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Production potential and economic feasibility of rice-based cropping sequences on cultivators' fields under sub-montane low-hills of Himachal Pradesh

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Abstract

Five rice-based cropping sequences *viz.* rice-wheat, rice - potato, rice-wheat – French bean, rice - onion and rice - cabbage/cauliflower were evaluated on cultivators' fields for their production potential and economic feasibility under sub-montane low hill conditions of Himachal Pradesh. Four year's (2003-04 to 2006-07) results revealed that rice - wheat - French bean sequence resulted in the highest rice equivalent yield (16376 kg/ha/year), total calories, net return (Rs 100614/ha/year), B:C ratio (2.08), land utilization efficiency and production efficiency (Rs 284/ha/day). The extent of rice equivalent yield and net returns increase in rice - wheat - French bean sequence was 179.1 and 160.8%, respectively, over the conventional rice-wheat cropping sequence. The other cropping sequences (rice - potato, rice - onion and rice - cabbage/cauliflower) were also superior to conventional rice - wheat cropping sequence in influencing rice equivalent yield, net returns, B: C ratio and production efficiency. Only rice – wheat - French bean cropping sequence could excel over the rice-wheat sequence in terms of total calories. Total calories in rice-onion and rice-cabbage/cauliflower sequence were as low as 35.7 and 38.1%, respectively, over the rice-wheat cropping sequence.

Key words: Production efficiency, economics, yield, cropping sequences, rice based

Introduction

Rice-wheat is the most predominant cropping system in sub-montane low hills of Himachal Pradesh. The farmers realize much of their food security from this cropping system. The system is over-exploitative of the natural resources and consequently leads to degradation in soil health and fertility. This is ultimately leading to decrease in the yield of both rice and wheat over a longer period of time (Woodhead *et al.* 1994). Besides food security, the low production levels jeopardize farmers' economic security to a considerable extent. To strengthen the economic conditions of the farmers, it is imperative to intensify and diversify the existing rice-wheat system. In general, problems with transplahted rice are less than direct seeded rice and wheat. Therefore, to sustain the productivity in a long-term perspective, it is essential to diversify the system with more productive and profitable crops. Keeping the facts in consideration, some rice-based cropping systems were evaluated on cultivators' fields on participatory mode.

Material and Methods

A field investigation on cultivators' field was conducted for four years (2003-04 to 2006-07) at Adhwani and Chinnaur centres of district Kangra within NARP Zone I of Himachal Pradesh. Three locations (farmers) at each centre were randomly selected and considered as replications. Five rice-based cropping sequences *viz.* rice-wheat, rice - potato, rice - wheat - French bean, rice - onion and rice - cabbage/cauliflower were evaluated. The soils of the zone were inceptisols having texture varying from loamy sand to silty clay loam, with pH 5.0-7.5 and organic C 0.5-1.0%. The crops in each cropping sequence were raised in accordance with the recommended package of practices (Table 1).

Economics of the crop sequences was computed based upon the prevalent market prices (minimum support price, market price and those fixed by the university). Yields were harvested from net plot (Gross pot, 13.8 m x 7 m). The detail of harvesting is given in Table 2.

For comparison between crop sequences, the yields of crops were converted into rice equivalent on price basis. The prices of different commodities are given in Table 3.

Land utilization efficiency was worked out by summation of duration of each crop in individual crop sequence divided by 365. Production efficiency (kg/ha/day) was obtained by

Table 1. Variety of crops grown and fertilizer dose

Crop	Variety				Fertilizer dose (kg/ha)		
	2003-04	2004-05	2005-06	2006-07	N	P_2O_5	K_2O
Rice	Punjab Basmati- 386	PR-108	RP-2421	Kasturi Basmati	90	40	40
Wheat	PBW-396	PBW-396	PBW-343	HPW-184	120	60	30
Potato	Kufri Jyoti	Kufri Jyoti	Kufri Jyoti	Kufri Jyoti	120	80	60
French bean	Contender	Contender	Contender	Contender	50	100	50
Onion	AFDR	AFDR	N-53	N53	125	75	60
Cabbage	Hybrid T-676	Sumit	Sumit	Sumit	125	100	50
Cauliflower	-	-	-	Pusa Snowball-1	125	100	50

