

Productivity potential of rice (*Oryza sativa*) - based cropping sequences under temperate environment

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ABSTRACT

An experiment was conducted on silty clay-loam soils during rainy and winter seasons from 1992 to 1995 to determine the impact of rice (*Oryza sativa* L.) - based cropping sequence on productivity, profitability, energy and sustainability under temperate environment. Mean rice grain yield of 51.2 and 56.9 q/ha obtained when rice was sequenced with oat (*Avena sativa* L.) and wheat (*Triticum aestivum* L. emend. Fiori & Paol.) respectively increased to 62.8, 63.6, 64.8 and 67.4 q/ha by following lentil (*Lens culinaris* Medikus), fallow, berseem [*Cymopsis tetragonoloba* (L.) Taubert] and rapeseed respectively. However, highest mean economic returns (Rs 21,869/ha) and benefit : cost ratio (2.27) were obtained from rice-wheat cropping sequence, followed by rice-rapeseed and the lowest recorded by rice-oat cropping sequence. Rice-wheat-based cropping sequence also proved most efficient in terms of rice equivalent, production efficiency, land-use efficiency and energy equivalent.

Key words: Rice-based cropping sequences, Productivity potential, Temperate environment

The land available for cultivation in our country is limited, while our population continues to rise. The need therefore is to intensify agricultural production through increasing the cropping intensity which can be achieved through rice-based double cropping system, as the rice being the main crop of the Kashmir valley. The data on performance of different cropping sequences, viz. cereal-cereal and cereal-legume, with regard to suitability, economics and productivity are meagre. Hence an experiment was conducted to study the production potential of various rice-

based cropping systems.

MATERIALS AND METHODS

A field study was conducted during 1992-95 at Shalimar Campus (34.0°N and 74.89°E at an elevation of 1,685 m above sea-level) of the university. The soil belonging to class Hapludalfs was silty clay-loam in texture, low in organic carbon (0.4%), available N (198 kg/ha) and P (9 kg/ha), but medium in available K (189 kg/ha), with pH 6.5-7.5. The precipitation was very erratic with mild to hot thermal index and dry to subdry hydric

Table 1. Cropping sequence and production technology adopted

Cropping sequence	Variety		Seed rate (kg/ha)		Spacing (cm x cm)		Fertilizer (kg/ha)		Duration (days)	
	Rainy season	Winter season	Rainy season	Winter season	Rainy season	Winter season	Rainy season	Winter season	Rainy season	Winter season
Rice-rapeseed	'SKAU 5'	'KOS 1'	60	6.5	15 x 15	30 x 10	80 : 45 : 20	60 : 30 : 20	102*	223
Rice-wheat	'SKAU 5'	'HUW 234'	60	100	15 x 15	23	80 : 45 : 20	100 : 60 : 40	102*	246
Rice-lentil	'SKAU 5'	'Precese'	60	40	15 x 15	25	80 : 45 : 20	40 : 60 : 20	102*	234
Rice-oat	'SKAU 5'	'Kent'	60	100	15 x 15	23	80 : 45 : 20	80 : 40 : 20	102*	236
Rice-berseem	'SKAU 5'	'Pusa Gaint'	60	30	15 x 15	Broadcast	80 : 45 : 20	40 : 80 : 20	102*	243
Rice-fallow	'SKAU 5'		60		15 x 15		80 : 45 : 20		102*	

N : P₂O₅ : K₂O : P₂O₅ : K₂O

*plus 35 days in nursery

index. The annual precipitation was 814–1,194 mm with mean maximum and minimum temperatures 17.9–19.3°C and 7.8–8.7°C respectively during cropping years. The details of sequence and production technology adopted are given in Table 1. The treatments were tested in randomized block design with 4 replications. The data of 4 years were pooled. For comparison between crop sequences, the yield of all crops were converted into rice equivalent on price basis (Yadav and Newaj, 1990). Land-use efficiency was calculated by dividing the total duration of crop sequences by 365 and expressed in percentage. Production efficiency was calculated by dividing the net monetary returns of the sequence by total duration of sequence (Tomar and Tiwari, 1990).

