



Plant Archives

Journal homepage: <http://www.plantarchives.org>

DOI Url : <https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.1.346>

EVALUATION OF NEED BASED INTENSIVE CROPPING SYSTEM IN KYMORE- SATPURA REGION OF MADHYA PRADESH INDIA

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(Date of Receiving-24-01-2026; Date of Revision-21-03-2026; Date of Acceptance-02-04-2026)

ABSTRACT

Experiment entitled “Evaluation of need based intensive cropping system in Kymore – Satpura region of Madhya Pradesh” was conducted under All India Coordinated Research Project on Integrated Farming System during the year 2021- 22 to 2024-25. The Study reveals that grain yield of rice was increased by 10% to 14.56% when rice was grown after barley, Gram + mustard - green manure, Potato - green gram and pea(pod) - green gram as compared to rice grown after wheat. The best existing cropping system was rice – wheat. Soil health improvement was better under rice – gram + mustard – green manure cropping system as it improved the soil organic carbon by 71.71% and available nitrogen 54% over initial status. Family nutrition was better under rice – potato – green gram which gave gross return Rs. 388447/ha and net profit Rs. 238316/ha. Fodder production was maximum in rice – barley – bajra fodder cropping system. Rice – garlic cropping system gave maximum gross return Rs. 752749/ha and net profit Rs 497736/ha and was most suitable for income enhancement. Rice – oat + wheat cropping system gave maximum yield 119.33 q/ha which was most suitable for concentrate production of cattle feeding. Sustainability of rice–berseem cropping system was maximum as it gave sustainable yield index 0.83 followed by rice – wheat (0.80) cropping system. System productivity 109.21 kg rice grain /ha/day was maximum in rice – garlic followed by 59.59 kg rice grain /ha/day under rice – potato – green gram. Land utilization efficiency 98.56% was maximum under rice – barley – bajra fodder cropping system followed by 92.87% under rice – potato – green gram and rice – pea(pod) – green gram cropping system.

Key words: Cropping system, Rice equivalent yield, System productivity and sustainable yield index (Sustainability)

Introduction

Rice and wheat are the dominant crops in Kymore Satpura Plateau of Madhya Pradesh. Rice crop occupies an area of 2.80 lakh ha with the production of 11.17 lakh tonnes and average productivity of 3990 Kg/ha. The wheat is cultivated over an area of 3.46 lakh ha with the production of 9.91 lakh tonnes. Rice – wheat is the most dominant cropping system in Kymore – Satpura plateau which cover more than 3.16 lakh hectares area and other predominant cropping systems are rice – gram and rice – barley. Among different cropping system rice – wheat cropping system is widely adopted by the farmers of Kymore Satpura Plateau due to stable production and less labour requirement (Kumar *et al.*, 2001). Continuous

adoption of rice – wheat system brings reduction in productivity, fields become infested with particular type of weeds and pest. Development of soil sickness due to continuous adoption of rice – wheat become serious problem in Kymore Satpura Plateau (Kharub *et al.*, 2003). The soil and climatic condition are more suitable for rice cultivation in *Kharif* therefore it is not possible to replace rice in *Kharif*. Therefore, only option is left to replace wheat in *rabi* by some more remunerative crops like pea, potato, onion, garlic and berseem.

Several workers have reported that the cultivation of berseem, potato, garlic, onion and mustard are found more remunerative than wheat when taken after rice (Chouriya *et al.*, 2017, Pradhan *et al.*, 2020 and Yadav

Table 1: Economic yield of different season, Rice equivalent yield, system productivity, sustainable yield index and land utilization efficiency of different cropping system.

