ECONOMICS OF WHEAT BASED CROPPING SYSTEMS IN RAINFED AREAS OF PAKISTAN

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ABSTRACT:- The Pothwar tract of rainfed area has enormous potential to meet incremental food grain needs of the country. However, a significant yield gap in wheat has been reported between yields of substantive and the progressive growers mainly due to poor management of soil, water and fertility issues. A field study was conducted at National Agricultural Research Centre (NARC), Islamabad and the traditional wheat-fallow-wheat (W-F-W) cropping system was evaluated with the improved wheat-maize fodder-wheat (W-MF-W) and wheat-mungbean-wheat (W-MB-W) cropping systems. Two tillage practices, i.e. shallow tillage with cultivator and deep tillage with moldboard; and four fertilizer treatments viz., control (C), recommended dose of fertilizer for each crop (F), farmyard manure (FYM) @ 5 tha^{-1}. The recommended doses of fertilizer for individual crop with FYM (F+FYM) were also included in the study to know their impact on the crops yield in the cropping systems. Economic analysis of the data revealed that the traditional wheat-fallow-wheat cropping system could be economically replaced with wheat-maize fodder-wheat cropping system even under drought condition and there will be no economical loss of wheat yield when planted after maize fodder. Application of recommended dose of fertilizer along with FYM @ 5 tha^{-1} will enhance the yield of wheat and maize fodder. The improved cropping system of wheat-maize fodder-wheat will help the farmers to sustain productivity of these crops, stable economic benefits and improvement in soil nutrients and organic matter over time.

Key Words: Wheat-Fallow; Maize Fodder; Rainfed Conditions; Fertilizer Treatments; Farm Yard Manure; Yield Components; Pakistan.

INTRODUCTION

Wheat (*Triticum aestivum L.*) is an important staple food for the peoples of Pakistan. It contributes 13.8% to the value added in agriculture and about 3.4% to gross domestic production (GDP). It was grown on 9.132 with 23.31 mt production during 2009-10. The last 5 year's (2004-09) average yield of wheat in Pakistan has been 2579 kg ha^{-1} (GoP, 2009-10). Punjab is the principal wheat producing province in the country and accounts for $\pm$15 mt of wheat over 6mha. Unachieved yield potential of about 62% is yet to be exploited (Parvez, 2001).

In Pakistan wheat is grown under diverse environmental conditions including major part grown under irrigated and about one fifth

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under rainfed (barani) conditions. Uncertain rainfall and frequent crop failure during dry periods hamper input use in rainfed areas. Crop husbandry methods are primitive and yield of rainfed wheat is less than one half than that of irrigated wheat (Aqil, 2003). In most parts of the country, annual rainfall varies from 100 to 500 mm with almost all occurring between February-April and July-September. The northern part of the country is the wettest with annual rainfall >250 mm (Siddiqi, 1992) that is why the rainfed agriculture is concentrated in this region. The rainfed environments for agriculture are extremely fragile and have limitations in various combinations for soil, water and crop management.

The Pothwar plateau in northern Punjab is a large barani tract, comprising 1.82 mha. Only 0.61 mha are cultivated and remaining 1.21 mha are severely affected by soil erosion. The region constitutes 90% of the rainfed cropped area in Punjab, spread over the districts of Islamabad, Rawalpindi, Jehlum, Chakwal and Attock. Stagnation in cereal crop yield in these areas is mainly due to uneven topography; moisture stress because of insufficient, erratic and torrential rainfall; eroded low-fertile soils due to nutrient deficiency and low organic matter (Khan and Qayyum, 1986). A hard pan about 20-30 cm deep has been developed (Ishaq et al., 2003). The soils are developed from loess and are medium textured, that has very low organic matter thus susceptible to crusting and sheet / gully erosions. These problems are intensified with the commencement of summer rains due to the fallow system (Abdullah, 1977). The average yield of crops under rainfed agriculture is far below the potential yield. Similarly the cropping intensity in the rainfed areas is very low. For example, wheat yield is 1.5 tha^{-1} with an average cropping intensity of about 70% as against the potential of 5 tha^{-1}, with cropping intensity of 200% that can be achieved with improved soil and water management practices in an annual rainfall of more than 750 mm (Khan et al., 1981).

