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Evaluation of suitable rice-based (*Oryza sativa*) cropping system for central plain zone of Uttar Pradesh

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ABSTRACT

The field results of a 3-year field experiment conducted at Kaushambi indicated that inclusion of pulses and oilseeds crop in rice (*Oryza sativa* L.) based crop sequences gave higher production and monetary gain over rice–wheat conventional system. The intercropping of pulses and oilseeds in recommended planting patterns after rice further enhanced the net return and sustained soil health. Highest net return of Rs 26,198/ha. was obtained with rice-chickpea + linseed, closely followed by rice–linseed + Indian mustard (Rs 24,681/ha) and rice–Indian mustard–mungbean (Rs 24,681/ha). Highest net profit on per rupee investment was recorded with rice–chickpea + linseed crop sequence (Rs 1.36).

Key words : Rice-based cropping systems, Profitability, Sustainability, Soil health

Development of improved production technology with suitable crop sequences for different agroclimatic zones plays a vital role in getting maximum monetary return without impairing the soil health. Therefore, it becomes imperative to work out proper crop sequence for different situation. The rice-wheat crop sequence plays a significant role in crop production in general and improving the economic condition of farmers of Central plain zone of Uttar Pradesh in particular. But its profitability and sustainability are not encouraging due to many reasons. However, an introduction of pulse in the system was found more beneficial than pure cropping of cereals after cereals (Umarani *et al.*, 1992). Hence to develop economically viable, technically feasible, sustainable and need-based crop sequences for central plain zone of Uttar Pradesh, the present investigation was planned and executed for 3 consecutive years.

MATERIALS AND METHODS

A field experiment was conducted in a permanent lay-out at Regional Research Sub-Station, C.S.Azad University of Agriculture and Technology, Saini–Kaushambi from 1994 to 1997 in randomized block design replicated thrice. Ten crop sequences,

viz. rice–wheat, rice–chickpea, rice–chickpea + linseed, rice–chickpea + Indian mustard, rice–lentil, rice–lentil + linseed, rice–lentil + Indian mustard, rice–Indian mustard–mungbean, rice–linseed and rice–linseed + Indian mustard. The varieties of the component crops of the sequences are 'Sarjoo 52', of rice 'K 88' of wheat, 'Awrodhi' of chickpea, 'Garima' of linseed, 'Vardan' of mustard 'K 75' of lentil, and 'T 44' of mungbean. All the crops received recommended package of practices. The soil of the experimental field was sandy loam with initial soil pH 7.8, organic carbon 0.36%, E.C. 0.25 dS/m, total available N 220 kg/ha. The total rainfall received was 785, 600 and 682 mm during 1994-95, 1995-96 and 1996-97 respectively. However, in the winter season (November to April) there was 51.8 mm rain in first year, 121.8 mm in second year and 10.8 mm during third year which affected the productivity of winter crop. The irrigations were given to the crops as and when required. Crops in association, viz. chickpea + linseed was planted at 3:1, chickpea + mustard and lentil + linseed at 5:1 and linseed + mustard and lentil + mustard at 10:1 row ratio. The net profit was computed at prevailing market rates.

RESULTS AND DISCUSSION

Grain/seed yield

On the basis of 3-year results, grain yield of the crops were affected due to different crop sequences (Table 1). Wheat yielded less grain yield by 329 kg/ha and 546 kg/ha during 1995-96 and 1996-97 respectively compared with the yield of base year (1994-95) under rice–wheat crop sequence. However, this trend was not observed in other tested crop sequences.

The rice yields in chickpea, chickpea + linseed, chickpea + Indian mustard, lentil, and Indian mustard-mungbean cropping system were at par during 1995-96 and 1996-97 and higher than preceeding wheat crop. This might be due to the fact that both crops (rice and wheat) are similar in nature and heavy feeder of nutrients as compared to pulses and oilseeds caused decline in yield of both the crops. Inclusion of pulses in the place of wheat not only improved the grain yield of rice but might have attributed to less exhaustion of soil fertility and improvement in physical properties of the soil to some extent as compared to wheat crop.

Rice equivalent

Adoption of the rice-Indian mustard-mungbean and rice-linseed + Indian mustard gave significantly higher rice equivalent during all the 3 consecutive years (1994-95 to 1996-97) over the rice-wheat conventional sequence. Whereas rice-chickpea + linseed during 1994-95 and 1996-97 and rice-chickpea during 1996-97 yielded significantly higher rice equivalent than rice-wheat crop sequence. During 1995-96 rice-Indian mustard-mungbean and rice-linseed + Indian mustard gave significantly higher rice equivalent yield than rice-wheat. It might be due to unfavourable weather condition for *rabi* pulses in general.