4 years pooled data							
Treatment	Yield q/ha			RE	SP	SYI	LUE
	Kharif	Rabi	Summer				
T ₁ Rice-wheat	45.30(00.00%)	53.36	-	100.89(0.00%)	37.99(0.00%)	0.80	76.71%
T ₂ Rice-Barley-green manure	49.89(10.13%)	69.02	54.86	109.52(8.55%)	33.85(-5.63%)	0.77	90.13%
T ₃ Rice-Gram+Mustard-GM	50.65(11.812%)	9.01G9.54M	77.34	100.19(-0.69%)	33.40(-12.08%)	0.57	90.13%
T ₄ Rice-Pea+Mustard-GM	48.75(7.61%)	30.25P8.88M	74.41	116.99(15.95%)	38.80(2.13%)	0.59	90.13%
T ₅ Rice- Potato- Green gram	49.6(9.49%)	195.15	7.40	187.20(85.54%)	59.59(56.85%)	0.78	92.87%
T ₆ Rice-Pea(pod)-Green gram	51.90(14.56%)	56.00	8.15	140.18(38.94%)	42.64(12.24%)	0.69	92.87%
T ₇ Rice- Berseem	43.73(-11.29%)	727.85	30.8	132.59(31.42%)	43.14(13.55%)	0.83	88.76%
T ₈ Rice - Barley-Bajra fodder	50.65(11.81%)	526.1	546.8	151.59(50.25%)	45.04(18.55%)	0.65	98.57%
T ₉ Rice- Garlic	46.37(2.36%)	134.39	-	336.79(233.81%)	109.21(187.47%)	0.59	80.54%
T ₁₀ Rice-Toria-onion	47.82(5.56%)	7.12	175.7	190.96(89.27%)	57.61(50.46%)	0.57	88.36%
T ₁₁ Rice-Barley+Chickpea	47.61(5.09%)	32.58B5.17G	-	101.63(0.733%)	37.74(-0.65%)	0.69	76.43%
T ₁₂ Rice- Oat+ Wheat	43.61(-3.73%)	32.902O 30.57W	-	119.33(18.27%)	42.53(11.95%)	0.64	78.90%
SEM CD at 5%	1.6154.71	—	—	4.1011.96	—	—	

RE: Rice equivalent yield q/ha; SP: System productivity kg/ha/day; SYI: Sustainable yield index; LUE: Land utilization efficiency; GG = Green gram, G = Gram, S = Berseem seed, P = Pea, F = Fodder, M = Mustard, O = Onion
Figures in parenthesis are % over rice-wheat

et al., 2025). In different regions of country rice – potato, rice – mustard, rice – vegetable pea, rice – garlic and rice – onion are found more beneficial than rice – wheat system. Inclusion of pulses in sequence ameliorate the soil fertility and improve the soil physical condition by adding organic matter (Kumpawat 2001). Keeping above facts in view present experiment was taken under All India Coordinated Research Project on Integrated Farming System at College of Agriculture, Rewa.

Materials and Method

The Present experiment was under taken under All India Coordinated Research Project on Integrated Farming System during the year 2021-22, 2022-23, 2023-24 and 2024-25 at Kuthuliya farm of JNKVV College of Agriculture, Rewa Madhya Pradesh. Twelve cropping Systems (T₁ Rice-wheat, T₂ Rice – Barley - Green Manure, T₃ Rice - Gram + Mustard - Green Manure, T₄ Rice - Pea(pod) + Mustard-Green manure, T₅ Rice - Potato - Green gram, T₆ Rice - Pea(pod) - Green gram, T₇ Rice - Berseem, T₈ Rice – Barley - Bajra fodder, T₉ Rice - Garlic, T₁₀ Rice – Toria - onion, T₁₁ Rice – Barley + Chickpea and T₁₂ Rice – Oat + Wheat) were taken in Randomized block design with three replications. The present experiment was started in the year 2017- 18 and same layout plan in the same field was taken. All the recommended package of practices were adopted for different cropping system irrigated condition. The experimental field was silty clay loam in texture, neutral

in soil reaction (pH 7.1), low in organic carbon (0.39%), available nitrogen (163.8 kg/ha) and Potassium (219.76 kg/ha) and medium in available phosphorus (16.33kg/ha).

Error variances for rice equivalent yield were subjected to test of homogeneity which were found homogenous therefore data has been presented on 4 years 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 rice equivalent yield for last 8 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.