The rainfed area contributes 10% to the total wheat production in the country (GoP, 2007-08). Rainfed lands support 70% of the livestock population in Punjab province (Ahmad, 1988). Therefore, fodder is another important component in the cropping system of this area. However, the existing cropping systems seldom provide the farmers with sufficient food, feed or income. Therefore, there is a need to modify the present cropping system for better food and feed production.

Rainfall, being a major source of moisture for crops, is the primary yield-limiting factor in the rainfed area. Manipulating soil moisture dynamics with deep tillage may turn out to be one of the most feasible ways of increasing wheat yields in the region (Razzaq et al., 1990). Deep ploughing improves rain water infiltration during rainfall and enhances root penetration. Khan et al. (1990) observed that there was an increase of 21% in grain yield of wheat by deep tillage over the conventional tillage. However, Razzaq et al. (1994) reported that soil looses by deep tillage and all the rainwater penetrates deep into the soil, while soil surface remains dry, which affects the early wheat emergence and crop establishment. Therefore, it may be hypothesized that along with tillage practices some cover crops like maize fodder during summer would help to conserve soil moisture in the upper soil surface by providing mulch effects. The main objectives of the study are to quantify the replacing of summer fallow with spring planted crops on the subsequent winter wheat crop and to suggest most economical wheat based cropping system for the rainfed area.

MATERIALS AND METHOD

The experiment was designed to evaluate the wheat based cropping systems such as wheat-fallow-wheat, wheat-maize fodder-wheat and wheat-mungbean-wheat in rainfed areas of Pakistan by applying tillage practices viz., deep tillage with moldboard and shallow tillage with cultivator and fertilizer treatments i.e., control (C), recommended fertilizer (RF), recommended fertilizer with manure (RF+FYM) and manure (FYM) alone were studied to evaluate their impact on the sustainable maize fodder yield under rainfed conditions at National Agricultural Research Center (NARC), Islamabad. The experiment was laid out in randomized complete block design (RCBD) and treatments were arranged in split plot fashion with three replications. The cropping systems were placed in the main blocks, tillage practices in the sub-plots and fertilizer treatments in the sub-sub-plots. The size of sub plots was 17x6 m^2. Deep tillage was done with moldboard plough once each year before the onset of monsoon rains (in the first week of May) and shallow tillage was done with cultivator at the time of land preparation. Fertilizer doses were randomly applied to each sub plot. The recommended doses of fertilizers viz., 90:90 kg ha^{-1} for wheat; 50:100 kg ha^{-1} for maize fodder and 20:50 kg ha^{-1} NP and 5tha^{-1} FYM were applied. The farm yard manure was broadcasted in the respective plot at the time of planting. The seed of wheat variety Chakwal-97 was planted in mid November, 2000 and 2001. The maize variety Gauher and mungbean variety MN-209 were planted in mid July in both the years. Wheat and mungbean were harvested at their physiological maturity, but the maize was harvested at 50% silking stage (after 65 days of sowing) for fodder.

The pooled experimental data were analyzed by using the methodology described by CIMMYT (1988). The methodology involved partial budgeting, marginal analysis and sensitivity analysis. The partial budget was constructed for each cropping system to evaluate costs and benefits associated with the individual system. In the preparation of partial budget, only the costs that vary among different cropping systems were considered. Yields of all crops were adjusted downward by 10% to reflect probable lower yields expected by the farmers due to differences in factors like management, plot size, harvest date and harvesting technology (Byerlee et al., 1992). The field prices of the crops were calculated by adjusting the average market prices of those crops downward by 10%. The gross field benefits for each cropping system were calculated by multiplying the field prices by the respective adjusted yields.

Gross benefit = Field price x Adjusted yield

The total cost that varied for each cropping system was calculated by adding up all the costs that varied for the system. The costs that varied for each input was calculated by using the following formula:

Cost of an input (that varied) = Field price of input x Quantity of input used

The net benefits of each cropping system were calculated by using the formula:

Net benefits = Gross field benefit - Total cost that varied

In the partial budget analysis total costs that varied and the net benefits for each cropping systems were calculated and actually have not compared the costs that varied with the net benefits. For such a comparison marginal analysis, was required.

For dominance analysis, cropping systems were arranged in order of increasing variable costs. A cropping system was dominated if its variable costs were higher than the preceding system, but its net benefits were lower. Such a cropping system was termed as dominated cropping system and denoted by "D".

