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Evaluation of Diversified Cropping Systems in Kymore Plateau and Satpura Hills Zone of Madhya Pradesh for Productivity

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ABSTRACT: The present investigation was carried Krishi Nagar Farm, Department of Agronomy, JNKVV, Jabalpur (M.P.) during *kharif–rabi* season 2022-2023. Major objective of the investigation was to identify most productive cropping system for the region to overcome the several problems posed by existing pre-dominant cropping systems *i.e.* rice-wheat and rice-chickpea. Major challenges for both pre-dominant cropping systems are heavy specific weed infestation and low productivity. The results of present study revealed thatokra-brinjal cropping system recorded highest rice equivalent yield among all cropping systems and cowpea (vegetable) –potato recorded highest system productivity among all cropping systems. Rice –potato and rice bean (fodder) –berseem (fodder) also recorded substantially higher rice equivalent yield than pre-dominant cropping systems. Present study contributed to find out need based more productive diversified cropping systems for the region.

Keywords: Cropping system, Crop diversification, Rice-wheat cropping system (RWCS), Rice equivalent yield (REY), System productivity, Water productivity.

INTRODUCTION

Rice–wheat cropping system (RWCS) is the pre-dominant agricultural production system in India. Rice–wheat cropping system covers an area of 12.3 million hectares in India (Ladha *et al.*, 2003) and plays a vital role in the nation's food security (Jat *et al.*, 2020). In Kymore plateau and Satpura hills agro-climatic zone of Madhya Pradesh rice-wheat cropping system is pre-dominant under adequate irrigation water situation (Jain and Kushwaha 2020) but having meagre productivity of 11.94 q/ha and 20 q/ha, respectively (Tarwariya and Maurya 2015).

Several emerging problems, such as the exhausting nutrient pool in soil, deteriorating soil health, groundwater depletion, escalating production cost, labor scarcity, environmental pollution due to crop residue burning and enhanced greenhouse gas emissions, climatic vulnerabilities, and herbicide resistance in weed species, are a few major threats to sustainability of RWCS (Dhanda *et al.*, 2022). Despite of, higher production potential of rice-wheat cropping system yield plateau, productivity stagnation and declined factor productivity has been recorded due to its continuous tremendous adoption (Ladha *et al.*, 2007). Hence, there is an urgent need to diversify the prevailing cropping system for improving the productivity without jeopardizing the soil environment health.

Crop diversification in India is viewed as a shift from traditionally grown less remunerative to a more remunerative crops (Hazra, 2000). It refers to the addition of new crops or cropping systems to agricultural production on a particular farm through introduction of system-based cereals, oilseeds, pulses, spices, fodder crops and other remunerative crops for their livelihood security (Tetarwal *et al.*, 2023). Crop diversification shows lot of opportunities in alleviating these problems through fulfilling the basic needs, regulating farm income, withstanding weather aberrations, conserving natural resources, environmental safety and creating employment opportunities (Gill and Ahlawat 2006). In view of these facts, the present investigation was carried out to find out the most productive cropping system by incorporating need-based pulse, oilseed, vegetable and fodder crops for substituting in existing rice-based cropping system as crop diversification.

MATERIAL AND METHODS

The field experiment was carried out during *kharif* – *rabi* 2022-2023 at Krishi Nagar Farm, Department of

Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, India. The regions soils are medium to deep in depth, black in colour. The soil in the experimental field had a sandy clay loam texture, neutral in reaction (pH 7.2) with a medium OC content (0.65 percent), and EC (0.50 dS/m) and analyzed medium in available nitrogen (277 kg/ha), low in available phosphorus (13.4 kg/ha), and high in available potassium (310 kg/ha). Total rainfall was 1524.30 mm throughout both cropping seasons. The field experiment consisted with 10 cropping systems and they were tested in randomized block design with 03 replications. The details of the treatments are presented in Table 1.

Table 1: Treatments details of the experiment.

Tr. No.	Cropping Systems
T_1	Rice–wheat
T_2	Rice–chickpea
T_3	Soybean–chickpea
T_4	Soybean–lentil
T_5	Rice-potato
T_6	Rice–mustard
T_7	Sorghum (fodder)–berseem (fodder + seed)
T_8	Ricebean (fodder)–berseem (fodder)
T_9	Cowpea(vegetable) –potato
T_{10}	Okra–brinjal

Agro-techniques for all crops were followed as per recommended practices and need of concerned crop in different crop sequences. Data on economic yields of individual crop were used to determine the combined yield of entire cropping system as rice equivalent yield (REY) as suggested by Yadav and Newaj (1990). System productivity(kg/ha/day) was worked out by dividing the REY with total duration (days) of all crop systems. Water productivity (kg/m^3) was calculated dividing REY with total consumptive use of water (m^3) by all crop components in cropping systems (Dastane, 1972). The data of the experiment were analyzed by using OPSTAT software (Sheoran *et al.,* 1998).

