up to 40 years, and about 19 percent belonging to a considerably older age group of more than 50 years. The level of education aids farmers in gaining more understanding about farming operations to make their vocation more profitable. The majority of seed growers (55%) had completed secondary school education, with the remaining 35 percent having completed a bachelor's degree or higher. This suggests that, as a result of their education, the respondents were well aware of the importance of high-quality seed and its advantages. On the other hand, roughly 43 percent of berseem fodder and wheat growers were matriculated, 21 percent had completed 10+2, 13.75 percent were in the middle class, 15 percent were graduates, and only 7.50 percent were illiterate.

The average size of total operational holding for the selected berseem seed growers was 6.01 hectares, of which about 67 percent was owned, some of the farmers took rental land for cultivation in addition to owned operational land (46%), and about 13 percent of the seed growers had leased out their land. The average operational holding of berseem fodder/wheat producers was 3.92 hectares, with the majority of the farmers having owned land (68.98%), followed by leased in (43.27%) and leased out (12.35%) holdings (Table 4). Wheat occupied the majority of the cropped area for both berseem seed (29.28%) and fodder growers (34.44%) during the *rabi* season, and the area under berseem seed and fodder production was 12.36 and 5.95percent, respectively (Table 5). This happened as the farmers that opted for berseem seed production were mostly large farms.

Comparative economics of berseem (seed and fodder) and wheat cultivation

It's crucial to examine the relative cost-return structures of berseem seed, berseem fodder, and wheat production. The results of the analysis of various components of the operational cost of berseem cultivation for seed and fodder production as well as wheat crop production are presented in Table 6 and Figure 2. The total operational costs per hectare for the berseem seed crop was Rs. 51312. Human labour, at Rs. 23649 (46.1%), occupied the largest share of the operational costs for seed production in the current study, followed by machinery costs at Rs. 12298. (24%). Apart from these expenditures, fertilizer, which includes urea, DAP, SSP, MOP, and potassium nitrate, had an 11 percent share. Some berseem seed growers used phosphorus in the form of DAP, while others used SSP. Along with phosphorus, SSP fertilizer contains about 12-14 percent sulphur, which is beneficial to the berseem crop. Farmers were observed to be applying 7.38 kg of potassium nitrate per hectare after the last cut of berseem fodder to increase berseem seed production. The cost of seed and seed treatment was Rs.4595 (9.3%), whereas the cost of plant protection measures was Rs.2880 (5.6%). Farmers in Punjab applied just approximately 8 irrigations to berseem seed crop due to ample rain in the year 2019-20, and farmers bore the expense of irrigation of Rs. 1075, which accounted for only 2.1 percent of total variable cost. Irrigation costs included maintenance costs, owing to the fact electricity supply is free to the farm sector in the state. The total variable expenses for berseem fodder production came out to Rs. 33733 per hectare. Because of the enormous labour involved in taking several cuttings for feeding the livestock, human labour had a substantial part of roughly 58 percent (Rs. 19458/ha) among the various inputs. Another significant factor was the usage of machinery, which accounted for Rs 6580 (19.5%), followed by fertilizers (15.6%), plant protection (1.7%), irrigation (1.6%), and seed & seed treatment (1.5%).

In the case of wheat, the total operational costs per hectare were around Rs. 33723. Among the various components of operational costs, machinery costs accounted for the greatest proportion, at Rs. 17105 (45.8 percent), due to mechanical harvesting and threshing. The cost of human labour was Rs. 5250, accounting for approximately 14 percent of total variable costs. Apart from these costs, fertilizer accounted for around 15 percent of the total, followed by seed and seed treatment (9%), and plant protection measures (6.3%). Farmers bore a cost of Rs. 1430 for ten irrigations to the wheat crop, accounting for only 3.8 percent of total variable costs. Marketing costs associated with unloading and cleaning, as well as transportation, accounted for 3.3 percent of total variable costs. From the analysis berseem seed production was found to be highly profitable on Punjab farms, with gross returns of Rs. 177080 per hectare from the production of roughly 5.4 quintals of seed (Rs 86,000) and 700 quintals of fodder as a byproduct (Rs. 91000). Berseem seed and fodder produced returns of Rs. 142300 per hectare which includes Rs. 128700 from fodder production and Rs. 13600 from seed produced as a byproduct. On the other hand, the gross returns earned from the cultivation of wheat crop came out Rs. 115453 from grains and wheat straw, which were much lower than those from berseem seed and fodder (Table 7). The berseem seed production has higher variable costs (Rs. 51312/ha) than berseem fodder production (Rs. 33733/ha) and wheat (Rs. 37338/ha). However, it yields higher returns over variable costs (Rs. 125688/ha) than berseem fodder (Rs. 108577/ha) and wheat (Rs. 78115/ha). This points towards the profitability of berseem seed production in comparison to its competing berseem fodder crop and wheat crop during the *rabi* season. The benefit-cost ratios for berseem seed, berseem fodder, and wheat were calculated to be 3.4, 4.2, and 3.1, respectively, implying a modest increase in net revenue for berseem seed growers relative to wheat producers. As a result, some *rabi* crops area especially wheat crop area must be shifted to berseem seed production to increase farm profitability and meet the state's demand for high-quality berseem seed.