RESULTS AND DISCUSSION

Crop productivity

The rice grain yield showed a significant variation under different cropping sequence (Table 2). The mean grain yield was higher when sequenced with rapeseed, lentil, berseem and fallow than oat and wheat cropping sequences (Table 2). The exhaustive nature of cereals included in the rice-based cropping

Table 2. Grain yield of different crops and rice-equivalent yield under various cropping sequences (mean data of 4 years)

Cropping sequence	Grain yield (q/ha)		Rice-equivalent yield (q/ha)
	Rainy season	Winter season	
Rice-rapeseed	67.4	11.8	116.0
Rice-wheat	56.9	52.0	118.1
Rice-lentil	62.8	13.1	116.7
Rice-oat	51.2	238.1	93.4
Rice-berseem	64.8	224.3	111.0
Rice-fallow	63.6		63.6
CD (P = 0.05)			3.5

Price (Rs/100 kg) : Rice grain, 170; rice straw, 100; wheat, 200; wheat straw, 100; lentil, 700; rapeseed, 700; oat green fodder, 30; berseem green fodder, 35

Table 3. Economics, production efficiency, land-use efficiency and energetics under different cropping sequences

Cropping sequence	Economics (Rs/ha)			Production efficiency (Rs/day/ha)	Land-use efficiency (%)	Energetics		
	Total variable cost	Net returns	Benefit: cost			Energy equivalent		
				Protein (kg/ha)	Carbohydrate (kg/ha)	Calori (k x 10 units/ha)		
Rice-rapeseed	8,275	16,815	2.03	51.7	89.0	702	5,374	30.1
Rice-wheat	9,606	21,869	2.27	62.8	95.3	974	7,852	36.3
Rice-lentil	9,373	14,600	1.55	43.5	92.1	734	5,454	29.6
Rice-oat	9,061	9,807	1.08	29.0	92.6	312	3,584*	15.8
Rice-berseem	8,972	14,256	1.57	40.5	94.5	416	4,790*	21.1
Rice-fallow	5,541	10,271	1.85	74.9	27.9	411	4,736*	20.9

Price (Rs/100 kg): Rice, 170; rice straw, 100; wheat, 200; wheat straw, 100; lentil, 700; rapeseed, 700; oat fodder, 30; berseem fodder, 35

*Values are for rice crop only

sequence may be the reason for the decrease in rice yields (Jadhav, 1989), whereas inclusion of legumes or crops of lower biomass might have helped in maintaining soil nutrient status (Patil *et al.*, 1995).

Amongst different cropping sequences rice-wheat cropping system gave the highest total grain production, followed by rice-rapeseed, as also reported by Parihar *et al.* (1995) under clay loam soils of Bilaspur, Madhya Pradesh.

Rice-grain equivalent

The pooled data indicated that rice-grain equivalent of rice-wheat sequence was significantly higher than rest of the sequences (Table 2). The results over individual years also followed similar trend. It may be attributed to higher yield of wheat which contributed towards the rice-equivalent yields, as also observed by Jadhao and Joshi (1993).

The highest land-use efficiency (95.3%) was in rice-wheat cropping sequence, because this sequence occupied the field or longest duration (246 days). Production efficiency was also highest in the same sequence, followed by rice-rapeseed sequence (Table 3).

Energetics

An intercropping of rice with wheat resulted in highest protein and carbohydrate productivity and also had maximum calories productivity than other crop sequences (Table 3). The rice-oat cropping sequence recorded lowest values for all these parameters. Improvement in energy, protein and carbohydrate productivity under rice-wheat cropping sequence may be because of highest grain production under the sequence.

Economics

Rice-wheat sequence gave the highest mean net return in spite of low market price compared with other crops of the sequence (Table 3). It may be attributed to the high yield realized from rice-wheat cropping sequence.

The study indicated that although rice-wheat cropping sequence proved remunerative, does not find favour under large-scale farming due to lack of short-duration genotypes of wheat and restricted rice-growing period. Therefore, rice-rapeseed or rice-berseem can be an alternate suitable cropping sequences under valley temperate conditions.

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