Net returns

Replacement of wheat by pulses and oilseeds in rice-based crop sequence gave higher net return than the rice-wheat conventional crop sequence (Table 1). The 3-year mean values revealed that rice-chickpea +

Table 1. Effect of different rice-based crop sequences on grain and straw yield and economics (pooled over 3 years except grain yield)

Crop sequence	Grain seed yield (kg/ha)			Straw/stover yield (kg/ha) (mean)	Gross return (Rs/ha/ year)	Net return (Rs/ha/year)	Benefit : cost ratio
	1994-95	1995-96	1996-97				
Rice–	5,358	4,833	5,209	6,809	42,970	19,208	0.81
Wheat	4,883	4,554	4,337	5,816			
R.E.	10,729	9,879	10,576				
Rice–	5,185	5,083	5,428	6,849	42,039	22,960	1.20
Chickpea +	2,481	1,567	2,465	2,044			
R.E.	11,562	8,978	11,962				
Rice–	5,494	4,929	3,349	6,956	45,489	26,198	1.36
Chickpea +	2,383	1,354	1,774	1,827			
Linseed	358	542	539				
R.E.	12,786	9,947	12,647				
Rice–	5,272	5,008	5,358	6,766	42,521	23,041	1.18
Chickpea +	1,957	1,092	1,374	1,474			
Mustard	537	625	638	1,551			
R.E.	11,986	9,427	11,430				
Rice–	5,241	5,016	5,354	6,860	36,526	18,047	0.98
Lentil	1,481	1,079	1,626	1,222			
R.E.	9,685	8,370	11,070				
Rice–	5,228	4,925	5,255	6,791	40,039	21,437	1.15
Lentil +	1,302	925	1,509	1,102			
Linseed	315	533	527				
R.E.	10,160	9,331	11,512				
Rice–	5,469	4,992	5,275	6,912	40,064	21,379	1.15
Lentil +	1,074	763	1,370	997			
Mustard	623	647	691	1,679			
R.E.	10,650	9,123	11,314				
Rice–	5,395	5,062	5,494	7,010	47,626	24,642	0.99
Mustard-	2,025	2,183	2,386	5,212			
Mungbean	745	681	563				
R.E.	11,784	11,049	12,185				
Rice–	5,444	4,841	5,263	6,831	41,583	21,724	1.09
Linseed	1,840	1,829	1,728				
R.E.	11,435	10,286	10,963				
Rice–	5,389	4,846	5,267	6,791	44,650	24,681	1.23
Linseed +	1,562	1,475	1,321				
Mustard	642	567	753	1,673			
R.E.	12,492	10,834	11,721				
CD (P = 0.05) for rice	210	767	141				
CD (P = 0.05) for R.E.	1,031	844	938				

R.E. = Inducate Rice Equivalent

linseed gave highest net return (Rs 26,198/ha), closely followed by rice-linseed + Indian mustard (Rs 24,681/ha), rice-Indian mustard-moongbean (Rs 24,642/ha) and rice-chickpea + Indian mustard (Rs 23,041/ha). Almost all tested crop sequences except rice-lentil gave higher net return that rice-wheat crop sequence. Rice-lentil gave the lowest return than rice-wheat crop sequence (Singh *et al.*, 1996). Crop sequence like rice-chickpea + linseed and rice-linseed + Indian mustard gave significantly higher net return during all the 3-years in comparison to rice-wheat. This advantage might be due to complementary relationship between chickpea and linseed and linseed and Indian mustard. These results are in accordance with the findings of Dubey *et al.* (1997) and Pali *et al.* (1997).

Benefit : cost ratio

Highest benefit : cost ratio (1:36) was computed with rice-chickpea + linseed crop sequence, followed by rice-linseed + Indian mustard and rice-chickpea (1.23 and 1.20 respectively). The lowest benefit : cost ratio (0.81) was noted with rice-wheat crop sequence (Table 1). It might be due to high production cost and cheaper market price of the economic produce in comparison with pulses and oilseeds. The mean values also indicated that rice-chickpea + linseed over rice-lentil and rice-linseed + Indian mustard over rice-linseed in every respect. However, inclusion of pulses and oilseeds in rice-based cropping system increases the productivity, monetary return and benefit : cost ratio and it was further enhanced when intercropping of pulses with oilseeds were introduced in the system.

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