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Diversification of traditional cropping system for sustainable production

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ABSTRACT

To meet out the demand of the specific commodities by sustaining the crop productivity and soil fertility, there is need to diversify the traditional rice (*Oryza sativa* L.)–wheat [*Triticum aestivum* L. emend. Fiori & Paol.] sequence that occupies 60–70% of the total cultivated area in eastern Uttar Pradesh. The findings of field trials, conducted for 4 years at the University Research Farm, Faizabad, revealed that among the six cropping systems tested, rice–potato (*Solanum tuberosum* L.)–cowpea. [*Vigna unguiculata* (L.) Walp.] provided the highest net profit of Rs 21,154/ha/yr and rice grain/equivalent yield of 22.55 t/ha besides the fertility benefit of legume crop. The second remunerative system was rice–potato–okra (seed), that showed the rice-equivalent yield potential of 20.02 t/ha and net profit of Rs 17,612/ha/yr due to vegetable cash crop.

Key words : Diversification, Cropping system

Rice–wheat is by and large the most important crop sequence, occupying 60–70% of the total cultivated area in eastern Uttar Pradesh. Wide adoption of this system is mainly due to high productivity and less element of risk. But continuously following the same sequence had adverse effect on soil conditions, ultimately reducing the productivity of the system (Nambiar and Abrol, 1989; Kumar and Yadav, 1993). An experiment was therefore conducted to find out the possibility of diversification in traditional rice–wheat system in the light of sustainability, potentiality and economic feasibility with the impact on soil fertility.

MATERIALS AND METHODS

The field trials were conducted during 1991–92 to 1994–95 on a silty–loam soil at university Research Farm, Masodha (Faizabad). The soil was low in available N (142 kg/ha) and organic carbon (0.48%) and medium in available P (15.6 kg/ha) and K (138 kg/ha). Six cropping systems were tested, viz. S_1, rice–wheat–*Sesbania* green manure; S_2, rice–maize–*Sesbania* green

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Table 1. Monthly rainfall (mm) at the experimental site

Month	1991–92	1992–93	1993–94	1994–95
June	247.4	102.0	340.0	126.8
July	51.2	342.6	126.4	308.4
August	348.2	214.0	180.8	423.2
September	179.0	81.0	215.0	166.2
October	-	181.8	-	-
November	4.0	12.2	-	-
December	24.6	-	-	-
January	10.8	3.4	28.6	34.0
February	6.0	23.4	35.2	13.2
March	-	26.4	-	-
April	-	3.4	-	7.0
May	22.6	56.6	-	-
Total	893.8	1,046.8	926.0	1,078.8

manure; S_3, rice–potato–okra (seed); S_4, rice–lentil–maize+cowpea (fodder) S_5, rice-potato–cowpea; and S_6, rice–mustard–greengram. Randomized block design was followed with 4 replications. The crops were raised with recommended packages of practices. Rice was transplanted in each cropping system. N, P and K were applied through urea, single superphosphate and muriate of potash respectively. To study the changes in soil fertility after 4 cycles of each sequence, composite soil samples (0–15 cm) were collected in June 1995 and analysed for organic C, available N, P and K a by standard methods. On an average, the number of irrigations given was 10, 11,15, 8, 14 and 8 for S_1, S_2, S_3, S_4, S_5, S_4, and S_6 respectively. About 5 cm water was applied under each irrigation. The annual rainfall received was 893.8, 1046.8, 926.0 and 1078.8 mm during 1991–92, 92–93, 93–94 and 94–95 respectively. Monthwise rainfall during each year is given in Table 1. The prevailing market prices of different commodities were used to work out the economics of different systems.

RESULTS AND DISCUSSION

Crop yield

Rice–wheat traditional cropping system gave 10.87 tonnes/ha cereals only (Table 2). Though a yield of 5.62 tonnes/ha cereals, 1.42 tonnes/ha oilseeds and 0.42 tonnes/ha pulses was obtained from rices–mustard–greengram cropping system (S_6), it

Table 2. Yield of crops (tonnes/ha/year) obtained from different cropping systems (average data of 4 years)