The marginal analysis involves dominance analysis; net benefit curve fitting and calculating the marginal rate of return (MRR) for the non-dominated cropping systems. For dominance analysis, cropping systems were arranged increasing variable costs. A cropping system was considered as dominated if its variable costs were higher than the preceding systems, but its net benefits were equal of lower. Graphs of net benefits curves for each cropping system were made by plotting net benefits against corresponding total variable costs. The cropping systems which were not dominated were connected with lines. Marginal rate of returns for each non-dominated cropping system were calculated by using the following formula:

$$MRR = \frac{\triangle NB}{\triangle TVC} \times 100$$

where;

MRR = Marginal rate of returns

NB = Change in net benefits

TVC = Change in total variable cost

On the basis of economic analysis the recommendations were made by arranging the cropping systems in order of increasing costs and then considering MRR between each pair of cropping systems. The cropping system with the highest net benefit was assumed that minimum MRR on investment of 100% was needed to persuade farmers to adopt new cropping systems.

It is common in Pakistan that input and output prices of agricultural commodities changed from year to year and location to location. To test the recommendations for a cropping system and its ability to withstand the possible price changes, "sensitivity analysis" was performed. In this analysis, marginal analysis was redone using the alternative set of input and output prices. Different scenario assumed about the input and output prices changes are as follows (Monod et al., 2006):

- Constant output prices and input prices increased by 10 % from current level.
- Constant output prices and input prices increased by 20 % from current level
- Constant input prices and output prices decreased by 10 % from the current level.

Data were collected using standard procedures and were transferred to computer files for analysis of variance (ANOVA) that was accomplished by using MSTAT. Treatment means were compared by DMRT (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Economic Analysis of Different Wheat Based Cropping Systems

In present studies the economic analysis was carried out using methodology described by CIMMYT (1988). However, economic analysis of different cropping systems under various environments have been reported by several researchers (Zahid et al., 1991; PARC, 1990; Seth and Balyan, 1985; Malavia et al., 1986; Velayudham and Seth, 1986 PODB, 2002 and Arif, 2009. In all such studies the researchers have mainly given gross benefits and net benefits of a cropping system.

In this analysis prices of inputs and outputs prevailing in the local market were used to calculate the partial budget of different cropping systems. This was in accordance with Arif (2009), Katsvario and Cox (2000) and CIMMYT (1988).

Partial Budget of different Cropping Systems (Rs ha^{-1})

The results of partial budget analysis (Table 1) revealed that in cropping systems intervention, the gross benefits per hectare of *kharif* crops ranged from Rs.15555 (mungbean) to Rs.24366 (maize fodder) and zero in fallow during *kharif* (Arif, 2009). Among *kharif* crops maize gave the maximum gross return of Rs.24366 ha^{-1}. The monsoon rains during crop season were above normal during both the year of experimentation that promoted the vegetative growth of the *kharif* crops that had positive effect on the maize fodder yield and negative effect on the grain yield of mungbean. Hou et al. (2011) and Arif (2009) reported similar results. However, Halvorson et al. (2010) reported higher gross return from mungbean. The gross monetary return from wheat was highest when it was planted in fallow-wheat system (Rs.18536). The lowest monetary return of Rs.8457, were achieved when wheat was planted in mungbean-wheat system. This was mainly due to better residual moisture in the fallowed wheat where emergence percentage of wheat was significantly higher than the plots planted with maize fodder and mungbean. The maize fodder partially covered the fallowed period and these plots possessed higher plant emergence count per unit areas than the plots planted with wheat crop. Katsvario and Cox (2000), Hou et al. (2011) and Arif (2009) reported similar results.

When the total gross benefits of different cropping systems were compared, maize-wheat system gave the highest gross monetary return of Rs.39610 including the income of Rs.24366 from maize fodder plus the income of Rs.5244 from the fallowed wheat crop. This was followed by gross income of Rs.24012 from mungbean-wheat cropping system (income from mungbean and the fallowed wheat crop).Whereas fallow-wheat cropp-ing system gave the lowest total gross benefits of Rs. 18536/- only. The highest gross income from maize-wheat system contributed the highest monetary