Table 4 Size of operational holding of the sampled respondents in Punjab (ha/farm)

Particulars	Berseem fodder-cum-wheat growers	Berseem seed producers
Owned land	2.70	4.03
Leased in land	1.70	2.78
Leased out land	0.48	0.80
Total operational holding	3.92	6.01

Note: Figures in parentheses indicate percentages to the total operational holding of the respective category

Table 5 Area under berseem crop at the sampled farms in Punjab

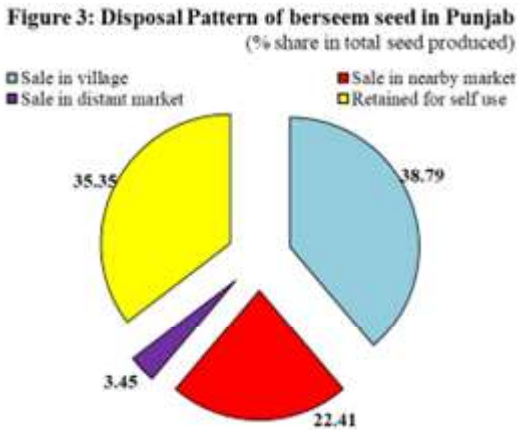
Respondents	Area (ha/farm)		% Share in total cropped area	
	Berseem	Wheat	Berseem	Wheat
Berseem fodder growers	0.45(95.69)	2.57	5.95	34.44
Berseem seed producers	1.46(100.0)	3.46	12.36	29.28

Figures in the parentheses indicate the percent share of the berseem crop in total *rabi* fodders

Table 6 Comparative cost of cultivation of berseem (seed and fodder) and wheat in Punjab (Per ha)

Sr. No.	Inputs	Berseem				Wheat	
		Seed		Fodder			
		Quantity	Value (Rs)	Quantity	Value (Rs)	Quantity	Value (Rs)
1	Seed & seed treatment						
	Seed (kg)	25	4595	30.6	483	100	3250
	Chlorpyriphos 20 EC (ml)	-	-	-	-	400	120
	Raxil Easy (ml)	-	-	-	-	32.5	155
	Rhizobium (Packet)	2.5	100	0.7	28	-	-
	Bavistin (gm)	70	75	-	-	-	-
	Subtotal	-	4770	-	510	-	3525
2	Fertilizers (kg)						
	Urea	143.4	850	4.7	1288	225	1335
	DAP	138.8	3330	73.9	438	137.5	3300
	Superphosphate	62.7	470	144.1	3338	-	-
	Muriate of potash	15.6	283	19.6	148	50	1000
	Potassium Nitrate	7.4	518	44.2	40	-	-
	Subtotal	-	5450	-	5250	-	5635
3	Plant protection		2880	-	585	-	2335
4	Irrigations (No.)	7.5	1075	3.8	536	10	1430
5	Human labour (hours)	364	23649	389	19458	105	5250
6	Machinery cost						
	Tractor (hours)	18.3	12298	10.7	6580	15	8355
	Combine harvester & straw reaper	-	-	-	-	-	8750
	Subtotal	-	12298	-	-	-	17105
7	Marketing & transportation charges	-	62	-	62	-	1236
8	Interest on variable costs @9% p.a. for half the crop period	-	1129	-	742	-	822
9	Total variable costs (1 to 8)	-	51312	-	33723	-	37338

Unlike berseem seed, wheat has assured marketing in the state at a minimum support price. Therefore, the disposal pattern for berseem seed produced by respondents was examined (Figure 3). The sample respondents produced a total of 232 quintals of berseem seed. Out of this, 90 quintals (38.97%) were sold directly to seed consumers, such as fellow farmers and relatives, while 80 quintals (35.35%) were retained for farmers' own use. The remaining 52 quintals (22.41%) were sold to seed dealers and distributors. Additionally, eight quintals (3%) were sold in distant marketplaces in neighboring states. Due to the great demand for seed, practically all of the seed produced by farmers was sold in the same year.



