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Assessment of rice based multiple cropping system at Bansagar area of Kymore Satpura region

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Abstract

Present field study was conducted under All India Coordinated Research Project on Farming System during 2022-2023 & 2023-2024. The study reveals that residual effect of rice-pea+mustard-green manure, rice-pea-green gram and rice-potato-green gram was found better as grain yield of rice was increased by 13-15% compared to existing rice-wheat system. Under different cropping system rice equivalent yield varied from 102.26 q/ha in rice-gram + mustard - green manure to 337.05 q/ha in rice - garlic. All the cropping system gave higher rice equivalent yield than existing rice - wheat except rice- barley and rice -gram + mustard-green manure. Sustainable yield index 0.91 was under rice-pea-green gram & rice berseem followed by rice-wheat & rice-toria-onion. Net profit was higher under all cropping system 4% to 292% but maximum net profit Rs. 521278 /ha and B:C ratio 3.17 was noted under rice-garlic followed by Benefit ratio 2.83 in rice-barley-bajra fodder cropping system.

Keywords: Multiple cropping system, residual effect of different *rabi* crops, sustainable yield, land use efficiency

Introduction

Rice - wheat is the dominating cropping system in of Rewa region of Madhya Pradesh. The climatic & soil condition of Rewa region is most suitable to rice crop which is cultivated in 6.12 lakh ha with the production of 5.57 lakh tonnes and average productivity of rice is 911 kg/ha which is quite low as compared to state and national average. Looking to climatic and soil condition it is not possible to replace rice in *kharif* by which only option left to diversify wheat by some other profitable crops like berseem, potato, onion, garlic, gram and barley. These crops have been found productive and profitable over existing wheat. Umarani *et al.* 1992^[9] reported that pulses and oilseed crop are preferable than cereal- cereal sequence. Kumpawat (2001)^[5] suggested that incorporation of vegetable, oilseeds and pulses in a cropping system has more benefits than wheat. Results of several experiment showed that intercropping significantly increases the yield as compared to sole cropping. This benefits are attained without the use of costly inputs and by implying the simple technique of growing crops in pairs make them profitable. In various region of the country it has been found that rice - potato, rice – berseem, rice- gram + mustard, rice-garlic, rice -gram and rice – toria-onion have been found profitable as compared to rice- wheat system (Upadhyay (2007)^[10], Chouriya *et al.* (2016)^[2], Jugnahake *et al.* (2018)^[3], Pradhan *et al.* (2020)^[6] and Sirse *et al.* (2019)^[8].

Continuous cropping of rice-wheat has also connected to development of soil sickness (Kharub *et al.*, 2003)^[4]. Both crops are exhaustive in nature, therefore productivity is decreasing day by day and also developed severe weed problem in the area. Therefore, it become essential to include some other profitable crops like onion, garlic, berseem, barley and pea in rotation. Keeping above facts in view present experiment was taken.

Materials and Methods

Present experiment was taken under All India Coordinated Research Project Integrated Farming System, Kuthuliya farm, College of Agriculture, J.N.K.V.V. Rewa (M.P) during 2022-23 and 2023-24. The experimental field was silty clay loam in texture, neutral in soil reaction (PH 7.1),

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low in organic carbon (0.33%), low in available nitrogen (163.8 kg/ha) and Potash (219.16 by kg/ha). Rice crop was transplanted on 7th July 2022 and on 13th July 2023. The present experiment was taken in RBD. Cropping Systems were T1 – Rice-wheat, T2– Rice – Barley-Green Manure, T3-Rice-Gram + Mustard-Green Manure, T4 – Rice- Pea + Mustard-Green manure, T5-Rice- Potato - Green gram, T6-Rice-Pea Arkel - Green gram, T7- Rice - Berseem, T8-Rice - Barley Fodder - Bajra fodder, T9-Rice- Garlic and T10- Rice – Toria- onion.

