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Production potential and economic feasibility of different rice (*Oryza sativa*)-based cropping sequences

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ABSTRACT

A 3-year (1988–91) experiment having 7 rice (*Oryza sativa* L.)-based crop sequences, viz. rice–fallow–rice, rice–fallow–groundnut (*Arachis hypogaea* L.), rice–French bean (*Phaseolus vulgaris* L.)–groundnut, rice–wheat (*Triticum aestivum* L. emend. Fiori & Paol.)–greengram (*P. radiatus* L.), rice–gram (*Cicer arietinum* L.)–sunflower (*Helianthus annuus* L.), rice–sunflower–cowpea [*Vigna unguiculata* (L.) Walp.] and rice–groundnut–greengram, showed that the rice–French bean–groundnut recorded the maximum grain productivity, gross returns, rice-grain equivalent, net returns (Rs 29,464/ha) and land-utilization efficiency, followed by rice–fallow–groundnut (Rs 24,932/ha). Rice–wheat–greengram sequence also showed more grain productivity, gross and net returns than rice–fallow–rice, a traditional sequence.

In command area of eastern Maharashtra, cropping intensity is low despite availability of irrigation water. Rice (*Oryza sativa* L.) a dominant crop in the area, is grown in monsoon as well as in summer. Thus, rice–fallow–rice is a popular sequence in irrigated area. This cropping sequence could not spread extensively due to its very high water requirement and limited availability of irrigation water in summer. Being a monoculture, it resulted in build up of disease and pest complex on rice endangering its cultivation and reduction in soil fertility. It was, therefore, necessary to find out the most suitable pulse and oilseed crops in a sequence after monsoon rice, so that the productivity, profitability, employment for labour and soil fertility may be improved and irrigation water may be utilized economically in the region.

MATERIALS AND METHODS

The study was conducted during 1988–91 at Amgaon. The soil was sandy clay in texture, low in organic carbon (0.24%) and available phosphorus (24 kg/ha), fairly rich in available potash (353 kg/ha), with pH 6.8 and electrical conductivity 0.31 mmhos/cm at 25°C. The treatments consisted of 7 cropping sequences, viz. rice–fallow–rice, rice–fallow–groundnut (*Arachis hypogaea* L.), rice–French bean (*Phaseolus vulgaris* L.) – groundnut, rice – wheat (*Triticum aestivum* L. emend. Fiori & Paol.)–greengram (*P. radiatus* L.), rice–gram(*Cicer arietinum* L.) – sunflower (*Helianthus annuus* L.), rice–sunflower– cowpea [*Vigna unguiculata* (L.) Walp.] and rice–

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groundnut--greengram, were tested in randomized block design with 4 replications in plots of 126 m^2. Rice crop was raised by transplanting the seedlings. All crops were raised as per the recommended package of practices. The total rainfall received was 1,219, 2,105 and 2,177 mm during 1988–89, 1989–90 and 1990–91 respectively. Presowing irrigation was applied to ensure good germination of winter and summer crops. Final crop yields (main and by-product) were recorded and their total gross returns (Rs/ha), total operating cost (Rs/ha) and net returns (Rs/ha) were calculated on the basis of prevailing market price of the produce. For comparison between crop sequences, the yield of all crops were converted into rice equivalents on price basis (Yadav and Newaj, 1990). Land-use-efficiency values were calculated by dividing the total duration of crop sequences with 365 and expressing in percentage. Production-efficiency values were calculated by dividing the total grain production/ha in a sequence with total duration of crops in a sequence (Tomar and Tiwari, 1990).

RESULTS AND DISCUSSION

Yield of main product

The low yields during 1989–90 in all the sequences were due to heavy incidence of the shoot-fly on rice crop. The rice–groundnut–greengram sequence consistently recorded the lowest values due to very low yields of winter groundnut.

The pooled data revealed that yield of main product of the rice–French bean–groundnut rice – wheat – greengram and rice–follow–rice sequences did not differ statistically (Table 1). The rice–groundnut–greengram cropping sequence recorded significantly lowest yield of main product. At Amgaon, the highest grain productivity of 96.7 q/ha was recorded in rice–fallow–rice crop sequence, followed by rice–fallow–groundnut (69.3 q/ha). PKV, Akola (1989) and Yadav and Nawaj (1990) reported the highest grain yield in rice–wheat–greengram sequence.

Rice-grain equivalent

The pooled data indicated that rice-grain equivalent of rice–French bean–groundnut sequence was significantly higher than rest of the sequences. Similar results were also obtained in the individual years except during 1989–90 where it was on a par with rice–fallow–groundnut. The pooled data revealed that rice–fallow–groundnut sequence recorded significantly more rice-grain equivalent than the remaining sequences. Similar results were also observed in the individual years except during 1988–89 when rice–wheat–greengram recorded significantly more rice-grain equivalent. High rice-grain equivalent of these sequences was due to inclusion of legumes which fetched higher price.

The highest land-use efficiency (88%) was in rice-French bean-groundnut and rice–gram–sunflower sequences, because these sequences occupied the field for longest duration (322 days). Production efficiency was the highest in rice–fallow–rice (25 kg/ha/day), followed by rice–fallow–groundnut (24.9 kg/ha/day) cropping sequence (Table 1).