Cropping system	I Crop	II crop	III crop	Rice-grain equivalent
S_1, Rice–wheat–GM*	5.64	4.81	-	10.87
S_2, Rice–maize–GM	5.65	4.92	-	11.69
S_3, Rice–potato–okra (seed)	5.56	21.80	0.36	20.02
S_4, Rice–lentil–maize + cowpea (fodder)	5.48	0.99	47.29	12.16
S_5, Rice–potato–cowpea	5.63	22.05	0.88	22.55
S_6, Rice–mustard–greengram	5.62	1.42	0.42	12.61
CD (P=0.05)				0.81

*Green manuring of *Sesbania aculeata*

Table 3. Economics and labour employment of different cropping systems (average data of 4 years)

Cropping system	Gross expen/ diture (Rs/ha)	Net returns (Rs/ha)	Net return re-invested	Labour employment (mandays/ha/yr)
S_1, Rice–wheat–GM*	23,618	14,408	0.61	324
S_2, Rice–maize–GM	24,730	11,004	0.44	456
S_3, Rice–potato–okra	41,477	17,612	0.42	645
S_4, Rice–lentil–maize + cowpea (fodder)	21,173	14,171	0.66	378
S_5, Rice–potato–cowpea	38,750	22,626	0.58	560
S_6, Rice–mustard–greengram	22,225	11,773	0.52	380

*Green-manuring of *Sesbania aculeata*

provided all the three commodities to the farmer. Rice–potato–cowpea (S_5) also gave three commodities with the average yield of 5.63 tonnes/ha cereals, 22.05 tonnes/ha tubers and 0.88 tonnes/ha pulses. The rice–equivalent yields of different systems showed that maximum yield (22.55 tonnes/ha) was obtained from rice–potato–cowpea (S_5) system followed by rice–potato–okra (20.02 tonnes/ha). The higher rice–equivalent yield in S_3 and S_5 cropping was because of high-yielding crops rice and potato and high price of legume and okra seed. The addition of short/duration third crop, mainly legume, between two main crops increased the productivity of the system (Soni and Kaur, 1984).

Economics

Economics of different systems (Table 3) showed that the highest cost of cultivation (Rs 41,477/ha) was incurred in rice–potato–okra followed by rice–potato–cowpea (Rs 38, 750/ha). Inclusion of potato

Table 4. Change in nutrient status of soil under different cropping systems over 4 years

Cropping system	Change in nutrient status of soil			
	Organic C(%)	Available nutrient (kg/ha)		
		N	P	K
S_1, Rice–wheat–GM*	0.05	7.0	4.2	9.0
S_2, Rice–maize–GM	0.04	8.0	3.7	11.0
S_3, Rice–potato–okra	–0.04	–3.0	1.8	–8.0
S_4, Rice–lentil–maize + cowpea (fodder)	0.02	5.0	2.7	6.0
S_5, Rice–potato–cowpea	–0.02	2.0	2.3	4.0
S_6, Rice–mustard–greengram	0.03	4.0	3.0	7.0
Initial values	0.48	142	15.6	138

*Green-manuring of *Sesbania aculeata*

in the system increased the cultivation cost, as it is a labour-intensive crop. Okra crop further increased the cost due to greater requirement of human labour for its cultivation and seed collection. However, net returns were also higher in these systems. Rice–lentil–maize + cowpea (fodder) system gave maximum net return per rupee invested (0.66) due to its minimum expenditure cost (Rs 21,173/ha) and human labour (378 mandays/ha/hr), followed by soil fertility traditional rice–wheat system.

Soil fertility

Changes Soil fertility in nutrient status of soil over the years (Table 4) showed that rice–potato–okra sequence (S_3) was most exhaustive, as both potato and okra are heavy feeders of nutrients. Inclusion of *Sesbania* green manure crop in rice–wheat (S_1) and rice–maize (S_2) sequences increased the organic carbon and available N P K level of the soil. The sequences that included legume crop also showed slight improvement in the nutrient status of the soil. It clearly indicates that inclusion of legume crop helps in maintaining the soil fertility. Rao and Willey (1980) concluded that multiple cropping systems with legume offer special advantage to farmers in terms of productivity and fertility.

It is concluded that progressive farmers having the facility of resources and human labour may adopt rice–potato–cowpea and rice–potato–okra system for higher net returns and productivity. The poor–resource farmers may get higher returns by inclusion of less expensive legume and fodder crops in their cropping systems, besides the sustainability in production and to maintain soil fertility.

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