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Diversification of existing rice–based cropping system for sustainable productivity under assured irrigation condition for Chhattisgarh plains

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Abstract
A field experiment was conducted at research and instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *kharif*, *rabi*, and summer season of 2006-07 under AICRP- cropping system research project. The treatments were consisted of seven cropping sequences *viz*. rice-wheat-fallow, rice-mustard-green manure, rice-coriander (green leaf)-mung, rice-pea (table)-maize (F), rice-brinjal- green manure, rice-onion- green manure & rice-potato-cowpea. Among different cropping sequences evaluated rice-potato-cowpea system was identified to be most productive with rice-equivalent yield of (270.39 q ha^{-1} $year^{-1}$), production efficiency (83.97kg ha^{-1} day^{-1}), profitability (Rs. 320.36 ha^{-1} day^{-1}), relative economic efficiency (199.29 per cent) and net return of higher Rs. 116929 ha^{-1} $year^{-1}$. Vegetable based cropping sequences also showed more production efficiency, grass and net returns than a traditional sequence.

Keywords: Rice-based cropping system. Diversification, Production efficiency, Profitability, Economics, soil fertility.

Introduction

Due to diverse agro-climatic conditions in the country, a large number of crops are grown. Around 66 percent of the total cultivated area is under food grain crops (cereals and pulses). Rice (*Oryza sativa*) stand first among all food grain crop of the world and is the staple food of more than half of world's population. It contributes around 40% of the total food grain production in India. The rice occupies about 37 m ha area with an average productivity of 1 to 1.1 t/ha in our country, which is not comparable to that in developed countries. The productivity is much less compared to the developed countries. The Chhattisgarh state contributes around 56 lakhs ha covering 78 percent of the total net sown area under rain fed. The productivity of the state is 1.0 to 1.3 t/ha, which need to be increased looking to the demand of food and economic unliftment of farmers.

The Chhattisgarh state comes under sub-humid agro-climatic region in the eastern part of India is relatively underdeveloped with regards to agriculture productivity as compared to most of Indian states. Chhattisgarh has varied soil type, physio-graphic situations and favorable ecological conditions through which prosperity in the agriculture sector can be attained. The importance of highly intensive crop sequence is well recognized to meet the growing demand of ever-increasing population. An intensive cropping which is not only highly productive and profitable but also stable over time and maintains soil fertility has a great importance in present conditions (Ghosh, 1987) [6]. An intensification of cropping sequence is essential depending on the need of the area. Oilseeds and pulses including vegetables are receiving more attention owing to higher prices due to increased demand. Inclusion of these crops in a sequence changes the economics of the cropping sequences (Tomar and Tiwari, 1990) [16]. Chhattisgarh is popularly recognized as rice bowl of the country, as rice is the principal crop of this state and about 69.70 per cent of net sown area is covered under *kharif* rice. Area under rice crop in Chhattisgarh is 1262997 ha and their production is 5441525 metric tones (Anonymus, 2007) [1]. Against national area and production of rice crop is 43.81 million ha and 93.35 million tones (Anonymus, 2007) [2]. During *rabi* 16.00 lakh hectares is under cultivation with the increase in area under minor and major irrigation projects in Chhattisgarh, a number of crops can profitably be grown during the winter (*rabi)* and summer season followed by rice under irrigated conditions.

Therefore, it was considered important to identify suitable rice-based crop sequences under irrigated conditions to enhance the total productivity, profitability and cropping intensity of the state. Also crop intensification and diversification will generate employment avenues in agriculture sector along with post-harvest and processing industries.

Materials and methods

A field experiment was carried out at the research and instructional farm Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur during *kharif*, *rabi*, and summer season 2006-07.The soil of the experimental field was silty clay in texture with medium in nitrogen (254 kg ha^{-1}), phosphorus (23 kg ha^{-1}) and potassium (243 kg ha^{-1}) contents. Climate of the region is sub-humid an average annual rainfall of 1200-1400 mm.

