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Assessment of Rice-mustard & Rice-chickpea Cropping Sequence through Conservation Agricultural Practices under Rice- Fallow Cropping System in Satna District of Madhya Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Rice – Fallow land due to the growing of a longer more extended duration variety of Rice by farmers affect timely sowing of rabi crop and land remains fallow due to inadequate moisture in field along with terminal heat stresses (about 14000 ha area) in district Satna (M.P.).The trial consisted of three treatments viz., T_1- Rice (Variety with maturity above 125 days) in Kharif- fallow in Rabi, T_2- Rice (MTU-1010)-Mustard (Pusa Mustard 28), T_3- Rice (MTU-1010)-Chickpea (RVG-202). The Rice-Mustard cropping system recorded higher Rice equivalent yield over Rice-fallow by 42.12 q ha^{-1}, system productivity 36.97 kg $ha^{-1}day^{-1}$, profitability by ₹470.94 $ha^{-1}day^{-1}$ and net return ₹ 103608 ha^{-}

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[1]. Similarly, Rice-Chickpea cropping system gave 37.84 q ha^{-1} Rice equivalent yield, 35.11 kg $ha^{-1}day^{-1}$ higher productivity, ₹ 431.56 $ha^{-1}day^{-1}$ and net return ₹ 94942 ha^{-1} higher profit than Rice-fallow cropping system. Thus, from the present study, it can be concluded that Rice-Chickpea and Rice-Mustard cropping systems are appropriate and effective ways to use fallow land under Rice-Fallow cropping system.

Keywords: Rice; Mustard; Chickpea; Cropping System; Yield; Rice Equivalent Yield.

1. INTRODUCTION

"Rice fallow (11.7 million ha) is a mono-crop rice–based production system in India. The Rice-fallow areas are mostly concentrated in the parts Satna district about 14000 ha. The reasons for fallowing after rainy season are lack of irrigation, fast depletion of the soil residual moisture and poor socio-economic condition of the farmers along with some regional constraints such as free grazing of cattle. Besides this, the late harvesting of long duration rice (150–160 days) delays the sowing of winter crops that, in turn, aggravates the moisture and terminal heat stresses in winter crops. Unfavourable physical attributes of soil owing to puddling (wet tillage), soil compaction and acidic soil reaction further add to the poor performance of winter crops in rice fallow areas. Replacing rice with any other crop is very difficult during the rainy season due to the region's prevailing soil and climatic conditions; intensification and diversification of the rice-based cropping system can only be the alternative option" [11]. "Efficient and proper utilization of rice-fallow lands in dry season after a rice crop has the ability to meet the demands arises for food and nutrition of the growing population. A number of short duration and moisture stress tolerant crops and their improved varieties can be grown in these fallow lands as the climatic and soil condition of the fallows varied from vary small duration to as long as 3 months. Pulses, because of shorter duration and their ability to grow under residual moisture are good candidates for efficient utilization of fallows. However, knowledge and technical gaps in management practices of pulses under fallows and different soil conditions creates hindrance in its proper utilization. Adoption of early and mid-early rice varieties in wet season will have a greater window for raising a good crop in dry season particularly the pulses and oilseeds having tolerance to low temperature. diversification and intensification of cropping system with the proper use of available and irrigation facility can provide higher yield as well as better net returns" [1]. "Addition of pulse and oilseed is more beneficial than cereals after cereals in Rice-based cropping system" [2,3]. "Crops like oilseeds and pulses are gaining more attention owing to higher prices due to increased market demand. Inclusion of these crops in a sequence, changes the economics of the cropping sequences" [4].