RESULTS AND DISCUSSION

A. Rice equivalent yield (REY)

Rice equivalent yield (REY) of different cropping systems varied significantly which is presented in Table 2. Among different cropping systems okra–brinjal recorded significantly higher rice equivalent yield (12173 kg/ha) followed by cropping systems *viz.* cowpea (vegetable) – potato (9522 kg/ha), rice–potato (9180 kg/ ha) and ricebean (fodder)–berseem (fodder) (9077 kg/ha). However, lowest rice equivalent yield was recorded in soybean–lentil (4749 kg/ha).

The use of vegetable crops (such as brinjal, potato, okra) in the study region is a practical choice for enhancing output. Forage being flexible in growing season duration and harvesting offers a good alternative to dominant grain and cash crops (Agrawal *et al.,* 2009). Growing of legumes in place of cereals season is being preferred by farmer because of its high market price, but low productivity again makes this effort futile. Similar results were recorded by Saha *et al.* (2022); Sirse *et al.* (2019).

B. System productivity

System productivity of different cropping systems varied significantly which is presented in Table 3. Cowpea (vegetable)–potato recorded significantly higher system productivity (51.47 kg/ha/day) followed by okra–brinjal (48.69 kg/ha/day) and rice–potato (45.90 kg/ha/day) while least system productivity was found in soybean–lentil (21.58 kg/ha/day). Diversification by inclusion of vegetables in the cropping sequence enhanced the productivity compared to the rice-wheat-fallow sequence (Banjara *et al.,* 2021). The productivity of rice-wheat and legume based cropping systems were limited due to specific weed and soil borne problem (Tarwariya and Maurya 2015). These present findings are in close conformity with those of Soni *et al.* (2012); Shah *et al.* (2015); Kumar (2020); Jain and Kushwaha (2020).

C. Water productivity

Water productivity of different cropping systems varied significantly which is presented in Table 3. Among different cropping systems water productivity found significantly higher in cowpea (vegetable) potato (0.99 kg/m^3) followed by okra–brinjal (0.96 kg/ m^3) while least water productivity was recorded in rice–wheat (0.46 kg/m^3). Diversification of crops can enhance water productivity by selecting crops with varying water requirements and optimizing their distribution in space and time. Highest water productivity of cowpea (vegetable)-potato was due to low water requirement and short duration of these crops than rice and wheat. Similar results were reported by Walia *et al.* (2010); Kumar (2020); Devi *et al.* (2020).

Table 2: Rice equivalent yield (REY) as influenced by different cropping systems.

Treatment No.	Cropping systems	Rice equivalent yield(kg/ha)		
		Kharif	***Rabi***	**Total**
T_1	Rice – Wheat	3160	4016	7176
T_2	Rice – Chickpea	3098	2823	5921
T_3	Soybean – Chickpea	2129	3657	5786
T_4	Soybean – Lentil	2160	2589	4749
T_5	Rice – Potato	3200	5980	9180
T_6	Rice – Mustard	3180	4948	8128
T_7	Sorghum (Fodder) – Berseem (Fodder + Seed)	3441	5257	8698
T_8	Rice bean (Fodder) – Berseem (Fodder)	3710	5367	9077
T_9	Cowpea (Vegetable) – Potato	3503	6019	9522
T_{10}	Okra – Brinjal	5433	6740	12173
SEm ±		**159**	**201**	**303**
C.D. (p = 0.05)		**491**	**610**	**918**

Table 3: System productivity and water productivity as influenced by different cropping systems.

Treatment No.	Cropping systems	System Productivity (kg/ha/day)	Water Productivity (kg/m^3)
T_1	Rice – Wheat	29.90	0.46
T_2	Rice – Chickpea	26.31	0.50
T_3	Soybean – Chickpea	26.91	0.76
T_4	Soybean – Lentil	21.58	0.62
T_5	Rice – Potato	45.90	0.64
T_6	Rice – Mustard	36.94	0.63
T_7	Sorghum (Fodder) – Berseem (Fodder + Seed)	34.79	0.66
T_8	Rice bean (Fodder) – Berseem (Fodder)	36.30	0.86
T_9	Cowpea (Vegetable) – Potato	51.47	0.99
T_{10}	Okra – Brinjal	48.69	0.96
SEm ±		**1.57**	**0.04**
C.D. (p = 0.05)		**4.83**	**0.13**

CONCLUSIONS

Based on the foregoing discussion, it can be concluded that that okra-brinjal cropping system recorded highest rice equivalent yield among all cropping systems and cowpea (vegetable) –potato recorded highest system productivity among all cropping systems. Rice –potato and ricebean (fodder) –berseem (fodder) also recorded substantially higher rice equivalent yield than pre-dominant cropping systems. Hence, need based crop diversification should be done by inclusion of vegetable, pulse, oilseed and fodder crops in existing cropping systems.

FUTURE SCOPE

A comparative study should be conducted for different cropping systems in the study region, such as multiple cropping, intercropping, crop rotation, and agroforestry by evaluating their productivity, profitability and sustainability.

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Conflict of Interest. None.

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