Gross returns

The pooled data indicated that rice–French bean–groundnut sequence gave significantly higher gross returns than all the other sequences. It was followed by rice–fallow–groundnut sequence which also recorded significantly more gross returns than rest of the sequences. Gross returns from rice–wheat–greengram were also

Table 1. Yield of main product and other parameters under different rice-based cropping sequences

Cropping	Yield of main product (q/ha)				Rice-grain equivalent (q/ha)				Duration (days)	Land-use efficiency (%)	Production efficiency (kg/ha/day)
	1988–89	1989–90	1990–91	Pooled	1988–89	1989–90	1990–91	Pooled			
Rice–fallow–rice	73.9	62.5	70.2	68.9	73.9	62.5	70.2	68.9	274	75	25.0
Rice–fallow–groundnut	64.9	59.1	72.6	65.5	106.7	85.3	261.4	151.1	263	72	24.9
Rice–French bean–groundnut	74.6	58.5	91.8	75.0	147.0	91.4	359.1	199.1	322	88	23.2
Rice–wheat–greengram	82.6	62.1	72.1	72.3	132.7	65.8	120.1	106.2	300	82	24.2
Rice–gram–sunflower	56.0	40.4	52.8	49.8	95.9	59.3	108.4	87.8	322	88	15.5
Rice–sunflower–cowpea	62.5	40.9	61.9	55.1	97.3	50.8	143.2	97.1	303	83	18.2
Rice–groundnut–greengram	36.5	35.9	29.0	33.8	74.6	58.3	93.5	75.4	303	83	11.2
CD (P = 0.05)	8.1	6.0	8.2	10.7	10.1	9.9	36.7	43.6			

Table 2. Economics and other parameters of different rice-based cropping sequences

Cropping sequence	Gross returns (Rs/ha)				Production cost (Rs/ha)	Net returns (Rs/ha)				Cost : benefit ratio	Man-days/ha/year
	1988–89	1989–90	1990–91	Pooled		1988–89	1989–90	1990–91	Pooled		
Rice–fallow–rice	18,440	29,041	14,912	20,789	10,880	7,560	18,161	4,032	9,918	0.91	333
Rice–fallow–groundnut	25,119	38,812	49,707	37,879	12,947	12,172	25,865	36,760	24,932	1.93	372
Rice–French bean–groundnut	33,156	40,721	66,608	46,828	17,364	15,792	23,357	49,244	29,464	1.70	525
Rice–wheat–greengram	30,825	30,883	25,111	28,940	13,807	17,018	17,076	11,304	15,133	1.10	499
Rice–gram–sunflower	21,768	23,997	16,878	20,881	14,103	7,665	9,894	2,775	6,778	0.48	502
Rice–sunflower–cowpea	20,774	22,974	28,089	23,946	13,527	7,247	9,447	14,562	10,419	0.77	531
Rice–groundnut–greengram	15,803	23,322	17,121	18,749	15,332	471	7,990	1,789	3,417	0.22	499
CD (P=0.05)	5,935	7,507	5,699	7,337		2,111	4,511	5,856	7,177		

Price (Rs/q) of different commodites: Main product and by-product of rice 188 and 55, 393 and 50, and 165 and 30; of wheat 376 and 50, 275 and 50, and 368 and 30; of gram 754 and 100, 755 and 70, and 675 and 70; of sunflower 525 and nil, 706 and nil, and 1,038 and nil; of groundnut 543 and 100, 765 and 100; and 675 and 70; of greengram 646 and 100, 658 and 70; and 675 and 70, and of cowpea 541 and 100, 590 and 70; and 700 and 70 during 1988–89, 1989–90 and 1990–90 respectively

Price of main product and by-product of French bean was 1,200/q and nil in all years

significantly higher than from the rice–fallow–rice, a traditional sequence. The highest gross returns were recorded in rice–fallow–groundnut sequence, as also reported by PKV, Akola (1989). Rice–wheat–greengram sequence also gave highest gross returns (Yadav and Newaj, 1990; Yadav *et al.*, 1991).

The total operating cost was highest in rice–French bean–groundnut (Rs 17,364/ha) and lowest in rice–fallow–rice (Rs 10,880/ha) sequence.

Net returns

The pooled data indicated that net returns from rice–French bean–groundnut were significantly more than all the sequences tested, except rice–fallow–groundnut which also recorded significantly more net returns than the remaining sequences. Similar results were also obtained during 1989–90. However, during 1988–89 and 1990–91 rice–French bean–groundnut gave significantly higher net returns than rice–fallow–groundnut cropping sequence. Additional net returns of Rs 19,546 and 15,014/ha were obtained from rice–French bean–groundnut and rice–fallow–groundnut respectively over rice–fallow–rice. Higher net returns could be possible due to high-yielding crops like rice and summer groundnut and high-priced French bean and groundnut crops included in these sequences. The cost : benefit ratio was the maximum under rice–fallow–groundnut, followed by rice–French bean–groundnut. Higher net returns and cost : benefit ratio were obtained in the rice–fallow–groundnut sequence (Palaniappan, 1984; PKV, Akola 1989).

Labour employment

Rice–French bean–groundnut system generated more labour employment (525 man-days/ha/year). It was higher by 58% than of rice–fallow–rice sequence (333 man-days/ha/year) (Table 2). The higher labour requirement under rice–French bean–groundnut system was mainly due to summer groundnut crop which is a labour-intensive one. In general, the labour requirement was more in all the sequences than traditional rice–fallow–rice sequence, due to increase in cropping intensity. These results are in agreement with those of Yadav and Newaj (1990).

It was concluded that rice–French bean–groundnut and rice–fallow–groundnut may be followed in eastern rice zone of Maharashtra as a profitable sequence.

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