2. MATERIALS AND METHODS

On-farm testing on Cropping System was conducted by Deendayal Research Institute-Krishi Vigyan Kendra, Majhgawan, District-Satna (M.P.) during 2021-22 at farmer's fields to assess on Rice-Mustard & Rice- Chickpea cropping sequence through conservation agricultural practices under the Rice- Fallow cropping system. 10 OFTs were conducted with randomly selected farmer's fields in Naugawan and Shahpur villages of Majhgawan block of Satna. Direct seeding of duration short variety of Rice (MTU 1010) followed by zero tillage sowing of Mustard or Chickpea by utilizing the residual soil moisture of Rice field. The trial consisted of three treatments *viz.*, T_1- Rice (Variety with maturity above 125 days) in kharif- fallow in Rabi, T_2- Rice (MTU-1010)-Mustard (Pusa Mustard 28), T_3- Rice (MTU-1010)-Chickpea (RVG-202). Geographically, Satna is in the Satpura and Kaymore Plateau range at an elevation of 313 metres above mean sea level and between 24°51'15" and 24°57'30"N latitude and 80°43'30" and 80°54'15"E longitude. "The place has a subtropical climate characterized by a hot and dry summer and a chilly winter. The farmer's fields had sandy loam soil with a shallow depth, low readily available nitrogen, low phosphorus and more readily available potassium. The soil reaction was close to neutral. The conventional Rice-Wheat cropping system has been observed on the ground since the last 15 years. The Rice, Chickpea and Mustard were sown with tractor operated seed drill in on farm testing field. Critical inputs like seeds, seed treatment, fertilizer, fungicide, herbicide and pesticide were managed by farmers himself as per recommended package and practices for Rice suggested by Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur. Selected farmers

were trained on use of seed drill for sowing and frequent field visits have made for collection of required data during crop growth period and on the harvest. Farmers were informed to note down all quantities of inputs used in all practices and used for economic analysis. The necessary step for the selection of site and farmers, lay out of demonstration, etc were followed as suggest by Chaudhary" [5]. "The farmer practices were maintained in case of local check. The data output was collected from both improved practices as well as farmer practices. The yields of all the crops in the sequences were converted into Rice Equivalent Yield (REY) for comparison between different cropping systems. The REY of the systems were calculated in terms of rice using the formula given" by Kumar *et al.* [6]

Rice Equivalent Yield (REY) (q ha^{-1}) =
Σ Yi × Pi/ P(p)

where, Yi= yield of non-rice crops; Pi= price of respective crops and P(p)= price of rice.

2.1 Gross Monetary Returns (GMR)

Based on the prices of output prevailing at the time of harvest, treatment-wise GMR (₹ ha^{-1}) was computed.

2.2 Net Monetary Returns (NMR)

Based on the current market price of inputs and outputs, the NMR (₹ ha^{-1}) was worked out by using the following formula.

Net monetary returns
(₹ ha^{-1})=[Gross monetary returns (₹ ha^{-1})]-
[Total cost of cultivation (₹ ha^{-1})]

2.3 Benefit: Cost Ratio

It was calculated by using the formulae given by Samui *et al.* [7].

$$\text{Benefit: cost ratio} = \frac{\text{Gross monetary returns } (₹\ ha^{-1})}{\text{Total cost of cultivation } (₹\ ha^{-1})}$$

Productivity values in terms of kg $ha^{-1}day^{-1}$ was calculated by dividing the production of the sequence by system duration in days, and profitability in terms of ₹ $ha^{-1}day^{-1}$ was obtained by dividing net returns of the sequence by the total duration of the sequence Reddy and Suresh [8]. Different efficiencies were computed by using the following formulae:

$$\text{System productivity (kg ha}^{-1}\text{ day}^{-1}) = \frac{\text{Total seed yield produce } (\text{kg ha}^{-1})}{\text{No. of days required in production}}$$

$$\text{System profitability (₹ ha}^{-1}\text{ day}^{-1}) = \frac{\text{Net monetary return } (₹\ ha^{-1})}{\text{No. of days required in production}}$$

3. RESULTS AND DISCUSSION

3.1 Effect on yield and Rice Equivalent Yield (REY)

The average of yield and Rice Equivalent Yield of all the cropping systems were presented in (Table 1). The highest yield (Rice 42.90 q ha^{-1} + Mustard 16.18 q ha^{-1}) and REY (42.12 q ha^{-1}) was recorded in Rice- Mustard cropping system followed by Rice-Chickpea cropping (Rice 42.90 q ha^{-1} + Chickpea 14.04 q ha^{-1}) and REY (37.84 q ha^{-1}) over Rice-fallow (Rice 45 q ha^{-1}). The present result conforms with the findings of Kalita et al. [9] and Sharmah *et al.* [10].

