

ECONOMIC COMPARISON OF DIFFERENT CROPPING SYSTEMS IN AGRO-ECOLOGICAL CONDITIONS OF GUJRANWALA ZONE

Falak Sher, Adnan Bashir, Muzzammil Hussain, Mirza Muhammad Qadeer Baig* and Muhammad Anjum Ali**

ABSTRACT

A field trial was conducted at Adaptive Research Farm, Gujranwala, Pakistan during the year 2010-12 to check the most profitable cropping pattern for Gujranwala zone. The study comprised four cropping systems viz. rice-wheat-rice-wheat, rice-green manuring-rice-wheat, rice-berseem-rice-wheat and rice-canola-rice-wheat. Layout system was RCBD with three replications. Plot size was kept as 15m x 21m. Rice crop (cv. Super Basmati) was transplanted on 26th July, 2010 and 13th July, 2011 while wheat, berseem and canola were sown soon after rice harvesting on November 12, 2010. During 2011 wheat (cv. Seher-2006) was sown on November 10 after rice harvesting on 2nd November. Maximum yield of rice (4.20 t/ha) was obtained in rice-green manuring-rice-wheat cropping pattern due to addition of organic matter which showed positive effects on rice yield and succeeding crop. The highest net return (Rs.315643/ha) was recorded in rice-berseem-rice-wheat cropping pattern followed by rice-green manuring-rice-wheat (Rs. 283441 ha). It was noted that green manuring crop did not contribute to the income. The cost of cultivation was minimum in case of rice-green manuring-rice-wheat cropping pattern (Rs. 83325/ha) followed by rice-berseem-rice-wheat system (Rs. 95175/ha). Maximum benefit cost ratio (3.32) was also recorded in rice-berseem-rice-wheat cropping system. So the rice-berseem-rice-wheat was found as the most profitable cropping system for Gujranwala zone.

KEYWORDS: *Triticum aestivum*; *Oryza sativa*; *Trifolium alexandrinum*; canola; cropping pattern; green manuring; agro-ecological conditions; cost benefit analysis; Gujranwala; Pakistan.

INTRODUCTION

A cropping system is an approach to help farmer in decision making to remain sustainable in an ever-changing agricultural environment. Cropping system may be mono-cropping or multiple cropping. Mono-cropping system

*Adaptive Research Farm, Gujranwala, **Director General Agriculture (Ext. & AR), Punjab, Lahore, Pakistan.

means raising of just one crop year after year, while in case of multiple cropping system two or more than two crops are sown on the same piece of land in a year. The cropping system adopted by the farmer must be physically viable, sustainable, less exhaustive acceptable to farming community and most important thing is that it should be economical.

The significant changes in cropping systems may be induced due to the relative prices rather than productivity (15, 16). An intensive cropping system should be highly productive, profitable and also could maintain soil fertility (4). The problems of price fluctuation, environmental pollution due to excessive use of pesticides and fertilizer and unemployment may be alleviated by changing of cropping system (5). Similarly the risk of low profitability, pest attack and risks of aberrant weather may be reduced by introducing new crops in cropping system (9). Most of the cropping systems adopted by farmers are exhaustive and deteriorate the soil fertility. This soil fertility deterioration leads to low productivity and ultimately lowers the income. In this regard the cropping system should be restorative. The inclusion of crops like oilseeds, vegetables, fodder especially legume fodder (berseem, lucern, etc.) and pulses will improve the economic conditions of small and marginal farmers (13). Rotation of high value crops especially legumes are very popular among people as these are beneficial to soil fertility and cereals productivity (1.12). Legumes improve soil health by fixing atmospheric nitrogen and may partially supplement the use of inorganic fertilizer (10).

The present study was conducted to find out the most profitable cropping system for the farmers in agro-ecological zone of Gujranwala.

MATERIALS AND METHODS

This study was carried out at Adaptive Research Farm, Gujranwala, Pakistan during 2010-2012. Four different cropping systems i.e. rice-wheat-rice-wheat (T_1), rice-green manuring-rice-wheat (T_2), rice-berseem-rice-wheat (T_3) and rice-canola-rice-wheat (T_4) were evaluated in RCBD with three replications as detailed below:-

Cropping systems	Summer 2010	Winter 2010-11	Summer 2011	Winter 2011-12
T_1	Rice	Wheat	Rice	Wheat
T_2	Rice	Green manuring	Rice	Wheat
T_3	Rice	Berseem	Rice	Wheat
T_4	Rice	Canola	Rice	Wheat

