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Impact of berseem (*Trifolium alexandrinum*) cultivation on productivity of subsequent crops in wheat-rice system

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Abstract

The field survey was conducted to evaluate the impact of berseem (*Trifolium alexandrinum*) cultivation on productivity of subsequent crops in wheat-rice cropping system. One hundred and twenty farmers were interviewed through random selection procedure in agro-ecological zone of Gujranwala during Rabi 2013-14. In berseem-rice-wheat cropping system, the yield of rice and wheat crop was increased by 11% and 8%. However the input cost of these crops was decreased by 5% and 3% respectively due to nitrogen fixation that reduced the weed population in subsequent crops. Similarly, net return per hectare for rice and wheat increased by 35% and 31% respectively than wheat-rice-wheat cropping system. Benefit cost ratios of rice and wheat was recorded 1.88 and 1.63 for berseem-rice-wheat system while it was 1.62 and 1.47 respectively for wheat-rice-wheat cropping system.

Keywords: Berseem, Wheat, Rice, Fertility, Economic, Gujranwala.

Introduction

Berseem (King of Rabi fodder) gives 4-6 cutting yielding from 40-50 tha^{-1} contains calcium and other vitamins which increase milk production (Ali, 2012). Berseem belongs to leguminoseae family that fix atmospheric nitrogen and converts it to useable part of plant. This fixed nitrogen is not only used by berseem but also by succeeding crops resultantly shows positive effects on subsequent crops. The yield of rice and succeeding crops cultivated after legumenous crop is higher than other crops (Singh, 1997 and Prasad *et al*. 2011). Legume crops increase 0.9% organic matter, 0.12% nitrogen, 2.8 ppm available phosphorus, 52 ppm available potassium, reduce pH of soil up to 0.4 and increase 0.5% organic carbon after its harvest compared to rice wheat cropping system (Ali *et al*. 2012). The major cropping system of Punjab is rice-wheat-rice which is adopted by 94% farmers and covers approximately 1.5 million hectares (Amir and Aslam, 1992).This cropping system is highly nutrient consuming, causing deficiency of many macro and micro nutrients and its continuously adaptation lowers soil fertility (Zia *et al*. 1997). According to the principles of crop rotation a restorative crop must be included in an exhaustive system so that fertility level

of soil maintained and organic matter may be added to soil. In this regard the introduction of green manuring and leguminous crop in the existing rice-wheat-rice cropping system can improve the soil fertility and crop productivity on sustainable basis (Ali *et al*. 2012). So the inclusion of berseem in rice-wheat cropping system fulfill fodder requirement and increase in yield of succeeding crops, improve soil fertility, increase water holding capacity, reduce nitrogenous fertilizer requirement, reduction in weed population in wheat crop (Singh *et al*. 1997). Therefore the present survey was conducted to evaluate the performance of rice and wheat cultivation after berseem in comparison with rice and wheat sown after wheat crop.

Materials and Methods

The field survey was conducted by Adaptive Research Farm, Gujranwala during 2013-14 to evaluate the impact of berseem (*Trifolium alexandrinum*) cultivation on productivity of subsequent crops in wheat-rice cropping system. Due to jurisdiction of the organization, division Gujranwala was selected for conducting research study. Six tehsils of Gujranwala division namely Gujranwala, Kamoki, Daska, Sialkot, Hafizabad and Badomalhi were randomly selected. The following crop calendar was observed in wheat-rice cropping system of agro-ecological zone of Gujranwala (Table 1).

Table 1: Crop calendar in wheat-rice cropping system

Month	Crop
October-April	Berseem
June-September	Rice (coarse)
Late May-October	Rice (fine)
November-April	Wheat

The data was collected by purposively selecting twenty farmers from each tehsil in which half farmers were growing berseem as fodder and fertility purpose, thus making a total sample of one hundred and twenty farmers. A well designed and pre-tested questionnaire was used to collect information from the selected respondents. It contained questions related to farmers about their area under wheat, rice and berseem during the year 2013 and 2014, inputs used (fertilizer, pesticides etc.), grain yield, fodder yield and income etc. Economic ratios like net return and Benefit Cost Ratio (BCR) were calculated to find out the most viable and profitable way.