Issues confronting berseem seed farmers

Various difficulties were encountered by seed growers throughout the production and marketing of berseem seed (Figure 4). The severity of challenges encountered by farmers varies according to producer and variety. The most frequent issue

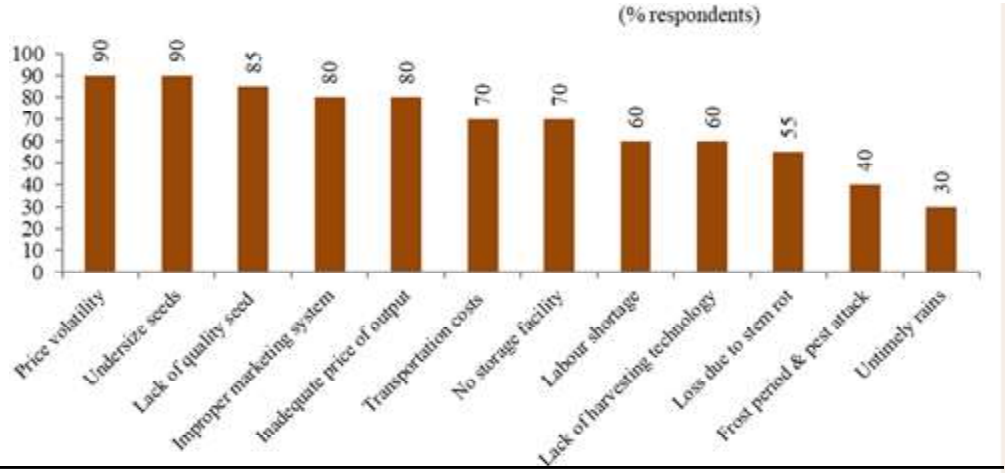


Fig. 4 Issues confronting berseem seed farmers (% respondents)

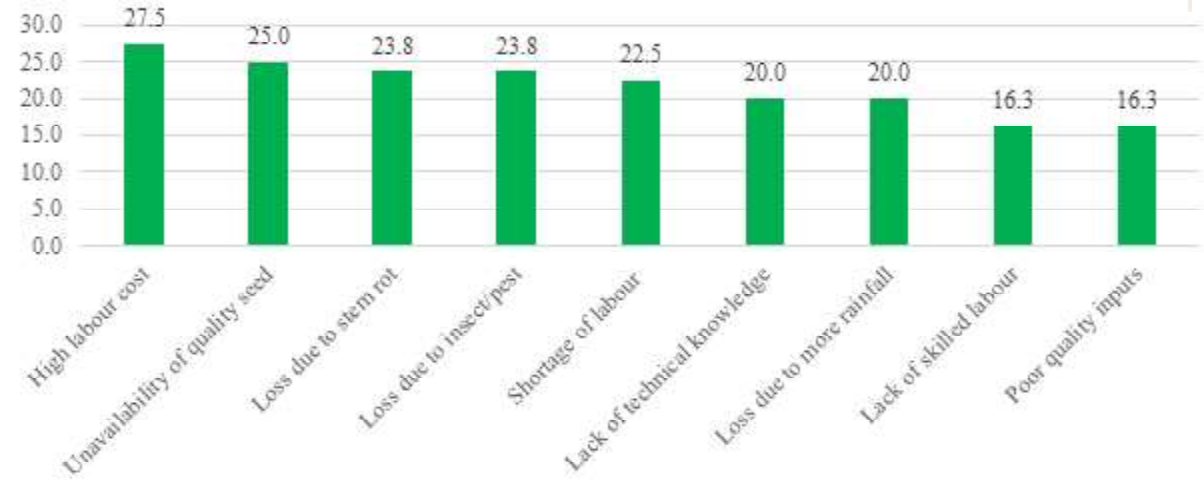


Fig. 5 Problems faced by the berseem fodder growers (% respondents)