3.2 Effect on Economics of Cropping Systems

The gross monetary returns, net monetary returns and benefit: cost ratio was affected by Rice-based cropping systems (Table-2). Rice-Mustard cropping system recorded higher in Gross monetary return (₹164943 ha^{-1}) net monetary return (₹103608 ha^{-1}) and Benefit Cost Ratio (2.69) followed by Rice-Chickpea cropping system over Rice-Fallow cropping system. The present result is in conformity with the findings of Kalita *et al.* [9] and Sharmah *et al.* [10]

3.3 Effect on System Productivity and Profitability of Rice-based Cropping Systems

The effect of different Rice-based cropping sequences on system productivity (kg ha^{-1} day^{-1}) and system profitability (₹ $ha^{-1}day^{-1}$) are presented in (Table 3). Data showed that the effect on system productivity was highest value in Rice-Mustard cropping system 36.97 kg ha^{-1} day^{-1}) after Rice-Chickpea cropping system (35.11 kg ha^{-1} day^{-1}) over Rice-fallow cropping system (33.90 kg $ha^{-1}day^{-1}$). The System profitability was highest value in Rice-Mustard (₹470.94 $ha^{-1}day^{-1}$) after Rice-Chickpea cropping system (₹431.56 ha^{-1} day^{-1}) over Rice-fallow cropping system (₹392.75 ha^{-1} day^{-1}). The present result is in conformity with the findings of Kalita *et al.* [9], Sharmah et al. [10] and Kumar et al. [11].

Table 1. Effect of treatments on Grain yield and Rice Equivalent Yield of different cropping systems

Treatments	Grain Yield (q ha^{-1})	Rice Equivalent Yield (q ha^{-1})
T_1 Rice (Variety with maturity above 125 days)	45.76	-
T_2 Rice (MTU-1010)-Mustard (Pusa Mustard 28)	42.90+16.18	42.12
T_3 Rice (MTU-1010)-Chickpea (RVG-202)	42.90+14.04	37.84

Table 2. Effect of treatments on economics of different cropping systems

Treatments	Cost of cultivation (₹ha^{-1})	Gross Monetary Return (₹ha^{-1})	Net Monetary Return (₹ha^{-1})	Benefit-Cost Ratio
T_1 Rice (Variety with maturity above 125 days)	35755	88776	53021	2.48
T_2 Rice (MTU-1010)-Mustard (Pusa Mustard 28)	61335	164943	103608	2.69
T_3 Rice (MTU-1010)-Chickpea (RVG-202)	61705	156647	94942	2.54

Table 3. Effect of treatments on System Productivity and System profitability of different cropping systems

Treatments	System Productivity (kg ha^{-1} day^{-1})	System profitability (₹ ha^{-1} day^{-1})
T_1 Rice (Variety with maturity above 125 days)	33.90	392.75
T_2 Rice (MTU-1010)-Mustard (Pusa Mustard 28)	36.97	470.94
T_3 Rice (MTU-1010)-Chickpea (RVG-202)	35.11	431.56

4. CONCLUSION

It can be concluded that Rice-fallow cropping of Satna district of Madhya Pradesh can effectively be use by diversified with inclusion of Mustard or Chickpea during *rabi* season which can act as viable systems in productivity and economical point of view. The Rice- Mustard cropping system recorded higher Rice equivalent yield over Rice-fallow by 42.12 q ha^{-1}, system productivity 36.97 kg $ha^{-1}day^{-1}$, profitability by ₹470.94 $ha^{-1}day^{-1}$ and net return ₹ 103608 ha^{-1}. Similarly, Rice-Chickpea cropping system gave 37.84 q ha^{-1} Rice equivalent yield, 35.11 kg $ha^{-1}day^{-1}$ higher productivity, ₹ 431.56 $ha^{-1}day^{-1}$ and net return ₹ 94942 ha^{-1} higher profit than Rice-fallow cropping system. Among all the tested cropping sequences, Rice-Mustard is the feasible sequence in terms of both productivity as well as economical point of view followed by Rice-Chickpea cropping system.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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