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Performance of rice based cropping systems under irrigated dry conditions of Telangana

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ABSTRACT

On farm experiments were conducted during 2013-14 and 2014-15 in 24 peasant fields spread across six villages of Warangal district, Telangana, India to evaluate the performance of diversification of the existing rice-rice cropping system with rice-maize, rice-sunhemp, rice-blackgram and rice-greengram. Among various cropping systems, rice-maize sequence recorded significantly higher rice equivalent yield (10.63 t ha^{-1}), gross and net returns (Rs 133627 ha^{-1} and Rs 69877 ha^{-1}) than other systems. Rice-sun hemp witnessed higher benefit cost ratio and per day net returns (2.35 and Rs 310 day^{-1}) and was followed by rice-maize sequence (2.10 and Rs 286 day^{-1}), rice-green gram (2.16 and Rs 264 day^{-1}). Total productivity and total profitability (29.1 kg ha^{-1} and Rs 192 ha^{-1} day^{-1}) was higher in rice-maize sequence.

***Keywords*:** Gross returns, net returns, rice-based cropping systems and rice equivalent yield

Agriculture in India has witnessed paradigm shift with diversification from traditional food crops like paddy, wheat *etc*. to commercial crops, plantation crops and horticultural crops during the last three decades (Nadkarni, 1996; Joshi *et al.*, 2004). Further, in the post-green revolution period, the incessant cereal-cereal crop rotation has undoubtedly made the India surplus in cereal production but has marginalized pulses. This has raised serious concern about sustainability of the production system. The area under pulses is decreased. Further, a large chunk of small and marginal farmers *i.e*., 85 per cent farm house holds falls in small and marginal category with average land holding size of 1.16 ha, are suffering from rural poverty, seasonal and lurking employment, less occupancy for farm labour, poor rural infrastructure, changed climate situations *etc* always pose a threat on the development of agrarian economy in India.

From this perspective of improving farm income, generating more occupancy for farm labour and year-round employment, cash flow throughout the year and conservation and augmentation of natural resources, crop diversification *i.e*. shifting from less profitable crop or enterprise to more profitable crop or enterprise comes out as a majority strategy (Vyas,1996). So there is need to diversify the existing crop, to attain sustainability.

Rice-rice is the pre dominant cropping system both under canals and bore wells command in Telangana state of India. Changing climatic conditions, decreasing water table and ever increasing demand for electricity seriously threatening rice cultivation during *rabi* (dry season)**.** Development of short duration, disease resistant and high yielding varieties in the recent past made pulses a viable alternative to low yielding coarse cereals under rainfed conditions and also provides an opportunity for expansion in rice fallows and in double cropping systems. Recognizing the importance of pulses for meeting dietary requirements of vast vegetarian population on one hand and their role in improving soil health and conserving natural resources on the other, it is the need of the hour for fitting of pulses in cereal based cropping system. Keeping in view, an on farm experiment was conducted in farmer's fields with five cropping systems *viz*., rice-rice, rice-maize, rice-sunhemp, rice-blackgram or cowpea and rice-greengram to diversify the existing cropping system (rice-rice) for attaining sustainability.

MATERIALS AND METHODS

The present study was conducted in 24 farm fields spread in six villages of Warangal district, Telangana, India situated in Central Telangana agro-climatic zone. The geographical co-ordinates of the study area are situated in 17º48' 38.0" to 17º 54' 25.6" N latitude, 79°22'19.1" to 79°59'05.1" E longitude and 267 m to 356m above the mean sea level. The study consists of 5 cropping systems *viz* rice-rice, rice-maize, rice-sunhemp, rice-blackgram or cowpea and rice-greengram evaluated in randomized block design during 2013-14 and 2014-15. Each village was considered as one replication. An area of 20 × 10 m (200 m^2) was earmarked for each treatment.

In all the treatments, rice is common crop during *kharif* season for both the years. Long duration BPT 5204 (150 days) with a yield potential of 6.5 t ha^{-1} was the test variety. Rice nurseries were sown during the last week

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of May to 2nd week of June and transplanted after attaining 30-40 days age of seedlings. Nutrient, weed management and pest management were adopted as per the recommendations of PJTSAU. Flood irrigation was given as per the need of the crop (55-65 times) for all the on-farm trials. Crop was harvested between the 1st to 3rd week of November. Sequence crops maize, sunhemp, blackgram/cowpea, greengram and rice were sown as per the treatment after thorough land preparation during *rabi*. A private hybrid of maize (100 days duration) was sown at a spacing of 60 x 20 cm. Local variety of sunhemp with 70 days duration was sown at 30 x 10 cm spacing. Blackgram (LBG 20 variety of 90 days) was sown for first year and it replaced with cow pea (Local variety of 80-85 days) for 2nd year. Green gram, black gram and cowpea were sown at 30 x 10 cm spacing. Greengram variety WGG-37 of 65 days duration was used in the study. All the weed, nutrient and pest management practices were followed as per recommendations of the University. For pulse crops 2-4 irrigations of 5cm each were given while 6-8 irrigations were provided to maize.