Results and Discussion

The results showed that maximum numbers of farmers (47.9%) fall in category of medium farmers (having 5-12 acres) followed by large farmers (41.1%) having the land more than 12 acres. While 11.1 percent farmers were small farmers. Fine rice varieties grown in the agro-ecological zone of Gujranwala were Super Basmati, Basmati-515 and Pakistan selection-2 (PS-2) while PK-386, Supri and Super Fine were recorded as coarse varieties. The mean yield of rice crop was found 118 and 130 mound ha^{-1} in wheat-rice-wheat and berseem-rice-wheat crop rotation respectively. Support price of wheat was consider as Rs. 1200 $mound^{-1}$ (Anonymous, 2013) while average rice output price was recorded as Rs. 1593 $mound^{-1}$ (Table 2).

Table 2: Discriptin of rice varieties in wheat-rice cropping system of Gujranwala zone

Cropping system		Fine varieties				Coarse varieties				**Mean of coarse and fine varieties**
		Super Basmati	Basmati-515	PS-2	**Mean**	PK-386	Supri	Super Fine	**Mean**	
Wheat-rice-wheat	Yield (Mound/ha)	95	100	118	**104**	130	138	124	**131**	**118**
Berseem-rice-wheat		103	109	128	**113**	145	157	136	**146**	**130**
	Price (Rs./mound)	1899	1843	1847	**1863**	1387	1313	1267	**1322**	**1593**

The yield of rice crop was increased by 10.53% when sown after berseem compared to the rice sown after wheat. The higher yield (4.83 t ha^{-1}) of rice was recorded in berseem-rice-wheat (B-R-W) rotation in comparison to the yield (4.37 t ha^{-1}) of rice crop sown after wheat (W-R-W). The increase in yield of rice crop might be due to the addition of nitrogen in the soil as fixed by the nitrogen fixing bacteria and addition of organic matter in soil. Similar results were recorded by Parsad *et al.* 2011 and Anwar *et al.* 2010 who reported that legumes had direct benefit of nitrogen fixation through root nodules to enhance soil fertility which could be used by companion as well as subsequent crop. On the other hand wheat-rice-wheat (W-R-W) is common rotation of Gujranwala zone that gave less yield of rice crop. The reason behind this reduction of yield of rice might be due to the exhaustiveness of soil and lowering of soil fertility. Similar results were reported by Ali *et al*. 2012. From table 3 the cost of inputs in rice cultivated after wheat was Rs. 115800 ha^{-1} where as it was Rs. 110500 ha^{-1} in rice sown after berseem. This reduction in inputs requirement was due to nitrogen fixation by berseem which reduced the weed population in subsequent crops due to which the dose of nitrogenous fertilizer is supplemented by fixed nitrogen thus cost of production was reduced. The income of rice in berseem-rice-wheat rotation was Rs. 207743 ha^{-1} compared to Rs. 187958 ha^{-1} in wheat-rice-wheat rotation claiming 10.5% extra income. Net return ha^{-1} for rice in berseem-rice-wheat system was 35% more than wheat-rice-wheat system.

Table 3: Economic impact of berseem cultivation on Rice crop

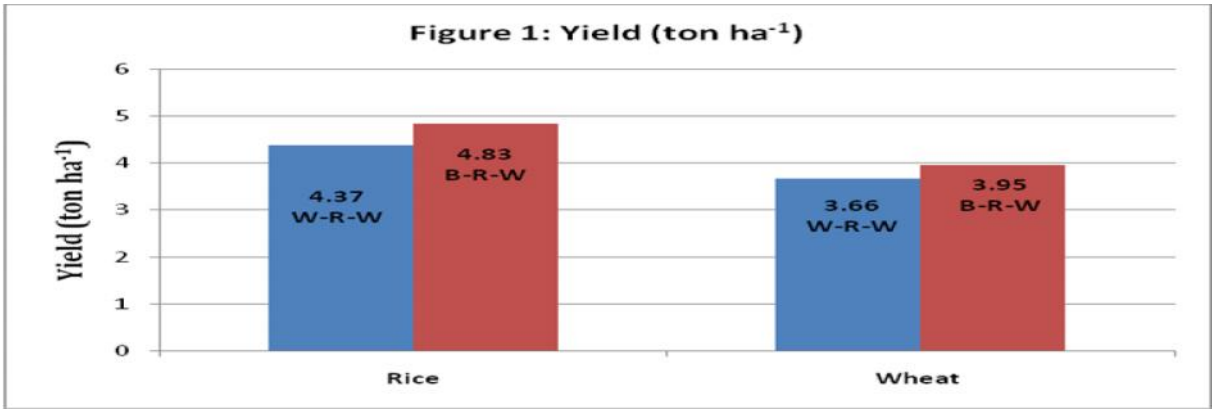
Crop/cropping system	Rice					
	Yield (ton ha^{-1})	Percent increase	Gross Income (Rs.)	Cost of production/ input cost	Net return ha^{-1}	% change in net return ha^{-1}
Wheat-rice-wheat	4.37	-	187958	115800	72158	-
Berseem-rice-wheat	4.83	10.53	207743	110500	97243	35