Table 2. Harvesting dates for different crops

Crop	Adhwani				Chinnaur			
	2003-4	2004-5	2005-6	2006-7	2003-4	2004-5	2005-6	2006-7
Rice	11-13 Nov	2-5 Oct	19-20 Sept	1-2 Oct	30 Oct	30-31 Oct	10-11 Oct	27-29 Oct
Wheat	14-23 April	20-21 April	16-22 April	20-26 April	20 April	28 April	25 April	24-26 April
Potato	21-25 April	20-22 May	4-5 May	23-28 April	20 May	25-26 May	18-19 May	10-11 May
French bean	28-30 June	25-26 June	21-22 June	10-16 June	6-7 July	9 July	5-6 July	1-2 July
Onion	2-3 May	15-18 May	4-6 May	1-2 May	26-27 May	26-27 May	19-20 May	23-24 May
Cabbage/ Cauliflower	23-31 March	25-28 March	29-31 March	10-18 April	22 March	17-18 April	19-20 April	10-19 April

Table 3. Prices (Rs/kg) of different commodities

Commodity	2003-04	2004-05	2005-06	2006-07
Rice grain	12.00	5.50	5.50	14.00
Wheat grain	6.25	6.30	6.50	7.50
Potato tuber	4.50	4.50	4.50	4.00
French bean pods	12.00	9.00	9.00	10.00
Onion bulb	5.00	5.00	5.00	6.00
Cabbage head	3.50	3.50	3.50	5.00
Cauliflower head	-	-	-	10.00

dividing total production in terms of rice equivalent in a sequence by the total duration of crop, while production efficiency (Rs/ha/day) was obtained by dividing net monetary return by total duration of crops in a particular sequence. Homogeneity of error variances was tested by using Bartlett χ^2 – test; which were found to be homogeneous. Therefore, the data were pooled and analyzed in randomized block design.

Results and Discussion

The data on initial soil status of the experimental sites are summarized in Table 4. Soil pH at different locations varied from 5.4 to 6.8 and from 5.2 to 7.1 in Adhwani and Chinnaur, respectively, with mean value of 6.3. The soils of the test sites, in general were medium in respect of available N, K and organic carbon and high in P status. The variation in the content of available P was large in both the farming situations and that of N and K in Chinnaur.

Crop yield

In the study years, the yields of rice, wheat, potato, French bean, onion and cabbage/cauliflower ranged between 2.22-2.86, 3.43-4.43, 14.81-18.98, 6.63-9.12, 11.60-19.33 and 17.95-30.90 t/ha, respectively (Table 5). Mean yield of rice, wheat and potato was 145, 200 and 48%, respectively, higher than the average yield of these crops in Himachal Pradesh (Anonymous 2005 and Baba 2007). Yearly variations in crop

yields were small in the study years. The CV values were < 10% for rice and wheat, and about 12% for potato.

The mean yield of French bean, onion and cabbage/cauliflower was about 20% lower than the state average yield of these crops.

Table 4. Soil fertility status of the farmers' fields before sowing of the crops

Parameter	Max	Min	Mean	Sd±	CV
Adhwani					
N (kg/ha)	443.0	301.1	365.5	37.3	10.2
P (kg/ha)	45.7	13.9	30.1	10.4	34.6
K (kg/ha)	198.1	134.7	157.7	17.9	11.4
OC (%)	0.69	0.38	0.52	0.08	16.1
pH	6.8	5.4	6.3	0.38	6.0
Chinnaur					
N (kg/ha)	603.5	276.0	386.7	102.8	26.6
P (kg/ha)	59.5	13.7	28.9	16.5	57.0
K (kg/ha)	445.7	112.0	208.1	93.6	45.0
OC (%)	0.84	0.51	0.68	0.12	16.8
pH	7.1	5.2	6.3	0.52	8.2

The yearly variation in yield indicated by CV value was about 14% for French bean and 25% for onion and cabbage/cauliflower. However, intensification of the rice-wheat system by growing French bean in between the two crops offers a bonus in spite of low yield.