Table 1. Partial budgets of pooled results for different treatments

	Cropping Systems		
Parametres	Wheat- Fallow	Wheat- Maize	Wheat- Mungbean
Yield (kg ha^{-1})			
Kharif crops			
Mungbean			
Grain	0	0	527
Straw	0	0	3671
Maize Fodder	0	18049	0
Rabi crops			
Wheat			
Grain	1625.77	1399.08	764.79
Straw	3360.89	2589.08	1464.44
Adjusted yield (kg ha^{-1})			
Kharif crops			
Mungbean			
Grain	0	0	474.2
Straw	0	0	3303.9
Maize Fodder	0	16244.2	0
Rabi crop			
Wheat			
Grain	1463.2	1259.17	688.31
Straw	3024.8	2320.17	1318.00
Gross Benefits (Rs. ha^{-1})			
Kharif crops	0	24366	15555
Wheat	18536	15244	8457
Total	18536	39610	24012
Cost that Vary (Rs. ha^{-1})			
Tillage practices			
Kharif crops	0	800	800
Wheat	600	600	600
Total	600	1400	1400
Seed			
Kharif crops	0	400	875
Wheat	1200	1200	1200
Total	1200	1600	1600
Fertilizer			
Kharif crops	0	2557	1545
Wheat	2706	2706	2706
Total	2706	5263	4251
Fertilizer Application			
Kharif crops	0	300	300
Wheat	300	300	300
Total	300	600	600
Planting			
Kharif crops	0	500	500
Wheat	500	500	500
Total	500	1000	1000
Earthing up			
Kharif crops	0	500	0
Wheat	0	0	0
Total	0	500	0
Weeding/Thinning			
Kharif crops	0	1600	1800
Wheat	1000	1000	1000
Total	1000	2600	2800
Harvesting			
Kharif crops	0	2000	1800
Wheat	2000	2000	2000
Total	2000	4000	3800
Threshing			
Kharif crops	0	0	1000
Wheat	975	833	458
Total	975	833	1458
Total costs that vary	9281	17789	17134
Net benefits (Rs. ha^{-1})	9255	21814	6628

benefits of both the crops. These results are in line with the findings of Arif (2009).

Total costs that vary were highest in maize fodder–wheat cropping system (Rs. 17789) followed by mungbean-wheat system (Rs. 17134). The lowest total cost (Rs. 9281) that varies was recorded in fallow-wheat system. Net benefits showed that maize-wheat gave maximum net benefits of Rs. 21814 followed by fallow-wheat cropping system (Rs. 9255). The lowest net benefit of Rs. 6628 was obtained in mungbean-wheat system. The summer season received above normal rains (1044 mm in 2000 and 965 mm in 2001) which promoted the vegetative growth of the maize and mungbean resulting in the increased fodder yield of maize but reduced the grain yield of the mungbean. Similar results have been reported by Arif (2009), Drew et al. (2004) and Malvia et al. (1986).They concluded that when summer rains are prolonged, the biological yield of the crop increases but the grain yields are decreased.

Marginal Analysis of Different Cropping Systems

In the partial budget analysis only total costs that vary and net benefits from each cropping system was calculated but did not compare actually the costs that vary with the net benefits. To determine the most profitable cropping system by comparing the costs that vary with the net benefits obtained, marginal analysis was performed. For dominance analysis, cropping systems were arranged in order of increasing variable costs. A cropping system was dominated if its variable costs were higher than the preceding system, but its net benefits were lower. Such a cropping system was termed as dominated cropping system and denoted by "D". The dominance analyses of the pooled results showed that mungbean-wheat and maize-wheat cropping systems were dominated by fallow-wheat system (Table 2). Arif (2009), Hou et al. (2011) and Malavia et al. (2004) reporting similar results stated that the variable cost of cropping system has direct impact on the overall return of the cropping system.

The economic analysis indicated that mungbean-wheat cropping system was less profitable than fallow-wheat and maize-wheat cropping systems. Hence, these were not included in the calculation of MRR.

MRR of different cropping systems for pooled data revealed that if instead of fallow-wheat system, maize wheat system was recommended, the MRR were 3685.92% (Table 3). These MRR were highest with maize wheat cropping system compared to mungbean–wheat system. This was mainly due to less difference in costs that vary between these cropping systems however; the differences in net benefits were quite high.