From table 4 the yield of wheat crop sown after berseem and rice was 3.95 tha^{-1} while the yield of wheat was 3.66 t ha^{-1} when grown after rice (wheat-rice-wheat) showed 7.92% increase in yield. The reason of this increase might be due to residual effects of nitrogen, fixed by berseem on subsequent crops. Similar results were recorded by Ahmad *et al*. 2001. The cost of inputs of wheat sown in wheat-rice-wheat rotation was Rs. 80700 ha^{-1} compared to Rs. 78500 ha^{-1} in berseem-rice-wheat rotation. This reduction might be due to less usage of weedicides because weeds germinated in berseem were cut off along with fodder crop, so that there was less need of herbicide application. Similarly crop required less nitrogenous fertilizer when sown after berseem. These results were in agreement with Singh *et al*. 1997 who reported that inclusion of legumes in multiple cropping systems offered many advantages to farmers. The income of wheat in berseem-rice-wheat rotation was Rs.127980 ha^{-1} compared to Rs. 118584 ha^{-1} in wheat-rice-wheat rotation claiming 7.92% more income. Net return ha^{-1} for wheat in berseem-rice-wheat system was 31% more than wheat-rice-wheat system.

Table 4: Economic impact of berseem cultivation on Wheat crop

Crop/cropping system	Wheat					
	Yield (ton ha^{-1})	Percent increase	Gross Income (Rs.)	Cost of production/ input cost	Net return ha^{-1}	% change in net return ha^{-1}
Wheat-rice-wheat	3.66	-	118584	80700	37884	-
Berseem-rice-wheat	3.95	7.92	127980	78500	49480	31

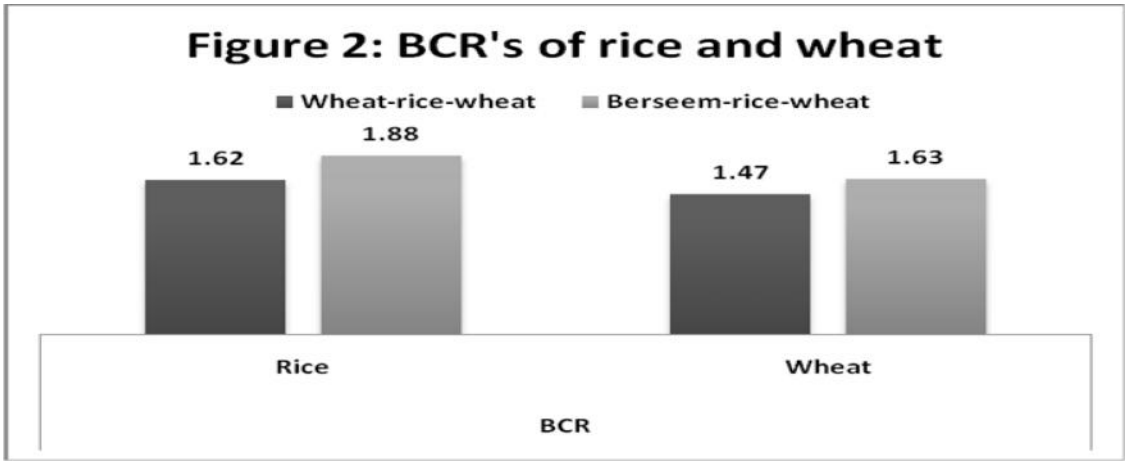
Figure 1 showed that the yield comparison between rice and wheat in wheat-rice-wheat and berseem-rice-wheat cropping system.



In berseem-rice-wheat system, benefit cost ratio s of both rice and wheat recorded (1.88 and 1.63) was more than rice and wheat (1.62 and 1.47) for wheat-rice-wheat cropping system respectively (Table 5 and Figure 2).

Table 5: Economic comparison

Crop/cropping system	BCR	
	Rice	Wheat
Wheat-rice-wheat	1.62	1.47
Berseem-rice-wheat	1.88	1.63



Conclusion

It is concluded that inclusion of berseem in the existing cropping pattern i.e. berseem-rice-wheat was beneficial in term of nitrogen fixation, reduction in inputs requirement, productivity enhancement and net income. So berseem-rice-wheat crop rotation is most profitable than wheat-rice-wheat in Gujranwala zone.

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