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Production potential and economics of different rice-based relay cropping systems under rainfed shallow lowlands of coastal Orissa

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ABSTRACT

The production potential of blackgram (Vigna mungo), fieldpea (Pisum sativum), linseed (Linum usitatissimum) and lathyrus (Lathyrus sativus) crops and their economics under rice (Oryza sativa) based relay cropping systems was studied in five different villages of Tangi Block in the Khurda district of Orissa. The highest seed yield (6.53 q ha^{-1}) recorded in lathyrus followed by linseed (6.44 q ha^{-1}). However, crops like blackgram (Rs. 9936 ha^{-1}) and fieldpea (Rs. 7742 ha^{-1}) showed better performance in terms of market value. Computation of economics revealed that rice – blackgram relay cropping system recorded the highest rice equivalent yield (63.1 q ha^{-1}), net return (Rs. 15,916 ha^{-1}), per day return (Rs. 75.08 ha^{-1}) and benefit: cost ratio (2.43). While rice-linseed sequence registered the highest land-utilization efficiency (64.1%) followed by rice-fieldpea sequence (60.3%).

Key words: *Rice,* utera *crops, production potentiality, economics*

Relay cropping system is widely practiced in several states like Madhya Pradesh, Orissa, Chattisgarh, Bihar, West Bengal and Assam in the paddy fields by broadcasting the seeds of other crops like lathyrus, linseed, blackram, greengram, lentil and fieldpea in standing rice crop 2-3 weeks after flowering. It is a traditional practice of rainfed cultivation to efficiently utilize residual moisture after rice (Agarwal *et al.*, 1986). In coastal Orissa, the traditional rice growing areas in rainfed shallow lowlands are generally monocropped with little scope to raise a second crop after rice during November and December by utilizing quick depletion of residual soil moisture. Relay cropping provides great scope to raise a second crop under such situation. Hence, the present study was undertaken in farmers' participatory approach to evaluate the production potential of different crops and their economic viability in rice-based relay cropping system under rainfed shallow lowlands of coastal Orissa.

MATERIALS AND METHODS

On-farm farmers' participatory trials were carried out during three consecutive crop-growing seasons of 2001–02, 2002–03 and 2003–04 under rainfed shallow lowland situations in five different villages of Tangi block in the Khurda district of Orissa. The soil of the experimental sites were clay loam, having pH in the range of 8.0– 8.7, organic carbon 0.60–0.78%, available phosphorus 18 – 25 kg ha^{-1} and available potassium 112–129 kg ha^{-1} at different locations. The experiment was laid out in randomized complete block design in ten farmer's field (two farmers from each village in five different villages). The treatments comprised of four different rice-based relay crop sequences like T_1, rice – blackgram, T_2, rice – linseed, T_3, rice- fieldpea and T_4, rice – lathyrus. The varieties of the component crops of the sequences were 'T_9 local' for blackgram, 'Sweta' for linseed, 'Rachana' for fieldpea and 'Nirmal' for lathyrus. An area of 200 m^2 was considered as one treatment plot and each farmer's field with an area of 800 m^2 was considered as one replication. Thus, the total number of replications were ten.

The rice variety 'Pooja' (140 days duration) was sown during the first fortnight of June in all the three years with a uniform fertilizer dose of 60:30:30 kg N, P_2O_5 and K_2O ha^{-1}. Weeding as well as other intercultural operations were carried out as per schedule. The seeds of blackgram, linseed, fieldpea and

lathyrus were sown by broadcasting the seeds in the standing crop of rice two weeks after flowering of rice (during early November) in the moist soil with a seed rate of one and half times more than the recommended rate of respective crop. The crops were evaluated in terms of blackgram seed equivalent, rice equivalent yield of the cropping systems and economic returns. Economic returns (Rs ha^{-1}) and cost of cultivation (Rs ha^{-1}) for individual crop in sequence was calculated on the basis of prevailing market rates of inputs and selling prices of produce. Net return value in terms of Rs. ha^{-1} day^{-1} was obtained by net monetary return of sequence divided by total duration of crops in that relay cropping system (Tomar and Tiwari, 1990). Blackgram seed equivalent and land utilization efficiency were computed using the following formula.

$$\text{Blackgram seed equivalent (t ha}^{-1}\text{)} = \frac{\text{Yield of the produce (t ha}^{-1}\text{) X price of the produce (Rs t}^{-1}\text{)}}{\text{Price of blackgram (Rs t}^{-1}\text{)}}$$

$$\text{Land utilization efficiency (\%)} = \frac{\text{Total duration of crop sequence}}{365} \times 100$$

RESULTS AND DISCUSSION

The yield performance of different crops (both rice and succeeding relay crops) was evaluated on pooled basis over 3 years of experimentation. Significantly the highest grain yield of rice (3.83 t ha^{-1}) was recorded in the treatment where rice-blackgram relay cropping sequence was adopted. This might be due to synergistic effect of blackgram to the succeeding rice crop through the improvement of soil fertility status. Similar effect of short duration grain-legumes was also recoded by Joy *et. al.* (1986). While considering the rice yield in terms of Rs ha^{-1}, the highest value (Rs. 17,080 ha^{-1}) was recorded in the same treatment plots (Table 1) indicating rice–blackgram as one of the most remunerative rice-based relay cropping system in coastal Orissa.