The plot size was kept as 15m x 21m. Rice variety Super Basmati was transplanted on 26th July 2010 and 13th July 2011 in 1st and 3rd seasons,

respectively. During 2010 wheat, berseem and canola crops were sown soon after rice harvesting on 12th November according to different cropping systems. Jantar crop was sown on 20th April 2011 for green manuring which was incorporated in the soil on July, 2011 before puddling for rice transplantation. Wheat crop (cv. Sehar-2006) was sown on 10th November, 2011 after rice harvesting on 2nd November, 2011 and harvested on 26th April 2012. Recommended fertilizer and irrigations to each crop were applied at appropriate time. All crops were raised following recommended package of production technology. The gross benefits for each cropping pattern were calculated by multiplying the market price of the produce with crop yield while net benefits for each cropping pattern were calculated by subtracting the total variable cost from gross benefits. The benefit cost ratio for each cropping system was calculated by dividing net return with cost of production.

RESULTS AND DISCUSSION

Crops yield

The results (Table 1) showed that the highest rice grain yield (4.20 t/ha) was obtained from T₂ where green manuring was done. It was followed by T₃ (3.61 t/ha) where berseem (legumes crop) was sown. Rice crop sown after wheat and canola produced less yield i.e. 3.35 and 3.32 tons per hectare, respectively (Table 1).

Table 1. Yield of crops in comparison with rice grain yield (t/ha) obtained under different cropping systems.

Treatments	1 st season (Summer, 2010)	2 nd season (Winter, 2010-11)	3 rd season (Summer, 2011)	4 th season (Winter, 2011-12)
T ₁	Rice 3.38	Wheat 2.83	Rice 3.35	Wheat 3.04
T ₂	" 3.37	Green manuring	" 4.20	" 3.31
T ₃	" 3.33	Berseem	" 3.61	" 3.21
T ₄	" 3.35	Canola 0.42	" 3.32	" 3.10

The increase in rice yield in green manuring treatment (T₂) could be due to increase in organic matter, addition of crop essential nutrients in soil especially nitrogen and improvement in water holding capacity of soil. Similarly in T₃ where rice was sown after berseem, yield was higher than T₁ and T₄. This is due to fixing of nitrogen in the soil by nitrogen fixing bacteria. Hegde (6) also reported that inclusion of legume crops in rice based cropping system increased the production of rice crop. Prasad *et al.* (8) and Anwar *et al.* (3) reported that legumes have direct benefit of nitrogen fixation through root nodules and enhance soil fertility which could be used for companion as well as subsequent crops.

The highest wheat grain yield (3.31 t/ha) was also received from green manured treatment (T_2) followed by T_3 (3.21 t) where berseem crop was sown before rice. Minimum wheat yield (3.04 t/ha) was noted in T_1 . The increase in wheat grain yield might be due to green manuring and nitrogen fixation by berseem crop. These results agree to those of Akhtar *et al.* (2). Prasad *et al.* (8) also observed that green manuring has good effects on grain yield of rice and succeeding crops.

Gross returns

The data (Fig. 1) showed that T_3 (rice-berseem-rice-wheat) gave maximum gross return (Rs.410818/ha). The reason is that berseem crop gave maximum income as compared to other treatments. It was followed by T_1 (rice-wheat-rice-wheat) (Rs.382816) and this cropping system is dominant in the area due to the reason that both crops have good sale value in the market. In T_2 (rice-green manuring-rice-wheat) gross return was slightly more than T_4 because of increase in the production of succeeding crops after green manuring. Minimum gross return (Rs.336875) was noted in T_4 (rice-canola-rice-wheat) due to less production and price of canola crop.

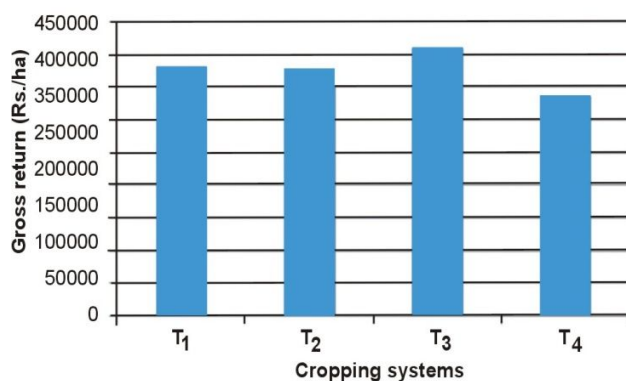


Fig. 1. Gross return of different cropping systems.