Rice equivalent yield

Rice equivalent yield of all the newly introduced cropping sequences was superior to prevalent rice - wheat sequence. Rice-potato cropping sequence was equal to rice-wheat sequence during 2006-07 in terms of rice equivalent yield. Rice - wheat - French bean cropping sequence was the best in terms of rice equivalent yield (16376 kg/ha) mainly due to additional yield of French bean. The next best cropping sequence was rice - cabbage/cauliflower, while rice-potato and rice-onion were statistically at par with each other in terms of rice equivalent yield. Rice - wheat - French bean, Rice - cabbage/cauliflower, rice - potato and rice - onion copping sequences resulted in 179.1, 129.2, 94.8 and 92.4%, respectively, higher rice equivalent yield over the rice-wheat cropping sequence.

Total calories

Rice - wheat - French bean cropping sequence excelled over the rice-wheat sequence in terms of kilocalories. Rice - potato was statistically at par with rice - wheat. In spite of tremendous increase in rice equivalent yield, total calories of rice - onion and rice - cabbage/cauliflower sequences were only 64.3 and 61.9% of rice - wheat cropping sequence.

Net return and B:C ratio

Rice- wheat- French bean sequence fetched the highest net returns (Rs 100614/ha/annum) (Table 6) due to higher yields. This was followed by rice-cabbage/cauliflower sequence (Rs 67036/ha/annum). Thakur *et al* (1994) and Chaudhary *et al* (2001) have also documented higher net income by diversification and intensification of the existing rice-wheat cropping system. Rice - onion cropping sequence was as good as rice - cabbage/cauliflower in terms of net returns. Rice – wheat - French bean, Rice - cabbage/cauliflower, rice - onion and rice - potato copping sequences resulted in 160.8, 73.7, 60.5 and 36.3%, respectively, higher net returns over the rice - wheat cropping sequence. Rice - wheat - French bean resulted in the highest B: C ratio of 2.08, followed by rice-onion cropping sequence. However, rice-onion as well as rice-cabbage/cauliflower and rice-potato were statistically at par with rice-wheat sequence in terms of B: C ratio.

Production efficiency

Land use efficiency ranged between 66.2 and 97.3% under different cropping systems. Rice-wheat-French bean sequence occupied the land for longer duration and thus had higher land utilization index than rice-wheat and other cropping sequences. Rice-onion, rice-potato and rice-cabbage/cauliflower occupied the land for a shorter duration than rice-wheat cropping sequence. All the cropping sequences resulted in higher production efficiency in terms of kg/ha/day as well as Rs/ha/day over the rice-wheat cropping

sequence. Rice-cabbage/cauliflower cropping sequence recorded the greatest production efficiency (kg/ha/day) followed by 'Rice-wheat-French bean'. However, 'rice-wheat-French bean' was at par with rice-potato and rice-onion cropping sequences in terms of production efficiency (kg/ha/day). Rice-wheat-French bean sequence recorded greater production efficiency in terms of Rs/ha/day (284) and was at par with rice-cabbage/cauliflower (Table 6).

Thus it is concluded that farmers of low hills of HP can adopt rice - wheat - French bean as well as rice - cabbage/cauliflower, rice-potato and rice - onion cropping sequences for higher net income.

Table 5. Yield and returns under different rice based crop sequence in low hills of HP

Crop sequence	Yield* (t/ha)			Rice equivalent (kg/ha)	Total calories (K x 1000)
	Kharif	*Rabi* I	*Summer*		
				2003-04	
Rice-wheat	2.79	4.31	-	5.03	21365
Rice-potato	2.84	18.98	-	9.95	24986
Rice-wheat-French bean	2.86	4.30	6.63	11.73	23228
Rice-onion	2.83	19.33	-	10.88	16223
Rice-cabbage	2.84	30.90	-	11.85	14920
LSD (P=0.05)				0.99	2386
				2004-05	
Rice-wheat	2.50	3.43	-	6.44	17686
Rice-potato	2.49	14.81	-	14.61	20145
Rice-wheat-French bean	2.50	3.67	9.10	21.60	20850
Rice-onion	2.60	11.60	-	13.15	11835
Rice-cabbage	2.50	22.26	-	16.67	11807
LSD (P=0.05)	-			5.03	4344
				2005-06	
Rice-wheat	2.24	4.26	-	7.28	19943
Rice-potato	2.22	15.04	-	14.52	19726
Rice-wheat-French bean	2.30	4.32	8.22	20.85	22394
Rice-onion	2.28	12.27	-	13.44	11417
Rice-cabbage	2.33	20.36	-	15.28	10887
LSD (P=0.05)	-	-	-	4.22	5185
				2006-07	
Rice-wheat	2.37	4.39	-	4.73	20702
Rice-potato	2.36	14.97	-	6.64	20001
Rice-wheat-French bean	2.45	4.43	9.12	11.33	23353
Rice-onion	2.45	12.20	-	7.68	11787
Rice-cauliflower/cabbage	2.38	17.95	-	10.01	11693
LSD (P=0.05)	-	-	-	2.26	5866
				Mean	
Rice-wheat	2.48	4.10		5.87	19924
Rice-potato	2.48	15.95		11.43	21214
Rice-wheat-French bean	2.53	4.18	8.27	16.38	22456
Rice-onion	2.54	13.85		11.29	12816
Rice-cauliflower/cabbage	2.51	22.87		13.45	12327
LSD (P=0.05)	-	-	-	1.81	2135

