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Productivity and economics of rice (*Oryza sativa*)-based cropping sequences on clay-loam soil

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ABSTRACT

A field experiment conducted from 1989–90 to 1993–94 revealed that among the different irrigation schedules adopted for individual crop significantly affected wheat (*Triticum aestivum* L. emend. Fiori & Paol.) and Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson]. Among the different cropping sequences, rice (*Oryza sativa* L.)–wheat recorded the highest yield on rice equivalent basis with maximum production efficiency. This sequence also secured the highest net return and benefit : cost ratio.

Rice (*Oryza sativa* L.) is a main crop grown extensively during the rainy season under both irrigated and rainfed conditions of Chhattisgarh region of Madhya Pradesh. In the recent past, with the increase in irrigation potential, winter crops are being grown by the farmers of the region. But still majority of the farmers grow rice as summer crop if the water is made available. It is established that rice not only requires more water but also other inputs. However, the suitability and economics of winter crops grown after rice has not yet been studied. Generally, land remains fallow after rice harvest. Some winter crops could be introduced in rice-based cropping sequence for maximum net return from the system. Since not much information is available on the suitability of different winter crops after rice in Chhattisgarh region, an experiment was conducted to assess the possibility of growing economical second crop after rice harvest.

MATERIALS AND METHODS

The study was conducted at Bilaspur during 1989–90 to 1993–94 on clay-loam soil. The soil was medium in organic carbon (0.74%), having pH 7.2. The experiment having 4 cropping sequences with a single crop of 'IR 36' rice during the rainy season and 4 crops, viz. 'Swati' wheat, 'JG 74' gram (*Cicer arietinum* L.), 'Varuna' Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] and 'Modern' sunflower (*Helianthus annuus* L.), during winter season. Rice seedlings at age of 24 days were transplanted in the first fortnight of July. All the winter crops were sown between the last week of November to first week of December. During all the years wheat was harvested between 25 and 30 March, Indian mustard between 12 and 20 March, gram between 26 and 31 March and sunflower between 8 and 13 April. All the crops were grown with recommended package of prac-

tices except irrigations. In rice irrigations were applied 1, 3 and 5 days after disappearance of 7 cm ponded water. In winter crops the schedules were: wheat with 0.6 (I_1), 0.9(I_2) and 1.2(I_3) irrigation water : cumulative pan evaporation (IW : CPE); sunflower with 0.4(I_1), 0.6(I_2) and 0.8(I_3) IW : CPE; gram with no irrigation (I_1), 1 irrigation at 45 days after sowing (I_2) and 2 irrigations each at 45 and 80 days(I_3); and Indian mustard with no irrigation(I_1), 1 irrigation at 45 days(I_2) and 2 irrigations each at 45 and 90 days(I_3). The experiment was laid out in split-plot design with 3 replications. Comparison among the cropping sequences was worked out by converting the yields of all crops into rice equivalent on price basis. The land-use efficiency was worked out by taking total duration of crops in individual crop sequence divided by 365 days, and production-efficiency values were obtained by total production in a sequence divided by total duration of crop in that sequence (Tomar and Tiwari, 1990).

RESULTS AND DISCUSSION

Crop yield

In general no significant difference was observed in the average yield of rice obtained from different cropping sequences (Table 1). Among the winter crops, yields of wheat and Indian mustard were significantly increased by I_2 and I_3 levels than I_1. However, rate of increase in yield of these crops were reduced beyond I_2 level. Among the winter crops wheat recorded significantly highest rice-equivalent yield, followed by sunflower (Table 2). The lowest rice-equivalent yield was accrued from Indian mustard. The reason being the poor yield in this region because of the short spell of winter which affected the Indian mustard yield under delayed sowing after rice harvest. Padhi (1993) also reported lower rice-equivalent yield from Indian mustard when compared with other sequences.

Table 1. Grain yield (tonnes/ha) of different crops as influenced by irrigation regimes (average data of 5 years)

Irrigation	Rice	Wheat	Gram	Indian mustard	Sunflower
I_1	4.95	3.72	2.02	1.05	1.91
I_2	4.88	4.16	1.88	1.22	2.11
I_3	4.82	4.37	1.85	1.25	2.10
CD (P = 0.05)	NS	0.33	NS	0.16	NS

Details of irrigation treatments are given in text

Table 2. Rice-equivalent yield (tonnes/ha) and water-use (cm) of different crops in rice-based cropping sequences (average data of 5 years)

Cropping sequence	Water use (cm)	Rice-equivalent yield of crops		
		Rainy season	Winter season	Total
Rice—wheat	121.80	4.80	4.82	9.62
Rice—gram	102.55	4.96	4.39	9.35
Rice—Indian mustard	107.30	4.81	3.25	8.06
Rice—sunflower	115.31	4.79	4.66	9.45
CD (P = 0.05)		NS	0.41	0.38

Average water use in rice, 89—92 cm

Yield of cropping sequence

Among the rice-based cropping sequences (Table 2), rice—wheat was found more productive, followed by rice—sunflower. The lowest rice-equivalent yield was obtained from rice—Indian mustard sequence despite good market price of Indian mustard. It was due to low yield of Indian mustard which attributed minimum towards the rice-equivalent yield. Similar findings were also reported by Yadav and Newaj (1990).

Cost of cultivation and net return

Maximum cost was incurred rice—wheat sequence, followed by rice—sunflower. The

Table 3. Economics, land-use and production efficiency of different rice based cropping sequences (average data of 5 years)

Cropping sequence	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	Benefit : cost ratio	Land-use efficiency (%)	Production efficiency (mg/day/ha)*
Rice—wheat	16,188	19,552	1.21	61.91	42.57
Rice—gram	15,634	14,236	0.91	63.83 (233)	40.13
Rice—Indian mustard	15,001	14,109	0.94	60.03 (220)	36.64
Rice—sunflower	15,896	16,734	1.05	64.66 (236)	40.43

Figures in parentheses are total duration of crops in that sequence
* Calculated on rice-equivalent yield basis

lowest cost incurred in rice—Indian mustard sequence because of minimum cost required in raising Indian mustard. This is in agreement with the findings of Padhi (1993). Rice—wheat sequence accrued the highest net return than other sequences, in spite of low market price compared with other winter crops of other sequences. (Table 3). It was due to high yield that realized from wheat. Rice yields were more or less similar under different rice-based cropping sequences. The lowest economic yield from Indian mustard affected the net return and benefit : cost ratio under rice—Indian mustard system. However, comparable net return and benefit : cost ratio obtained from rice—gram and rice—mustard sequences (Table 3).

Land-use efficiency and production efficiency

Rice—sunflower sequence achieved the highest land-use efficiency, followed by rice—gram and rice—wheat sequences (Table 3). It is mainly due to the duration of the winter crops. Sunflower took longer time to mature followed by gram. Indian mustard took less number of days to harvest resulting in lowest land-use efficiency. The production efficiency of rice—wheat was maximum, followed by rice—sunflower and rice—gram cropping sequences.

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