The treatments consisted of seven cropping sequences *viz.* rice-wheat-fallow, rice-mustard-green manure, rice-coriander (green leaf)-mung, rice-pea (table)-maize (Fodder), rice-brinjal- green manure, rice-onion- green manure and rice-potato-cowpea were tested in approved design from AICRP project *i.e.* Balanced Incomplete Block Design (BIBD) with four sets in plot size of 70 m^2 each. Rice crop was raised by transplanting method. All crops were raised as per the recommended package of practices .The total rainfall received was 979.40 mm out of which the rice crop received 938.0 mm during its growth period. Presowing irrigation was applied to

ensure good germination of *rabi* and summer crops. Final crop yields (main and by-product) were recorded and their total gross returns (Rs ha^{-1}) were calculated on the basis of prevailing market price of the produce. For comparison between crop sequence the yield of all crops were converted into rice- equivalents on price basis (Manjunath *et al*., 2004) [9]. The profitability of the system was calculated by dividing the net returns ha^{-1} in a sequence by 365 days. The production efficiency value was calculated by dividing the total grain production ha^{-1} in a sequence with total duration of crops in a sequence (Tomar and Tiwari, 1990) [16]. The relative economic efficiency (REE) of the system was calculated by using the following formula:

$$\frac{B-A\times100}{A}$$

Where A, net return of existing system (Rice-wheat); B, net return of diversified /alternative expressed in percentage. The soil fertility analysis for different cropping system was made using standard method in practice.The benefit: cost ratio for different sequences was calculated dividing the net return by cost of cultivation in the system.

Results and discussion

Crop Yield

The yield of rice was the highest where inclusion of green manure or legume in system showed increasing in grain yield of rice and its effect on succeeding crops. During *rabi* season the vegetable crop like potato, brinjal, pea, onion, coriander out yielded other crops which offers good scope for their introduction. In Chhattisgarh raising of crop like maize (fodder), cowpea, moong, green manure in summer session. However vegetable crops specially potato and brinjal were found highly productive

System productivity

The total production of sequence in term of rice-equivalent yield was significantly higher in rice-potato-cowpea 270.39 q ha^{-1} (Table 2) than other sequences followed by rice-brinjal-green manure (213.9 q ha^{-1}). Significantly lower total productivity (80.06 ha^{-1}) was recorded in rice-pea (table)-maize (F) cropping sequences which were significantly lower even in comparison with existing rice-wheat cropping system. Higher production in above sequence was owing to higher quantum in terms of yield and price with comparable to vegetable crops like pea, potato, brinjal, onion and coriander etc. Choudhary *et al*. (2001) [4] also reported more productivity by replacing wheat in existing system with vegetables like radish and potato. Despite higher price of oilseed, rice-mustard could not give higher equivalent yield level when compared to other system. Inclusion of green manure crop of sunhemp along with rice and oilseed in rice-mustard- green manure could not significantly improve the productivity of cereal-oilseed cropping system in spite of improved rice yield. Inclusion of a vegetable crop of potato along with rice and pulse in rice-potato-cowpea sequence improved rice equivalent yield significantly than other rice based cropping systems, because of high yield of potato and cowpea with better remunerative price of the produce. Shah *et al*. (1999) also recorded lower rice-equivalent yield in rice-oilseed crop sequence as compared to rice-wheat. Similar results also been reported by Padhi (1993).

Production efficiency and relative economic efficiency

The maximum production efficiency (83.97 kg ha^{-1} day^{-1}) and relative economic efficiency (199.29%) was recorded in sequence of rice-potato-cowpea followed by rice-brinjal-green manure cropping sequence with 64.82 kg ha^{-1} day^{-1} and 178.33% Production efficiency and relative economic efficiency respectively (Table 2). Sequence rice-mustard-green manure had the lowest production efficiency (32.57 kg ha^{-1} day^{-1}) and relative economic efficiency (-13.49%), followed by rice-pea (table)-maize (F) (33.92 kg ha^{-1} day^{-1} and -60.97%) This was obviously due to less rice equivalent yield of mustard and pea in rice-pea-maize and rice-mustard- green manure sequence and price are important factor for influencing the production efficiency of a particular system which was the major reason for higher efficiency of rice-brinjal- green manure and rice-potato-cowpea cropping system.