Result and Discussion

Performance of rice

Performance of rice under different cropping system has been given in Table 1. It is evident from the data that rice yield was affected significantly under different cropping system due to residual effect of different cropping system. Rice – pea(pod) – green gram gave maximum rice yield 51.9 q/ha followed by rice – gram +

Table 2: Gross and net profit under different cropping system.

4 years pooled data				
Treatment	Cost of Cultivation (Rs/ha)	Gross return (Rs/ha)	Net profit (Rs/ha)	B:C ratio
T ₁ -Rice-Wheat	104802	231082(0.00%)	124922(0.00%)	2.17
T ₂ -Rice-Barley-GM	104842	243840(5.52%)	137998(10.46%)	2.30
T ₃ -Rice-Gram+Mustard-GM	97086	223555(-3.25%)	126469(1.23%)	2.30
T ₄ -Rice-Pea+Mustard-GM	113857	260103(12.55%)	146247(17.07%)	2.29
T ₅ -Rice-Potato-Green gram	158464	388447(68.09%)	238316(90.77%)	2.36
T ₆ -Rice-Pea-Green gram	135568	291944(26.33%)	176375(41.18%)	2.30
T ₇ -Rice-Berseem(seed+fodder)	116981	294936(27.63%)	562538(350.30%)	2.52
T ₈ -Rice-Barley-Bajra fodder	121508	344486(49.07%)	222978(78.49%)	2.84
T ₉ -Rice-Garlic	255013	752749(225.74%)	497736(298.43%)	2.90
T ₁₀ -Rice-Toria-Onion	172115	435817(88.59%)	263703(111.09%)	2.49
T ₁₁ -Rice-Barley+Chickpea	106014	267362(29.15%)	161348(29.15%)	2.10
T ₁₂ -Rice-Oat-Wheat	105941	281639(21.87%)	175698(40.64%)	2.65

Figures in parenthesis are % over rice- wheatc

mustard – green manure and rice – barley – bajra fodder cropping system (50.65q/ha). Rice yield was 49.60q/ha in rice – potato – green gram and 49.89 q/ha in rice – barley – green manure. These cropping system gave higher yield of rice by 7.61% to 14.56% over existing rice – wheat system. These cropping system gave higher yield due to superior chemical properties of soil in which organic carbon was higher by 15.38% to 71.71% and available nitrogen by 23% to 54.45% over initial status. Similarly available potassium status was also increased under these cropping system. Improvement in soil physical condition, organic carbon content and more availability of nutrient gave superior growth and yield attributes which finally increased the rice yield. Positive residual effect of barley, potato, green gram, mustard on succeeding rice by 4% to 15% over existing rice – wheat system was reported by Yadav *et al.*, (2025). Several workers like Pradhan *et al.*, (2020) and Sirse *et al.*, (2019) have also supported the above findings.

Performance of different *Rabi* and *Summer* crops

Economical yield of different *rabi* and *summer* crops have been presented in Table 1. These yield data were converted into rice equivalent yield due to different nature and after adding rice yield it has been presented on yearly basis which is given in Table 1.

Rice equivalent yield

Yield of different cropping system were converted into rice equivalent yield which is given in Table 1. It is clear from the data that all the cropping system gave 8% to 233.81% higher rice equivalent yield over existing rice – wheat except rice – gram + mustard – green manure and rice – barley + chickpea cropping system. Maximum rice equivalent yield 336.79q/ha was noted in rice - garlic

followed by 190.96 q/ha in rice – toria – onion and 187.2 q/ha in rice – potato – green gram. These cropping system gave 85.54% to 233.81% higher rice equivalent yield as compared to existing rice – wheat cropping system. Other cropping system like rice – barley – green manure, rice – pea + mustard – green manure, rice – pea(pod) – green gram and rice – berseem were also found superior over rice – wheat system which gave 8% to 50.25% higher yield over existing rice – wheat cropping system. Yadav *et al.*, (2025) also reported higher rice equivalent under rice – potato, rice – garlic and rice – toria- onion by 11% to 185% over rice – wheat system.