Rice variety was Danteshwari in Rice - wheat, Rice- barley, Rice-Gram + Mustard-Green Gram, Rice – Pea + Mustard - Green manure, Rice - Potato - Green Gram, Rice- Pea - Green Gram, Rice- Barley- Bajra (fodder) and Rice - Toria - onion cropping system. Rice variety PS-5 was taken in Rice-Berseem and Rice -garlic cropping system. The recommended variety of different *rabi* crops for irrigated condition of Rewa region were taken. All the recommended package of practices were adopted for irrigated condition. Error variances for grain yield data were found homogenous therefore data has been presented on pooled basis. Land utilization efficiency was calculated by summing the duration of different crop, divided by 365 days and multiplied by 100. Sustainable Yield Index was calculated by following formula on the basis of grain yield for last 5 years under different cropping system,

$$SYI = (GY-SD)/Y_m$$

Where GY is the average grain yield, SD is the standard deviation and Y_m is the maximum grain yield under different cropping system over study period.

Results and Discussion

1. Performance of different crops

Grain yield of rice under different cropping system have been given in Table 1. After perusal of data it is evident that grain yield of rice 46.88 q/ha was obtained under existing rice- wheat system which was lowest under all cropping system which was except rice-toria-onion. All other cropping system gave 4% to 15% higher rice grain yield as compared to existing rice-wheat system. The maximum grain yield of rice 54.18 q/ha was obtained in rice-barley- bajra fodder cropping system followed by 53.3 q/ha in rice-potato-green gram and rice-gram + mustard-green manure cropping system. These cropping systems gave 13% to 15% higher rice yield as compared to existing rice-wheat. It may be due to favorable and carry over residual effect of gram + mustard-green manure, potato-green gram and barley-bajra fodder cropping system. Residual effect of these cropping system gave superior growth and yield attributing character by which grain yield of rice was increased in these cropping system as compared to existing rice- wheat. Inclusion of pulses and green manure in cropping sequence ameliorate the soil fertility. These findings are in conformity with the findings of Choriya *et al.* (2016) [2], Sirse *et al.* (2019) [8] and Pradhan *et al.* (2020) [6]. Grain and economical yield of different *rabi* & *summer* crops has been given in Table 1. All the yield data were converted into rice equivalent yield which is given in Table 2.

2. Rice equivalent yield and System Productivity

To evaluate the different cropping system, yield of different cropping systems were converted into rice equivalent yield which is given in Table 2. It is clear from the data that rice equivalent yield was affected significantly under different cropping system. Existing rice- wheat cropping system gave

118.22 q/ha rice equivalent yield which was superior over rice-barley and rice-gram+ mustard. Other cropping system like rice-pea+mustard-green manure, rice- potato-green gram, rice-pea-green gram, rice- berseem, rice-garlic and rice-toria-onion gave more rice equivalent yield over rice-wheat system by 11% to 185%. Maximum rice equivalent yield 337.05 q/ha was noted under rice-garlic followed by 209 q/ha in rice- potato-green gram. These cropping system gave significantly maximum rice equivalent yield by 76% to 185% over rice-wheat system.

System Productivity of different cropping system have been given in Table 2. reveals that rice- garlic cropping system gave maximum system productivity 117.48 kg/ha/day which was maximum followed by 65.31 kg grain/ha/day in rice-potato-green gram and 64.7kg grain/ha/day in rice- toria-onion. These cropping system gave 64% to 158% higher system productivity on the basis of per day over existing rice-wheat.

3. Sustainable Yield Index

Sustainability of different cropping system have been calculated in terms of sustainable yield index which is given in Table 2. It is clear from the data that rice- berseem and rice- pea- green gram were found more sustainable as compared to rest of the cropping system under study. Rice- wheat cropping system gave sustainable yield index 0.9 but were found inferior than rice-berseem and rice- pea-green gram. It is due to stability in yield in different years by which these cropping system have been found more sustainable in Kymore Satpura Plateau of Rewa region (Jugnahake *et al.* 2018 and Pradhan *et al.* 2020) [3, 1].

4. Land Utilization Efficiency

Land Utilization Efficiency has been given in Table 2 make it clear that land utilization efficiency in rice- barley -bajra fodder system was 96% while lowest land use efficiency 65.75% was noted in rice- wheat cropping system. Rice- potato- green gram and rice- pea- green gram gave 84.93% land utilization efficiency which was found superior than existing rice-wheat. These findings are also supported by Sirse *et al.* 2019 [8].