Cost of cultivation

Maximum cost of cultivation (Rs.99375/ha) was noted in T_1 which is the most dominant cropping system of the area (Fig. 2). Both rice and wheat crops need more inputs and management practices than crops of other cropping systems. Minimum cost of cultivation (Rs.83325/ha) was involved in T_2 because green manuring crop needed minimum inputs. Moreover, fertilizer requirements of succeeding crops reduced due to green manuring.

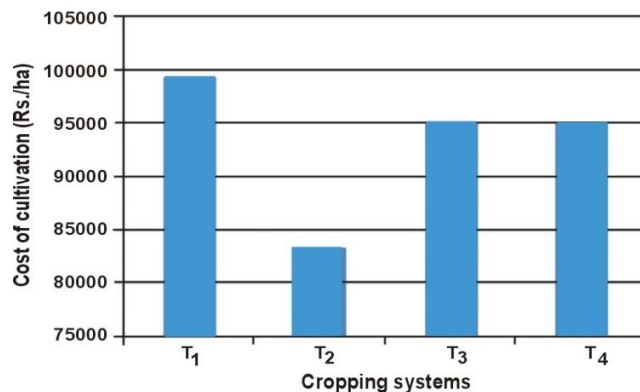


Fig. 2. Cost of cultivation of different cropping systems.

Net return

Maximum net return (Rs 315643/ha) was obtained in rice-berseem-rice-wheat (T₃) cropping system (Fig. 3). Higher net return in this treatment is due

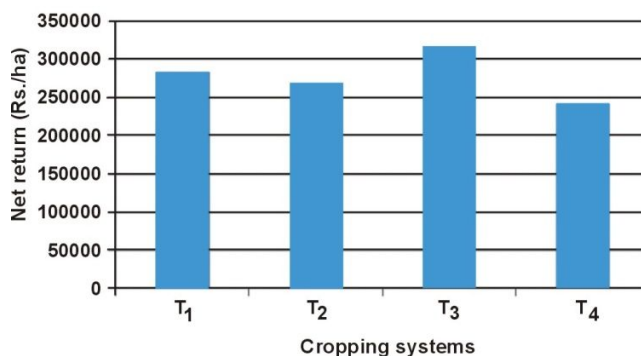


Fig. 3. Net return of different cropping systems.

to high price of berseem fodder and nitrogen fixation by berseem crop which gave positive effect on yield of succeeding crops. It was followed by T₁ (Rs. 283441) i.e. rice-wheat-rice-wheat cropping system which is conventional cropping system of Gujranwala zone and both the crops are high value cash crops. The net return of T₂ (rice-green manuring-rice wheat cropping system) was Rs 268565 per hectare. The reason of this low net return in this treatment is green manuring crop which did not contribute to the income. Rice-canola-rice-wheat cropping system (T₄) produced minimum net return (241800/ha) due to low yield of canola crop in rice area.

Benefit cost ratio

The economic analysis (Fig. 4) showed the highest benefit cost ratio (3.32) also in rice-berseem-rice-wheat cropping system (T₃). This highest benefit cost ratio might be due to the high price of berseem and increase in production of rice and wheat sown after berseem which is a nitrogen fixing crop. It also reduced the weeds population in subsequent wheat crop. So

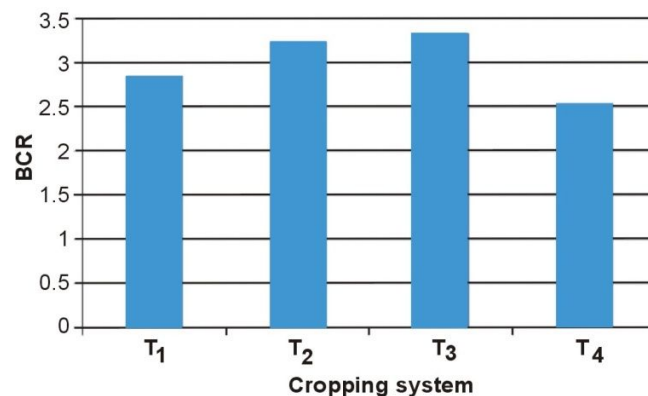


Fig. 4. Benefit cost ratios of different cropping systems.

nitrogen fixation and lesser weeds infestation resulted in reducing cost of inputs i.e. fertilizers and herbicides. Moreover, less cost is involved in berseem cultivation than wheat crop. These results agree to those of Singh *et al.* (14) who reported that inclusion of legumes in multiple cropping systems offer many advantages to the farmers. Second highest benefit cost ratio (3.22) was recorded in rice-green manuring-rice-wheat cropping system (T₂). This is due to the beneficial effect of green manuring. Although green manuring crop did not contribute to direct income yet it increased the soil fertility due to which yield of succeeding crops increased. BCR of rice-wheat-rice-wheat (T₁) which is the most common cropping system in the area, attained third position (2.85). Minimum benefit cost ratio (2.54) was recorded in rice-canola-rice-wheat cropping system (T₄). This is because of low yield of canola crop in the rice area and farmers of rice region do not prefer to grow canola crop. Shah *et al.* (11) and Padhi (7) also reported that although price of oilseed crops are higher but their yields are not equivalent to other crops of cropping systems.