K. cal./100 g: rice & wheat 346; potato 97; French bean 26; Onion 50; Cabbage 27; Cauliflower 66.

Table 6. Economics of different crop sequences, duration and production efficiency in Kangra

Crop sequences	Returns (Rs/ha)		B:C ratio	Duration (Days)	LUE* (%)	Production efficiency	
	Gross	Net				kg/ha/day	Rs/ha/day
				2003-04			
Rice-wheat	74067	49840	2.06	272.2	74.6	18.5	183.4
Rice-potato	123297	84936	2.17	256.2	70.2	38.7	329.7
Rice-wheat-French bean	156160	111452	2.52	341.7	93.6	34.3	326.4
Rice-onion	134445	97641	2.65	265.0	72.6	41.2	370.0
Rice-cabbage	146058	96891	1.96	239.3	65.6	49.6	405.4
LSD (P=0.05)	-	11784	0.30	11.6	3.2	3.9	45.7
				2004-05			
Rice-wheat	48449	22640	0.88	305.0	83.3	21.1	74.4
Rice-potato	84172	44411	1.12	282.7	77.2	52.4	160.8
Rice-wheat-French bean	133383	86625	1.85	365.5	99.9	59.2	237.5
Rice-onion	76382	38084	0.99	295.2	80.6	43.9	125.3
Rice-cabbage	95623	44754	0.88	251.2	68.6	65.4	171.9
LSD (P=0.05)	-	26874	0.65	13.0	3.5	17.4	93.7
				2005-06			
Rice-wheat	54685	28877	1.12	287.2	78.7	25.4	100.9
Rice-potato	83235	43474	1.09	256.0	70.1	55.8	164.3
Rice-wheat-French bean	130585	83827	1.79	352.2	96.5	59.2	237.8
Rice-onion	77324	39026	1.02	260.0	71.2	50.8	144.5
Rice-cabbage	87558	36689	0.72	231.0	63.3	64.3	146.8
LSD (P=0.05)	24039	24039	0.60	7.8	2.1	15.1	NS
				2006-07			
Rice-wheat	82003	52973	1.82	306.8	84.1	15.4	173.1
Rice-potato	97343	37527	0.63	275.2	75.4	23.8	131.1
Rice-wheat-French bean	176463	120553	2.16	362.2	99.2	31.4	334.5
Rice-onion	111257	73011	1.91	280.7	76.9	27.1	256.3
Rice-cauliflower/ cabbage	143696	89811	1.67	245.7	67.3	40.1	355.2
LSD (P=0.05)	33504	33504	0.74	10.0	2.7	7.2	112.7
				Mean			
Rice-wheat	64800	38583	1.47	292.8	80.2	20.1	132.9
Rice-potato	97218	52587	1.25	267.5	73.2	42.7	196.5
Rice-wheat-French bean	149014	100614	2.08	355.4	97.3	46.0	284.0
Rice-onion	99853	61940	1.64	275.2	75.3	40.7	224.0
Rice-cabbage/cauliflower	118287	67036	1.31	241.8	66.2	54.9	269.8
LSD (P=0.05)	12558	13002	0.31	5.6	1.5	6.1	47.8

*LUE, Land utilization efficiency

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