5. Gross and Net Return

Data in respect to gross and net return from different cropping system has been given in Table 3. It is evident that gross return in existing rice-wheat cropping system was lowest Rs. 230541/ha followed by rice-gram + mustard. Other cropping system gave higher gross return as compared to existing rice-wheat system by 3% to 225% and maximum gross return Rs. 751428 /ha was noted under rice- garlic followed by Rs. 498258/ ha under rice-potato-green gram and rice- toria- onion (Rs. 426706/ha). These cropping system gave 85% to 225% higher gross return. Similarly, the net profit Rs. 521278 /ha was maximum in rice- garlic followed by Rs. 303471/ha in rice- potato- green gram. All other cropping system gave higher net profit by 4% to 99% over existing rice-wheat system. It may be due to higher yield and higher market price gave higher gross & net return. Jugnahake *et al.* 2018 [3] and Pradhan *et al.* 2020 [6] have also reported the higher net profit from rice -garlic while Upadhyaya *et al.* (2007) [10] reported the higher net profit from rice- berseem over existing rice- wheat system.

Benefit cost ratio has been given in Table 3 reveals that benefit cost ratio 3.17 was maximum under rice -garlic followed by 2.83 under rice -barley fodder cropping system. Other cropping system except rice - pea -green gram gave higher B:C ratio over existing rice -wheat system. Lower B:C ratio in rice -pea -green gram was due to higher picking charges of pea and green gram.

Table 1: Economical Yield q/ha of different cropping system *Kharif Mean Rabi Mean Summer Mean*

Treatment	Kharif Mean (2022-23)	Kharif Mean (2023-24)	Rabi Mean (2022-23)	Rabi Mean (2023-24)	Summer Mean (2022-23)	Summer Mean (2023-24)	Overall Mean (2022-24)	Notes
T1 - Rice (Danteshwari)-Wheat (HD02864)	42.53	51.24	51.33	52.36	-	-	49.93	-
T2 - Rice (Danteshwari)-Barley (Geetanjali)-GM	45.53	60.71	50.43	54.15	9.3G, 9.98M	7.93G, 8.26M	78.08	GM = Green Manure
T3 - Rice (Danteshwari)-Gram (JG322)+Mustard (Pusabold)-GM	50.51	56.09	50.36	54.20	9.45GG	7.16GG	53.3	GG = Green Gram
T4 - Rice (Danteshwari)-Pea (Arkel)+Mustard (Pusabold)-GM	40.83	56.92	40.80	60.36	54.60P	58.10P	54.18	P = Pea
T5 - Rice (PS-5)-Berseem (JB-1)	45.96	62.40	508.60B	532.00B	-	-	520.3	B = Berseem Fodder
T6 - Rice (Danteshwari)-Toria (T-9)-Onion (AFLR)	40.06	52.59	8.28T	6.33T	212.33O	183.85O	46.32	T = Toria, O = Onion
T7 - Rice (Danteshwari)-Potato (Kurfi Chandramukhi)-Greengram (PDM-139)	50.51	56.09	-	-	207.60GG	157.50GG	182.55	GG = Green Gram
T8 - Rice (Danteshwari)-Pea (Arkel)-Greengram	50.36	54.20	-	-	54.60P	58.10P	56.35	P = Pea, GG = Green Gram
T9 - Rice (PS-5)-Garlic (G-1)	40.80	60.36	-	-	460F	509.30F	484.6	F = Fodder
T10 - Rice (Danteshwari)-Toria (T-9)-Onion (AFLR)	40.06	52.59	8.28T	6.33T	212.33O	183.85O	46.32	T = Toria, O = Onion
Sem+	1.49	1.86	1.67					
CD at 5%	4.31	5.50	4.95					

P = Pea, F = Fodder, M = Mustard

O = Onion, GG = Green gram, G = Gram S = Berseem seed

Table 2: Rice equivalent yield System Productivity, Sustainable yield index and Land utilization efficiency of different cropping system