Among the succeeding relay crops, no significant difference in yield was observed in all the four relay crops tested. The crop performance in terms of growth and yield attributing characters like plant population m^{-2}, no. of pods $plant^{-1}$ and no. of seeds pod^{-1} were concerned, the linseed crop performed well (Table 2). However, the highest seed yield of 0.65 t ha^{-1} was obtained with lathyrus followed by linseed (6.44 q ha^{-1}). This might be due to relatively more tolerance of lathyrus to late season moisture stress. (Barik and Sahoo, 1990 and Jana *et al.*, 2002). In terms of blackgram seed equivalent (blackgram being the most commonly preferred crops after rice by the farmers of the region), yield of relay crops differed significantly. The blackgram seed equivalent yield of fieldpea (0.48 t ha^{-1}) was significantly superior to linseed (0.40 t ha^{-1}) and lathyrus (0.29 t ha^{-1}). This is in conformity with Joy *et al.* (1986). Further, it was observed that the rice – blackgram relay cropping sequence recorded

Table 1. Crop performance and economics and land utilization efficiency of different rice-based relay cropping systems (pooled data of three years)

Treatment	Rice grain yield (t ha^{-1})	Relay crop seed yield (t ha^{-1})	Rice equivalent yield of the cropping system (t ha^{-1})	Net return (Rs ha^{-1})	Per day return (Rs. ha^{-1} day^{-1})	Benefit: Cost ratio	Land utilization efficiency (%)
Rice – blackram	3.83	0.62	6.31	15, 916	75.1	2.43	58.1 (212)
Rice – linseed	3.80	0.65	5.41	12,627	54.0	2.18	64.1 (234)
Rice – fieldpea	3.78	0.55	5.72	12, 822	58.3	2.10	60.3 (220)
Rice – lathyrus	3.76	0.65	5.23	11, 521	53.4	2.05	58.9 (215)
CD (P = 0.05)	0.004	-	0.037	-	-	-	-

Price of paddy – Grain - Rs. 4000 t^{-1} and straw – Rs. 400 t^{-1} Figures in parentheses are total duration of crops (days) in that sequence, Cost of cultivation : T_1 Rs 11,100 ha^{-1}, T_2 Rs 10725 ha^{-1}, T_3 Rs 11,700 ha^{-1} and T_4 Rs 10, 980 ha^{-1}

Table 2. Performance of different component crops in rice-based relay cropping systems (pooled data of three years)

Utera crops	Plant population m^{-2}	Pods no. $plant^{-1}$	Seeds pod^{-1}	Seed yield (q ha^{-1})	Blackgram equivalent yield (q ha^{-1})
Blackgram	100	53	7	6.21	6.21
Linseed	240	69	7	6.44	4.03
Field pea	64	27	6	5.53	4.84
Lathyrus	65	34	4	6.53	2.86
CD (P= 0.05)	-	-	-	-	0.45

Price of blackgram Rs 16000 t^{-1} ; linseed Rs. 10000 q^{-1} ; fieldpea Rs. 14000 t^{-1} and lathyrus Rs. 9000 t^{-1}

significantly the highest rice equivalent yield of the cropping systems (6.31 t ha^{-1}) followed by rice – fieldpea sequence (5.72 t ha^{-1}) (Table 1).

Rice – linseed sequence registered the highest land-utilization efficiency (64.1%), followed by rice–fieldpea (60.3%), as these sequences occupied the field for relatively longer duration (220 – 234 days). The sequence rice – blackgram showed the lowest land-utilization efficiency (58.1%) (Table 1).

Rice – blackgram sequence fetched the highest net monetary return (Rs 15,916 ha^{-1}), followed by rice – fieldpea (Rs 12, 822 ha^{-1}) giving the highest net return ha^{-1} day^{-1}. The highest benefit: cost ratio of 2.43 was obtained in rice – blackgram sequence followed by rice-linseed (2.18). The lowest benefit: cost ratio (2.05) was recorded with rice – lathyrus relay cropping system (Table 1). Patra *et al. (*1989) and Das and Bhanja (1986) also reported that the rice– blackgram and rice – fieldpea relay cropping system were the most remunerative relay cropping systems.

Thus, considering the production and net return, it may be concluded that rice – blackgram is the most remunerative relay cropping system under rainfed shallow lowlands of coastal Orissa.

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