Table 2. Dominance analysis of different cropping systems

Cropping system	Costs that vary (Rs.ha^{-1})	Net benefits (Rs.ha^{-1})
Fallow-wheat	9281	9255
Mungbean-wheat	17134	6628 D
Maize-wheat	17789	21814 D

D = Dominated by cropping system

Table 3. MRR analysis of different cropping systems

Cropping system	Cost that vary (Rs. ha^{-1})	Marginal costs (Rs. ha^{-1})	Net benefit (Rs. ha^{-1})	Marginal net benefit (Rs. ha^{-1})	MRR (%)
Wheat-Fallow	9281		9255		
		8103		- 2627	- 39.63
Wheat- Mungbean	17384		6628		
		412		15186	3685.92
Wheat- Maize fodder	17796		21814		

The MRR was only -39.6 percent, when comparison was made between mungbean-wheat and fallow-wheat system. According to the economic analysis it seems better if farmers in high rainfall zone of Rawalpindi and Islamabad do not leave their land fallow during *kharif*, then they may replace it with maize fodders. However, producer's choice of a cropping system will also depend on the variability in returns and risk attitudes as well as the average level of returns. To evaluate how sensitive are the net benefits of these cropping system to changes in the prices of inputs and output to make it acceptable to the farmers. For this purpose “sensitivity analysis” was carried out. The findings of Hou et al. (2011), Arif (2009) and Katsvario and Cox (2000) supported the results of this study.

Sensitivity Analysis of Different Cropping Systems

In Pakistan, the output and input prices are subjected to change from year to year and location to location. This analysis may be performed by changing one price or a combination of prices and determining the effects of that change on the net benefit. Therefore, in the analysis, major emphasis was given to change in prices, their effect on net benefit and MRR of different cropping systems. With different assumptions in change of output and input prices as practiced by CIMMYT (1988), Arif (2009), Katsvario and Cox (2000), the results are as follows.

Sensitivity Analysis with Output and Input Prices Increased by 10 %

Analysis was carried out to monitor the effects of increase in prices of input and output by 10% from current prices on the returns from a cropping system (Table 4). The dominance analysis given indicated that the net benefits increased with the increase in input and output prices (Table 5).

Among different cropping systems, net benefits were high in maize-wheat system (Rs.43571). Mungbean-fallow was the next with high net benefits of Rs.26409. The data revealed that mungbean-wheat and maize-wheat systems were dominated by fallow-crop system.

Analysis showed that MRR in mungbean-wheat system was on negative side (-68.6) as compared to fallow-wheat system (Table 5).

Table 4. 10% increased market prices

Crops	Grain	Straw / Fodder
Wheat	8.25	2.75
Maize	-	1.65
Mungbean	38.50	1.23

However, MRR resulted from the comparison of maize-wheat system and mungbean-system was increased substantially, with current rates. Similar trend was recorded when MRR of mungbean-wheat and maize-wheat were compared with fallow-wheat system, despite of 10% increase in input and out put prices of these crops. The MRR resulted from the comparison of mungbean-wheat and maize-wheat systems changed considerably by increasing 10% input and output prices of these crops.

The analysis clearly indicated that if the future prices of inputs and outputs are increased by 10% from the current prices, even then it is economical to recommend that maize-wheat cropping system, is better alternatives than mungbean-wheat and fallow-wheat cropping systems.

Sensitivity Analysis with Output and Input Prices Increased by 20 %

The data for sensitivity analysis to monitor the effect of increases in prices of outputs and inputs by 20 % from current prices for different cropping systems showed that the net benefit of all the cropping systems increased with the increase in output and input prices by 20% (Table 6). Maximum net benefits were obtained in maize-wheat cropping systems (Rs. 47533) which was 117.9 % higher than the net benefits achieved with current rate (Table 7). The minimum net benefit of Rs.22243 was obtained in fallow-wheat system, which was again 235.6 % higher than current prices. Analysis also revealed that mungbean-wheat and maize-wheat cropping system were dominated by fallow-wheat cropping systems.

The net benefit in maize-wheat

Table 5. Sensitivity analysis with output and input prices increased by 10 %

Cropping system	Cost that vary (Rs. ha^{-1})	Marginal costs (Rs. ha^{-1})	Net benefit (Rs. ha^{-1})	Marginal net benefit (Rs. ha^{-1})	Marginal Rate of Return
Dominance analysis					
Wheat-Fallow	10209	-	20298	-	-
Wheat- Mungbean	19122	-	26409 D	-	-
Wheat- Maize fodder	19576	-	43571 D	-	-
MRR					
Wheat-Fallow	10209		20298		
		8913		-6111	-68.6
Wheat- Mungbean	19122		26409		
		454		17162	3780
Wheat- Maize fodder	19576		43571		