Observations on yield of crops were recorded at harvest. The data on grain yield was collected by random crop cutting method. The yield data of all the crops was converted to rice equivalent yields using following formula, so as to facilitate the statistical analysis following the procedure outlined by Gomez and Gomez (1984).

$$\text{Rice equivalent yield (REY)} = \frac{\text{Component crop yield (kg ha}^{-1}) \times \text{price of component crop (Rs kg}^{-1})}{\text{Price of rice (Rs kg}^{-1})}$$

Economics were calculated as per procedures (Perin *et al*., 1979). Benefit cost ratio, gross and net returns were calculated based on grain yield and prevailing market price. Per day net returns were worked out by dividing total net returns with the duration of the crop sequence period.

Production and Economic indices are calculated based on following formulae.

Total productivity (kg ha^{-1} day^{-1})=Total productivity÷ 365

Profitability (Rs ha^{-1} day^{-1}) = Total profitability ÷ 365

RESULTS AND DISCUSSION

Grain yield

Pooled data of two years indicated that among five cropping systems, rice-maize sequence recorded significantly higher rice equivalent yield (10.6 t ha^{-1}) than other systems (Table 1). Rice-sunhemp was next best system better after rice-rice (9.3 t ha^{-1}). Among pulses, rice - greengram system significantly recorded higher rice equivalent yield (8.383 t ha^{-1}) than the rice-blackgram system (7.321 t ha^{-1}).

Economics

Higher gross and net returns were obtained in rice-maize sequence (Rs 1,33,627 ha^{-1} and Rs 69,877 ha^{-1}) followed by higher net returns in rice-sunhemp (Rs 66,464 ha^{-1}) and in rice-greengram (Rs 55,468 ha^{-1}) (Table 2). Lower gross and net returns observed in rice-blackgram sequence (Rs 89,208 ha^{-1} and Rs 40,458 ha^{-1}). Higher gross and net returns in rice-maize system were due to higher rice equivalent yield in respective crop sequence. Though gross returns were lower in rice-sunhemp and rice-greengram than rice-rice, net returns were higher due to less cost of cultivation than rice-rice. Rice-sunhemp witnessed higher benefit cost ratio and per day net returns (2.35 and Rs 310 day^{-1}) followed by rice-maize sequence (2.10 and Rs 286 day^{-1}), rice-greengram (2.16 and Rs 264 day^{-1}). High B:C ratio and per day net returns in rice-sunhemp was due to lower cost of cultivation and higher market price and less duration of crop sequence as compared with other crop sequences.

Similar higher yield of maize after *kharif* rice were reported earlier by Reddy (2001). A study on different rice-based crop rotations like rice-rice, rice-wheat, rice-maize, rice-pulse and rice-oilseed at 13 centers of AICRP on Rice to economize the nutrient recommendation, enhancing nutrient use efficiency, soil-health and sustain productivity also indicated the highest rice equivalent yield (10.2 t ha^{-1}) and gross monetary returns (Rs 59,110 ha^{-1}) with rice-maize rotation followed by rice-pulse (8.5 t ha^{-1} Rs 49152 ha^{-1}) rotation (Mangaldeep *et al.*, 2018). Studies of Rao *et al.* (2015) also confirm the superiority of maize during *rabi* after *kharif* rice.

Reports from different parts of the country indicated that inclusion of legumes in rice-based system increased the productivity of rice (Hegde, 1992). Introduction of a legume crop in rice-based cropping system may have advantages well beyond the N addition through biological nitrogen fixation including nutrient recycling from deeper soil layers, minimizing soil compaction, increase in soil organic matter, breaking of weed and pest cycles and minimizing harmful allelopathic effects (Sanford and Hairston, 1984; Wani *et al*., 1995).

Production and economic indices

Total per day productivity was higher with rice-maize sequence (29.1 kg ha^{-1} day^{-1}) succeeded by rice-rice (27.0 kg ha^{-1} day^{-1}), rice-sun hemp (25.5 kg ha^{-1} day^{-1}) and low productivity recorded in rice-black gram system (20.1 kg ha^{-1} day^{-1}) (Table 3). Total per day profitability was higher in rice-maize system (Rs 192 ha^{-1} day^{-1}) followed by rice-sunhemp (Rs 183 ha^{-1} day^{-1}) due to less cost of cultivation and higher gross returns.