CONCLUSION

The study concludes that inclusion of berseem in existing cropping pattern of rice-wheat-rice-wheat in Gujranwala zone is beneficial in terms of nitrogen

fixation and reduction in inputs cost of fertilizers and herbicides. So rice-berseem-rice-wheat cropping system is the most profitable cropping system in this zone.

REFERENCES

1. Ahmad, T., F.Y. Hafeez, Mahmood and K.A. Malik. 2001. Residual effect of nitrogen fixed by mungbean and blackgram on subsequent rice and wheat crops. *Australian J. Exp. Agric.* 41: 245-248.
2. Akhtar, N., A. Ali, Z. Ali, J. Iqbal, M. A. Nadeem and A. Sattar. 2011. Effect of integrated use of organic manures and inorganic fertilizers on grain yield of wheat. *J. Agric. Res.* 49(2): 181-186.
3. Anwar, A., M. Ansar, M. Nadeem, G. Ahmad, S. Khan and A. Hussain. 2010. Performance of non-traditional winter legumes with oats for forage yield under rainfed conditions. *J. Agric. Res.* 48(2): 171-180.
4. Ghosh, A. B. 1987. Some aspects of sustainability in soil fertility and crop production. *J. Indian Soc. Soil Sci.* 35(4): 552-565.
5. Gill, M.S. and I. Ahlawat. 2006. Crop diversification - its role towards sustainability and profitability. *Indian J. Fert.* 2 (9): 125-138, 150.
6. Hegde, D.M. 1992. Cropping System Research- Highlights. Project Directorate for Cropping System Research, Modipuram, Meerut, Uttar Pradesh. Pp. 40.
7. Padhi, A. K. 1993. Productivity and economics of rice (*Oryza sativa*)-based cropping sequences. *Indian J. Agron.* 39(3): 351-356.
8. Prasad, D., J. S. Urkurkar, S.K. Bhoi and N. Nag. 2011. Production potential and economic analysis of different rice based cropping systems in Chhattisgarh plains. *Res. J. Agric. Sci.* 2(1): 36-39.
9. Reddy, B.N. and G. Suresh. 2009. Crop diversification with oilseed crops for maximizing productivity, profitability and resource conservation. *Indian J. Agron.* 54(2): 206-214.
10. Safdar, A., M. A. Riffat and S. Sohail. 2005. Enhancing water use efficiency, nitrogen fixation capacity of mashbean and soil profile nitrate content with phosphorous and potassium application. *Pak. J. Agron.* 4:340-344.
11. Shah, M. H., G. M. Khan., A. S. Bali, K. N. Singh and R. Kanth. 1999. Productivity potential of rice-based cropping sequences under temperate environment. *Indian J. Agron.* 44(1): 12-15.
12. Sharar, M.S., M. Ayub, M.A. Chaudhry, A.A. Rana and M.M. Amin. 2000. Growth and yield response of cultivars of mungbean to various levels of phosphorous. *Int. J. Agric. Biol.* 2: 1385-1386.
13. Sharma, A.K., N.P. Thakur, K. Sanjay and K. Dileep. 2007. Profitable and energy efficient rice-based cropping system under subtropical

irrigated conditions of Jammu. *In: Extended summaries of 3rd National Symposium on Integrated Farming Systems, October 26-28, 2007 organized by Farming System and Development Association (Project Directorate for Cropping System Research, Modipuram, Meerut) at Agricultural Research Station, Durgapura, Jaipur.*

14. Singh, G., V. P. Singh, O. P. Singh and R. K. Singh. 1997. Production potential of various cropping systems in flood-prone areas of eastern Uttar Pradesh. *Indian J. Agron.* 42(1): 9-12.
15. Vivekananda, M. and V.S. Satyapriya. 1994. Karnataka's changing cropping pattern. *Agricultural Situation in India.* 49(6): 441-444.
16. Vyas, V.S. 1996. Diversification in agricultural research. *Indian J. Agri. Econ.* 51(4): 639-640.