System productivity

System productivity of different cropping system have been given in Table 1 make it clear that system productivity of different cropping system varied from 33.4 kg rice grain/ha/day to 109.21 kg rice grain/ha/day. Existing rice – wheat system gave system productivity 37.99 kg rice grain /ha/day while system productivity under rice – barley – green manure, rice – gram + mustard – green manure and rice – barley + chickpea was negative over existing rice – wheat system. System productivity was higher by 2.13% to 187.47% under rice – pea + mustard – green manure , rice – potato – green gram, rice – pea – green gram, rice – berseem, rice – barley – bajra fodder, rice – garlic and rice – toria – onion. Maximum system productivity 109.21 kg rice grain/ha/day was noted under rice – garlic followed by 59.59 kg rice grain/ha/day in rice – potato – green gram and 57.16 kg rice grain/ha/day in rice – toria – onion. Superiority of rice – garlic, rice – potato – green gram, rice - toria – onion and rice – pea(pod) – green gram cropping system was also reported by Yadav *et al.*, (2025).

Table 3: Chemical properties of soil under different cropping system.

Treatment	EC ds/cm	Soil pH	Organic carbon (%)	Available N Kg/ha	Available P ₂ O ₅ Kg/ha	Available K ₂ O Kg/ha
T ₁ -Rice-Wheat	0.29	7.18	0.60(53.3%)	261(51.55%)	16.12(-1.28%)	236(7.38%)
T ₂ -Rice-Barley-GM	0.37	7.03	0.67(71.71%)	253(54.45%)	10.75(-34.17%)	292(32.87%)
T ₃ -Rice-Gram+Mustard-GM	0.29	6.94	0.67(71.71%)	253(54.45%)	14.33(-12.24%)	202(-8.80%)
T ₄ -Rice-Pea+Mustard-GM	0.38	7.22	0.60(53.8%)	225(37.36%)	16.12(-1.28%)	213(-3.07%)
T ₅ -Rice-Potato-Green gram	0.25	7.13	0.52(33.3%)	210(28.20%)	12.54(-23.20%)	270(22.86%)
T ₆ -Rice-Pea-Green gram	0.31	7.05	0.45(15.38%)	202(23.22%)	21.50(31.65%)	236(7.38%)
T ₇ -Rice-Berseem	0.28	7.10	0.45(15.38%)	202(23.32%)	27.5(68.40%)	270(22.86%)
T ₈ -Rice-Barley - Bajra fodder	0.29	7.25	0.60(53.84%)	225(37.36%)	16.12(-1.28%)	292(32.87%)
T ₉ -Rice-Garlic	0.26	6.98	0.62(58.97%)	288(75.82%)	12.54(-23.20%)	247(4.66%)
T ₁₀ -Rice-Toria-Onion	0.26	7.22	0.52(33.33%)	210(28.20%)	12.54(-23.20%)	247(4.66%)
T ₁₁ -Rice-Barley+Chickpea	0.24	7.16	0.52(33.33%)	210(28.20%)	17.92(9.73%)	236(7.38%)
T ₁₂ -Rice-Oat+Wheat	0.24	7.21	0.67(71.71%)	253(54.45%)	14.33(-12.24%)	213(-3.07%)
Initial Value	0.5	7.10	0.39	163.80	16.33	219.76

Figures in parenthesis are % over initial status

Sustainable Yield Index

Sustainable yield index of different cropping system was calculated on the basis of previous eight years data to find out the sustainability of different cropping system which is given in Table 1. After perusal of the data it is clear that rice – gram + mustard – green manure and rice – toria – onion gave sustainable yield index of 0.57 which was lowest the among all cropping system. The maximum yield index 0.83 was noted under rice – berseem followed by 0.80 in rice – wheat and 0.78 in rice – potato – green gram and 0.77 in rice – barley - green manure. It may be due to stability in the yield of berseem, barley, rice – potato – green gram and rice – wheat in different years by which these cropping system were found more sustainable than other cropping system. This finding was in conformity with the findings of Yadav *et al.*, (2025).