Profitability

Profitability of various rice-based cropping systems was calculated and the results are presented in table 2. The maximum profitability could be obtained in an agriculture year by using rice-potato-cowpea (Rs. 320.36 ha^{-1} day^{-1}) sequence, followed by rice-brinjal- green manure sequence(Rs. 297.92 ha^{-1} day^{-1}) while lowest in rice-pea (table)-maize (F) sequence (Rs 41.78 ha^{-1} day^{-1}) followed by rice-mustard- green manure sequence. The profitability is higher of rice-potato-cowpea sequence. This might be due to higher value of total produce. Similar results have also been reported by Singh *et al.* (1997) [15] found that available nutrients like nitrogen, phosphorus and potassium was improved due to legume included in cropping sequence.

Fertility status

Among the various cropping system the incorporation of green manure was found higher status of available nutrient like N, P_2O_5, K_2O, and sulphur content in soil (Table 3). The reduction in soil fertility due to inclusion of cereal and oilseed cropping sequence may be due to higher uptake and lower addition of nutrient in soil. Inclusion of green manure and pulse crop in rice-based cropping systems increased the available nitrogen, phosphors, potash and sulphur level of soil it may be owing to addition of nutrient by biologically N-fixation by these crops. Kumar *et al*. (2001) [7] also reported that inclusion of green manure crop in the system increased the organic carbon and available N, P_2O_5, K2O and S of the soil. Similar results have been reported by Mahapatra *et al.* (2002) [8], Singh *et al.* (2004), Choudhary *et al.* (1995), and Setty *et al.* (1997) [12]. Increase in available N, P_2O_5, K_2O and S content in cropping sequences involving vegetable pea, green gram were reported by Gangwar and Ram (2005) [5].

Economics

Economic analysis (Table 4) showed that the highest gross returns (Rs. 189275 ha^{-1}) were recorded with rice-potato-cowpea followed by rice-onion- green manure (Rs. 118351 ha^{-1}). It was owing to higher system productivity over other cropping systems. The lowest gross return (Rs. 56041 ha^{-1}) were recorded in rice-pea (Table)-maize (F) followed by rice-

mustard- green manure (Rs.60868 ha^{-1}) because of lower productivity in system. Similar results have also been reported by Singh *et al.* (1997) [15] found that available nutrients like nitrogen, phosphorus and potassium was improved due to legume included in cropping sequence.

The highest net return (Rs. 116929 ha^{-1}) was recorded in rice-potato-cowpea because of higher value of the produces and proved to be the most remunerative cropping systems. Singh *et al.* (1997) [15] reported that multiple cropping systems with legumes offers special advantage to farmer. Similar results have also been reported by Saroch *et al.* (2005). Rice-brinjal-green manure was the next in order with a net return of Rs.108741 ha^{-1} the B: C ratio was also highest (2.65) of Rice-brinjal- green manure cropping sequence. The lowest economic yield from pea showed the poor net return (Rs. 15249 ha^{-1}) and B: C ratio (0.37) under rice–pea (table)-maize (F).

Thus, the existing rice based cropping system can effectively be diversified with the inclusion of vegetable crops like potato, brinjal and onion during *rabi* and cowpea, green-gram during summer season in periurban area. The rice-potato-cowpea and rice-brinjal- green manure were viable system in productivity and economical point of view but rice-onion-green manure, rice-wheat; rice-mustard-green manure systems have still scope to sustain productivity in long term basis due to better market price even in remote area.