Treatment	Rice equivalent yield (q/ha)	System Productivity (kg/gm/ha/ day)	Sustainable yield index	Land utilization Efficiency (%)
T1-Rice (Danteshwari)-Wheat (HD02864)	118.22 (0.00%)	39.31 (0.00%)	0.90	83.75
T2-Rice (Danteshwari)-Barley (Geetanjali)-GM	108.27 (-8.5%)	36.12 (-9%)	0.88	83.3
T3-Rice (Danteshwari)-Gram (JG322)+Mustard (Pusabold)-GM	102.26 (-13.6%)	32.37 (-18%)	0.81	83.3
T4-Rice (Danteshwari)-Pea (Arkel)+Mustard (Pusabold)-GM	131.27 (11.1%)	41.67 (6%)	0.82	83.3
T5-Rice (Danteshwari)-Potato (kurfichandramukhi)-Greengram (PDM-139)	209.00 (76%)	65.31 (66%)	0.80	84.93
T6-Rice (Danteshwari)-Pea (Arkel)-Greengram	140.22 (18.6%)	43.94 (11%)	0.91	84.93
T7-Rice (PS-5)-Berseem (JB-1)	132.35 (11.1%)	43.34 (10%)	0.91	83.65
T8-Rice (Danteshwari)-Barley fodder (JB-58)-Bajra fodder	152.28 (28%)	44.04 (12%)	0.81	96.00
T9-Rice (PS-5)-Garlic (G-1)	337.05 (185%)	117.48 (158%)	0.76	76.7
T10-Rice (Danteshwari)-Toria (T-9)-Onion (AFLR)	194.10 (64%)	64.7 (64%)	0.89	84.93
Sem ±	4.17			
CD at 5%	12.34			

Figures in parenthesis are % over rice- wheat

Table 3: Cost of Cultivation, Gross return, Net return and B:C ratio

Treatment	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs/ha)	B:Cratio
T1-Rice (Danteshwari)-Wheat (HD02864)	97552	230541 (0.00%)	132944 (0.00%)	2.34 (0.00%)
T2-Rice (Danteshwari)-Barley (Geetanjali)-GM	98674	238290 (3%)	139616 (5%)	2.41 (2%)
T3-Rice (Danteshwari)-Gram (JG322)+Mustard (Pusabold)-GMT4Rice (Danteshwari)-Pea (Arkel)+Mustard (Pusabold)-GM	89416	228455 (-1%)	139039 (4%)	2.51 (7%)
T5-Rice (Danteshwari)-Potato (kurfichandramukhi)-Greengram (PDM-139)	118995	289112 (25%)	170117 (27%)	2.44 (4%)
T6-Rice (Danteshwari)-Pea (Arkel)-Greengram	154787	458258 (98%)	303471 (128%)	2.57 (9%)
T7-Rice (PS-5)-Berseem (JB-1)	133956	309161 (34%)	175205 (31%)	2.29 (-3%)
T8-Rice (Danteshwari)-Barley fodder (JB-58)-Bajra fodder	110940.5	292238 (26%)	181297 (36%)	2.63 (12%)
T9-Rice (PS-5)-Garlic (G-1)	116503	329562 (42%)	213059 (60%)	2.83 (20%)
T10-Rice (Danteshwari)-Toria (T-9)-Onion (AFLR)	230505	751428 (225%)	521278 (292%)	3.17 (35%)
	161033	426706 (85%)	265673 (99%)	2.64 (12%)

Figures in parenthesis are % over rice-wheat

Conclusion

On the basis of experiment conducted it has been concluded that best pre-dominant cropping system in Bansagar area of Kymore Satpura region is rice -wheat -fallow. The best cropping system for soil health improvement was rice-pea+ mustard -green manure as it improve the organic carbon content by 71.79% over

initial status and gave net profit Rs. 170117/ha. Rice potato-green gram is good for family nutrition while rice- barley- bajra fodder gave more fodder yield. Rice-garlic cropping system gave higher rice equivalent yield 337.05 q/ha, net profit Rs. 521278/ ha and B:C ratio 3.17. Rice-garlic was found best for income enhancement of farmers.

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