Among five cropping systems, rice-maize sequence recorded higher rice equivalent yield, gross and net returns. However, B:C ratio and per day net returns were

Table 1: Grain yield under different rice based cropping systems

Cropping system	Grain yield (t ha^{-1})								
	2013-14			2014-15			Mean		
	Kharif	*Rabi*	REY	*Kharif*	*Rabi*	REY	*Kharif*	*Rabi*	REY
Rice-rice	4.55	4.92	9.47	5.20	5.00	10.20	4.88	4.96	9.836
Rice-maize	4.59	5.93	10.01	5.38	5.88	11.25	4.98	5.90	10.631
Rice-sun hemp	4.55	1.44	8.66	5.35	1.49	9.94	4.95	1.47	9.299
Rice-black gram	4.55	0.96	7.01	5.28	0.85	7.63	4.91	0.90	7.321
Rice-green gram	4.55	1.06	7.43	5.29	1.05	9.33	4.92	1.06	8.383
SEm (±)	**0.02**	**0.25**	**0.07**	**0.07**	**0.27**	**0.06**	**0.02**	**0.26**	**0.07**
LSD (0.05)	**NS**	**0.72**	**0.19**	**NS**	**0.80**	**0.18**	**0.05**	**0.77**	**0.19**

Table 2: Economics under different rice-based cropping systems

Cropping system	2013-14			2014-15			Mean		
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*	Total
				Gross returns (Rs. ha^{-1})					
Rice-rice	50039	68922	118961	62400	65000	127400	56220	66961	123181
Rice-maize	50501	75878	126379	64500	76375	140875	57501	76127	133627
Rice-sun hemp	50028	57600	107628	64200	59600	123800	57114	58600	115714
Rice-black gram	50039	34416	84455	63360	30600	93960	56700	32508	89208
Rice-green gram	50039	40356	90395	63540	52500	116040	56790	46428	103218
SEm (±)	**170**	**2090**	**2412**	**820**	**2205**	**2202**	**460**	**2240**	**2350**
LSD (0.05)	**NS**	**6200**	**7008**	**NS**	**6500**	**6534**	**NS**	**6600**	**6900**
				Cost of cultivation (Rs. ha^{-1})					
Rice-rice	35000	33000	68000	36000	34000	70000	35500	33500	69000
Rice-maize	35000	28000	63000	36000	28500	64500	35500	28250	63750
Rice-sun hemp	35000	14000	49000	36000	13500	49500	35500	13750	49250
Rice-black gram	35000	13500	48500	36000	13000	49000	35500	13250	48750
Rice-green gram	35000	12500	47500	36000	12000	48000	35500	12250	47750
SEm (±)		**2200**	**2420**		**2300**	**2510**		**2250**	**2470**
LSD (0.05)		**6500**	**7100**		**6800**	**7400**		**6600**	**7300**
				Net returns (Rs. ha^{-1})					
Rice-rice	15039	35922	50961	26400	31000	57400	20720	33461	54181
Rice-maize	15501	47878	63379	28500	47875	76375	22001	47877	69877
Rice-sun hemp	15028	43600	58628	28200	46100	74300	21614	44850	66464
Rice-black gram	15039	20916	35955	27360	17600	44960	21200	19258	40458
Rice-green gram	15039	27856	42895	27540	40500	68040	21290	34178	55468
SEm (±)	**180**	**2400**	**1146**	**800**	**2300**	**1170**	**450**	**2350**	**1160**
LSD (0.05)	**NS**	**7200**	**3333**	**NS**	**6800**	**3471**	**NS**	**6900**	**3420**

Table 3: Production and economic indices under different rice based cropping systems

Cropping system	2013-14	2014-15	Mean
BC Ratio			
Rice-rice	1.75	1.82	1.79
Rice-maize	2.01	2.18	2.10
Rice-sun hemp	2.20	2.50	2.35
Rice-black gram	1.74	1.92	1.83
Rice-green gram	1.9	2.42	2.16
Returns (Rs. ha^{-1} day^{-1})			
Rice-rice	189	213	201
Rice-maize	259	312	286
Rice-sun hemp	273	346	310
Rice-black gram	163	204	184
Rice-green gram	204	324	264
Total Productivity (kg ha^{-1} day^{-1})			
Rice-rice	26.0	27.9	26.95
Rice-maize	27.4	30.8	29.1
Rice-sun hemp	23.7	27.2	25.45
Rice-black gram	19.2	20.9	20.05
Rice-green gram	20.4	25.6	23
Total Profitability (Rs. ha^{-1} day^{-1})			
Rice-rice	140	157	149
Rice-maize	174	209	192
Rice-sun hemp	161	204	183
Rice-black gram	99	123	111
Rice-green gram	118	186	152

higher with rice-pulse systems like sun hemp and green gram sequence. As the water requirement of rice in Telangana state is >1400 mm compared to < 500 mm of pulses, if land is not constraint, there is scope for the farmer to increase the area under cultivation, thus over all higher returns and employment. The study clearly indicated ample scope of diversifying rice ecosystems through pulses in Telanagana.

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