Table 1: Cropping sequence, crop duration and fertilizer used

Treatment	Crop sequence			Fertilizer dose Kg ha^{-1} (N:P:K)			Total duration of cropping system (No. of days)
	Karif	***Rabi***	***Zaid***	***Karif***	***Rabi***	***Zaid***	
T_1	Rice (ISD-1)	Wheat (GW-273)	Fallow	100:60:40	100:60:40	-	227
T_2	Rice (ISD-1)	Mustard (Pusa-Bold)	Green manure (Sunhemp)	100:60:40	80:50:30	-	267
T_3	Rice (ISD-1)	Coriander (leaf) (Pant Dhania-1)	Moong (HUM-1)	100:60:40	80:60:60	20:50:00	284
T_4	Rice (ISD-1)	Pea (Table) (Arkil)	Maize (ProAgro-4640)	100:60:40	20:50:00	80:60:30	236
T_5	Rice (ISD-1)	Brinjal (Hybrid Nisha)	Green manure (Sunhemp)	100:60:40	120:60:40	-	330
T_6	Rice (ISD-1)	Onion (Nasik red)	Green manure (Sunhemp)	100:60:40	80:60:100	-	262
T_7	Rice (ISD-1)	Potato (Kufri Badsaha)	Cowpea (Gomti)	100:60:40	150:100:100	20:50:00	322

Table 2: Crop yield, rice-equivalent yield (REY), Production efficiency, Profitability and relative economic efficiency of different rice based cropping sequence

Treatment	Yield q ha^{-1}			Total productivity REY (q ha^{-1})				Production efficiency kg ha^{-1} day^{-1}	Profitability Rs. ha^{-1} day^{-1}	Relative economic efficiency
	K	R	S	K	R	S	Total			
Rice-Wheat-Fallow	56.53	25.76	-	56.23	40.48	-	96.71	42.60	107.03	-
Rice-Mustard-GM	61.34	8.15	-	61.34	25.61	-	86.95	32.57	92.60	-13.49
Rice-Coriander (leaf)- mung	57.55	104.34	7.96	57.55	89.43	20.47	167.45	58.97	210.43	96.59
Rice-Pea (Table)-Maize (F)	55.28	10.49	221.02	55.28	8.99	15.79	80.06	33.92	41.78	-60.97
Rice-Brinjal-GM	57.55	364.82	-	57.55	156.35	-	213.9	64.82	297.92	178.33
Rice-Onion-GM	55.05	199.54	-	55.05	114.02	-	169.07	64.53	212.77	98.77
Rice-Potato-Cowpea	55.14	221.77	35.23	55.14	190.09	25.16	270.39	83.97	320.36	199.29
SEm± CD							0.34 1.0			

K, *Kharif;* R, *Rabi*; S, summer, Farm gate price of crops (Rs.q^{-1}) year 2006-07: Rice scented Rs. 700/-, Wheat Rs. 1100/-, Mustard Rs. 2200/-, Coriander green leaves Rs. 600/-, Table pea Rs. 600/-, Brinjal Rs. 300/-, Potato Rs.600/-, Cowpea Rs. 500/-, Onion Rs. 400/-, Maize fodder Rs. 50/-, Mung Rs. 1800/.

Table 3: Soil fertility status as affected by different rice-based cropping Systems after completion of one cycle

Treatments	Available nutrient (kg ha^{-1})			
	N	P_2O_5	K_2O	S
T_1 : Rice-Wheat-Fallow	243.3	22.9	241.1	12.2
T_2 : Rice-Mustard-GM	250.5	19.4	227.1	10.2
T_3 : Rice-Coriander (leaf)-Moong	262.2	24.6	252.1	13.4
T_4 : Rice-Pea (Table)-Maize (F)	254.9	21.5	251.2	11.5
T_5 : Rice-Brinjal-GM	250.9	24.3	255.1	12.7
T_6 : Rice-Onion-GM	292.1	27.2	275.8	13.8
T_7 : Rice-Potato-Cowpea	284.3	26.9	258.2	13.4
SEm±	2.22	0.23	0.39	0.13
CD (5 %)	6.71	0.71	1.18	0.37