D = Dominated by cropping systems

Table 6. 20 % increased market prices during 2000-2002

Crops	Grain	Straw / Fodder
Wheat	9.00	3.00
Maize	-	1.80
Mungbean	42.00	1.35

system were observed to be higher than mungbean-wheat and fallow-wheat cropping system (Table 7). MRR of mungbean-wheat system was –167 %, compared to fallow-wheat system, with output/input prices increased by 20 % (Table 7)

The MRR changed significantly when comparison was made between mungbean-wheat and maize fodder-wheat cropping systems. Hence, it can be concluded that in future if prices of outputs and inputs may increase by 20%, the sup-eriority of maize fodder-wheat cropping systems would not be changed. Therefore, it is safe to recommend this cropping system as a better alternative than fallow-wheat and mungbean-wheat cropping systems.

Sensitivity analysis with constant output prices and input prices increased by 10 %

The sensitively analysis with the assumption that if output prices remained constant, but input prices increased by 10%, then how it affects different cropping systems. The dominance analysis indicated that at constant output prices, the increase in input prices did not result in change in recommendations of maize fodder-wheat cropping systems (Table 8). The maximum net benefit of Rs.21814 was obtained from maize fodder-wheat systems with increase in input prices by 10%.

However, these net benefits were lower than the net benefits obtained with current input and output prices. The MRR showed that the MRR also increased slightly than the MRR at current prices of inputs and outputs (Table 8). It may be concluded from the analysis that with the increase in input prices in 10 %, no risk was involved to recom-

Table 7. Sensitivity analysis with output and input prices increased by 20 %

Cropping system	Cost that vary (Rs. ha^{-1})	Marginal costs (Rs. ha^{-1})	Net benefit (Rs. ha^{-1})	Marginal net benefit (Rs. ha^{-1})	Marginal Rate of Return
Dominance analysis					
Wheat-Fallow	11137	-	22243	-	-
Wheat -Mungbean	20861	-	28835 D	-	-
Wheat - Maize fodder	21355	-	47533 D	-	-
MRR					
Wheat-Fallow	11137		6164		
		9724		-167	-1.72
Wheat- Mungbean	20861		5997		
		494		9636	1951
Wheat- Maize fodder	21355		15633		

D = Dominated by cropping systems

Table 8 . Sensitivity analysis with constant output prices and input prices increased by 10 %

Cropping system	Cost that vary (Rs. ha-1)	Marginal costs (Rs. ha-1)	Net benefit (Rs. ha-1)	Marginal net benefit (Rs. ha-1)	Marginal Rate of Return
Dominance analysis					
Wheat-Fallow	10209	-	9255		
Wheat-Mungbean	19122	-	6628 D		
Wheat- Maize fodder	19556	-	21814 D		
MRR					
Wheat-Fallow	10209		9255		
		8913		-2627	-29.17
Wheat- Mungbean	19122		6628		
		454		15186	33.45
Wheat- Maize fodder	19556		21814		

D = Dominated by cropping systems

mend maize fodder-wheat cropping systems compared to mungbean-wheat and fallow wheat cropping systems.

The sensitivity analysis depicts that the increase in input and output prices by 10 or even 20 % will have no impact on the net profitability of wheat-maize fodder cropping system and as such no risk is involve in replacing the traditional fallow-wheat-fallow-wheat cropping system with the wheat-maize fodder. The results of Arif (2009), Hou et al. (2011) and Katsvario and Cox (2000) have supported the findings of this research and stated when the net returns of cropping system is significantly higher with resultant higher marginal returns as compared to other cropping systems the overall profitability of the system will not alter due to increase or decrease in the market prices.

Agronomic performance of *kharif* crops, i.e., maize, fodder and mungbean and *rabi* (wheat) crop under study and results of economic analysis revealed that the existing fallow-wheat cropping system can be safely replaced with maize fodder-wheat system even under drought conditions. The inclusion of maize fodder crop in the traditional cropping system in the rainfed area will not affect the wheat yield, soil fertility status and residual moisture of monsoon rains. But the net profitability by growing an additional fodder crop will be much higher. Therefore, it may be suggested that under high rainfall areas of Islamabad and Rawalpindi, traditional fallow-wheat system may be replaced with maize fodder-wheat cropping system. Application of recommended dose of fertilizer along with FYM @ 5 tha^{-1} will enhance the productivity of wheat and maize fodder. This will help the farmers to sustain crop productivity of the rainfed area through stable economic benefits, improvement in soil nutrition and organic matter.

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