Land Utilization Efficiency

On the basis of four years pooled data land utilization efficiency was calculated which is given in Table 1. It is evident from the data that rice – barley – bajra fodder cropping system gave maximum land utilization efficiency 98.56% followed by 92.87% under rice – pea(pod) – green gram and rice – potato – green gram. Land utilization efficiency was minimum 76.43% under rice – barley + chickpea and rice – wheat cropping system.

Gross and Net Return

Data in respect to gross and net return under different cropping system have been given in Table 2. After perusal of the result it is clear that all the cropping system gave higher gross return as compared to existing rice – wheat system except rice – gram + mustard – green manure cropping system. Maximum gross return Rs 752749/ha

was noted under rice – garlic followed by Rs- 435817/ha in rice – toria – onion and Rs- 388447/ha in rice - potato – green gram. These cropping system gave 68% to 225% higher gross return over existing rice – wheat system. Similarly net return Rs- 562538/ha was maximum under rice – berseem followed by Rs- 497736/ha under rice – garlic and Rs- 263703/ha under rice – toria – onion. All other cropping system also gave higher net return as compared to rice – wheat system. It may be due to higher yield and market price which gave higher gross and net profit. Upadhyay *et al.*, (2007) has reported higher net profit from rice – berseem over existing rice – wheat system while Pradhan *et al.*, (2020) and Yadav *et al.*, (2025) have reported the higher net profit from rice – garlic and rice – potato – green gram.

Benefit cost ratio is given in Table 2 reveals that on the basis of 4 years pooled data rice – garlic gave maximum B:C ratio of 2.9 followed by rice – barley – bajra fodder (2.84). Rice – barley +chickpea gave lower B:C ratio(2.10) as compared to existing rice – wheat system(2.17).

Chemical properties of the soil

Chemical properties of the soil after the completion of 8 crop cycle has been given in Table 3. After perusal of the result it is evident that electrical conductivity and pH of the soil after the completion of 8 crop cycle were unaffected over initial year. Organic carbon content was increased by 15.38% to 71.71% under different cropping system as compared to initial year. Maximum organic carbon in soil 0.67% was noted in rice – barley – green manure, rice – gram + mustard – green manure and rice – oat + wheat cropping system. Data pertaining to available nitrogen in soil after completion of 8 crop cycle

which has been given in Table-3 make it clear that available nitrogen status was increased by 23.32% to 75.82% and maximum available nitrogen 288kg/ha was noted in rice – garlic. Similarly available potassium was increased by 4% to 32% under all cropping system except rice – gram + mustard – green manure, rice – pea + mustard – green manure and rice – oat + wheat. Available phosphorus status was decreased by 1% to 34% under different cropping system.

Conclusion

On the basis of experiment conducted during the year 2021-22, 2022-23, 2023-24 and 2024-25 it has been concluded that the best existing cropping system in Kymore Satpura region is rice – wheat – fallow. The best cropping system for soil health improvement was rice – gram + mustard - green manure as it improved the organic carbon by 71.71% and available nitrogen 54%. Family nutrition was better under rice – potato – green gram which gave gross return Rs 388447/ha and net profit Rs- 238316/ha. Fodder supply was better from rice – garlic cropping system which gave maximum gross return Rs 752732/ha and net profit Rs 497736/ha under income enhancement. Concentrate production 119.33 q/ha was maximum for cattle feeding under rice – oat + wheat. Rice – berseem gave maximum sustainable yield index of 0.83 followed by rice – wheat (0.80). System productivity was 109.21 kg rice grain /ha/day was maximum in rice – garlic followed by 59.59 kg rice grain /ha/day under rice – potato – green gram. Land utilization efficiency was maximum under rice – barley - bajra fodder cropping system followed by 92.87% under rice – potato – green gram and rice – pea – green gram cropping system.

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