Table 4: Economic of different rice -based cropping sequence

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Rice-Wheat-Fallow	28628	67697	39069	1.36
Rice-Mustard-GM	27070	60868	33798	1.25
Rice-Coriander (leaf)- Mung	40412	179617	76805	1.90
Rice-Pea (Table)-Maize (F)	40792	56041	15249	0.37
Rice-Brinjal-GM	40990	149731	108741	2.65
Rice-Onion-GM	40690	118351	77661	1.91
Rice-Potato-Cowpea	72346	189275	116929	1.62

References

1. Anonymus a. Directorate of Statistics C.G. Raipur, Agriculture statistics, 2007.
2. Anonymus b. Directorate of Economic and statistics govt. of India, 2007
3. Chaudhary DC, Singh Y, Singh D, Bhardwaj AK, Singh SP. Green manuring for sustainability of rice-wheat cropping (in) Proceedings of National Symposium on Organic Farming for Sustainable Crop production and Environmental protection, organized by Agronomy Society, New Delhi, at Govind Ballabh pant University of Agriculture and Technology, Pantnagar, 1995, 61-63.
4. Chaudhary JB, Thakur RC, Bharagava M, Sood RD. Production potential and economics of rice-based cropping systems on farmers" fields under mid-hill conditions of Himachal Pradesh. Himachal J. agric. Res. 2001; 27(1-2):32-35
5. Gangwar B, Baldev Ram. Effect of crop diversification on productivity and profitability of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) system. Indian J. of Agri. Sci. 2005; 75(7):435-438.
6. Ghosh AB. Some aspects of sustainability in soil fertility and crop production. J. Indian Soc. Soil Sci. 1987; 35(4):552-565.
7. Kumar Alok, Yadav DS, Singh RM, Achal. Productivity, profitability and stability of rice (*Oryza sativa*)-based cropping systems in eastern Uttar Pradesh. Indian J. of Agron. 2001; 46(4):573-577.
8. Mahapatra BS, Ajay Kumar, Shukla DK, Shukla RK, Summer legumes in relation to productivity and fertility in rice-wheat cropping system. Paper presented at the International Agronomy Congress, held during New Delhi, 2002; 1(26-30):155-156.
9. Manjunath BL, Korikanthimah VS. Productivity under different rice based cropping systems and physico-chemical properties of soil as influenced by source of manure in Coastal Eco-System of Goa. J. Farming system Res. Dev. 2004; 10(1-2):33-40.
10. Padhi AK. Productivity and economics of rice (*Oryza sativa*)-based cropping sequences. Indian J. of Agron. 1993; 39(3):351-356.
11. Saroch Kapil, Bhargava M, Sharma JJ. Diversification of existing rice (*Oryza sativa*)-based cropping system for sustainable productivity under irrigated conditions. Indian j. Agron. 2004; 50(2):86-88.
12. Setty TKP, Gowda NAJ. Performance of rice (*Oryaza sativa*)-based cropping systems in coastal Karnataka. Indian J. Agron. 1997; 42(1):5-8.
13. Shah MH, Khan GM, Bali AS, Singh KN, Bali AS, Kanth R. Productivity potential of rice-based cropping sequences under temperate environment. Indian J. Agron. 1999; 44(1):12-15.
14. Singh G, Mehta RK, Kumar T, Singh RG, Singh OP, Kumar V. Economics of rice (*Oryza sativa*)-based cropping system in semi-deep water and flood-prone situation in eastern Uttar Pradesh. Indian J. of Agron. 2004; 49(1):10-14.
15. Singh G, Singh VP, Singh OP, Singh RK. Production potential of various cropping systems in flooed-prone areas of eastern Uttar Pradesh. Indian J. Agron. 1997; 42(1):9-12.
16. Tomar S, Tiwari AS. Production and economics of different crop sequences. Indian J. Agron. 1990; 35(1-2):30-35.