Table 7 Returns from the cultivation of berseem (fodder and seed) and wheat in Punjab (Per ha)

Particulars	Berseem				Wheat	
	Seed Quantity	Value (Rs)	Fodder Quantity	Value (Rs)	Quantity	Value (Rs)
Main Product (q)	5.38 (seed)	86080	990 (fodder)	128700	53.75 (grain)	103469
By Product (q)	700 (fodder)	91000	0.85 (seed)	13600	36.88 (straw)	11984
Gross returns	-	177080	-	142300	-	115453
Returns over variable costs	-	125688		108577		78115
B:C ratio	3.4	4.2	3.1			

encountered by over 90 percent of producers was high price volatility throughout the marketing of berseem seed, which rendered growers unable to forecast the actual price of the output (Figure 4). Almost 10-15 kg of seed is wasted during cleaning and grading in the form of broken seeds, undersized seeds, and so on, and approximately 90 percent of respondents experienced this issue. According to about 85 percent of respondents, the supply of high-quality seed was insufficient in comparison to the demand in Punjab.Apart from these concerns, almost 80 percent of respondents reported a lack of an adequate marketing channel. Another 80 percent of respondents reported having difficulty in pricing their produce because the BL 1 and BL 10 varieties are identical in size, shape, and colour, making differentiation impossible. While BL 10 have more price than BL 1, its producers received the same price as BL 1's producer. Additionally, farmers faced challenges such as high transportation costs and a lack of storage space (70% each); labour shortages during peak harvesting periods and a lack of appropriate technology for seed harvesting (60% each); stem rot disease loss (55%); frost and insect/pest damage (40% each); and heavy rainfall (30%).

Problems reported by the berseem fodder growers

The state's berseem fodder growers face a variety of problems, as presented in Figure 5. Around 28 percent of berseem fodder growers expressed concern about high labour expenses associated with berseem fodder growing and selling. Berseem fodder production is extremely susceptible to frost damage and is especially vulnerable to stem rot disease and insect/pest assault during February and March. As a result, adequate technical advice is required throughout the production period. Around 24 percent of farmers have run into this difficulty. Additionally, growers faced labour shortages during peak harvesting periods (22.50%), crop loss due to increased rainfall (20%), lack of high-quality seed (18.75%), lack of skilled labour (16.25%), and lack of high-quality inputs such as pesticides, fertilizers, and so on (16.25%).

Conclusions and policy implications

Berseem and wheat are two competitive crops grown in the state during the rabi season. Berseem is in high demand in the state due to the large consumption of dairy products and the multiple benefits it provides to dairy animals. Berseem cultivation in the form of seed and fodder is more profitable than wheat production. Considering the cattle population, demand for nutritious and high-quality fodder has been increasing and will continue to do so. Village-based fodder seed bank concept can also be introduced through the establishment of fodder seed villages/ farmers, fodder seed producer organizations/groups with facilities for seed processing and storage (Ghosh and Mahanta, 2016).Farmers should be educated by extension professionals on scientific methods of agricultural production technology, such as the use of the optimal seed rate, certified seed, sowing time, and crop care, to increase crop productivity. The government should stabilize input and output prices, which might be critical in sustaining increased productivity and livelihoods for Punjab's dairy farmers, resulting in more effective rural development and poverty reduction. Some important policy implications of berseem seed production are as under:

- Some area must be shifted to berseem cultivation, particularly seed production. This will not only increase income for berseem growers and dairy producers but will also provide nutritious fodder for milch animals to reach their maximum potential.

- Quality seed production of improved varieties of berseem will also address the issue of unavailability of high-yielding recommended varieties during the peak sowing season.

- The price of berseem seed shows high volatility in the market. The farmers can take the advantage of high prices during the sowing season by selling the seed at the time of sowing.

- There are no producer incentives or minimum support prices for the production of fodder crops or their seed. Educating farmers/livestock keepers/policy makers about improved high-yielding and nutritious varieties of forage crops, providing incentives, and ensuring a market for seed/fodder production would all significantly contribute to the rising demand for high-quality fodder and, consequently, seed production of forage crops.

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