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PRODUCTIVITY AND ECONOMIC POTENTIAL OF MAIZE-BASED CROPPING SYSTEMS UNDER SANDY LOAM SOILS IN TELANGANA, INDIA

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ABSTRACT

A field experiment was conducted during 2021–22 and 2022–23 at the Agricultural Research Station, Karimnagar, Telangana, PJTAU, to evaluate the performance of eight maize-based cropping systems under irrigated dry conditions on sandy loam soils of Northern Telangana. Among the systems tested, the Okra–maize cropping system recorded the highest system productivity (24,718 kg ha⁻¹), system profitability (Rs. 874 ha⁻¹ day⁻¹), production efficiency (111.6 kg ha⁻¹ day⁻¹), gross returns (Rs. 4,72,067 ha⁻¹), net returns (Rs. 3,18,995 ha⁻¹), and benefit-cost ratio (3.09). This was followed by the Maize–onion system, which achieved system productivity of 22,039 kg ha⁻¹, system profitability of Rs. 749 ha⁻¹ day⁻¹, production efficiency of 99.9 kg ha⁻¹ day⁻¹, gross returns of Rs. 4,20,932 ha⁻¹, net returns of Rs. 2,73,506 ha⁻¹, and a benefit-cost ratio of 2.86. The results suggest that the Okra–maize system is the most profitable and productive maize-based cropping system for sandy loam soils under irrigated dry conditions in Northern Telangana.

Keywords: Cropping system, system productivity, production efficiency, maize equivalent yield.

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops globally, valued for its high productivity, diverse uses as food, feed, and industrial raw material and adaptability to varied agro-climatic conditions. In India, maize occupies a prominent place in rainfed and irrigated agriculture and serves as a key component of farming systems in semi-arid regions. In Telangana, particularly in the Northern Telangana zone, maize has emerged as a dominant kharif crop due to its comparatively higher yield potential and market demand. However, continuous mono-cropping of maize has led to several production constraints, including depletion of soil organic carbon, imbalance of macro- and micronutrients, deterioration of soil structure, and increased vulnerability to pests and diseases, ultimately affecting long-term productivity and sustainability (Yadav *et al.*, 2017; Tiwari *et al.*, 2019).

Sandy loam soils of Northern Telangana are inherently low in organic matter and nutrient-holding capacity, making them highly susceptible to nutrient mining under intensive mono-cropping. Declining factor productivity and increased cost of cultivation under such systems necessitate the adoption of diversified and resilient cropping strategies. Crop diversification through maize-based cropping systems has been widely recognized as an effective approach to enhance system productivity, improve soil health, and mitigate production risks under rainfed conditions (Singh *et al.*, 2018). Inclusion of legumes, oilseeds, and high-value vegetable crops in sequence with maize not only improves nutrient recycling and soil biological activity but also contributes to better moisture use efficiency and yield stability (Kumar and Rana, 2020).

Maize-based sequential cropping systems have been shown to produce higher system productivity when evaluated in terms of crop equivalent yield, such

as maize equivalent yield (MEY), compared to sole cropping. This improvement is largely attributed to efficient utilization of residual soil moisture and nutrients, complementary resource use among component crops, and higher economic returns from short-duration and high-value crops (Reddy *et al.*, 2021). Vegetable-based systems, in particular, have demonstrated superior MEY and profitability due to higher market prices and frequent harvesting, despite comparatively lower biological yields (Patel *et al.*, 2022). Moreover, diversified cropping systems help stabilize farm income by distributing economic risk across multiple crops, which is especially important under rainfed farming situations prone to climatic variability.

Several studies have emphasized that maize-based cropping systems improve land use efficiency, employment generation, and overall farm profitability compared to conventional cereal-based systems (Meena *et al.*, 2020; Sharma and Singh, 2021). In the context of Telangana, where rainfall is erratic and soils are marginal, identification of economically viable and agronomically sustainable maize-based cropping systems is crucial for enhancing farmers' livelihoods and ensuring long-term resource conservation.

In view of the above considerations, the present study was undertaken to evaluate the productivity and economic potential of different maize-based cropping systems under sandy loam soils of Northern Telangana, India, with the objective of identifying suitable and sustainable cropping options for the region.

Material and Methods

The experiment was conducted during two consecutive *kharif* and *rabi* seasons of 2021-22 and 2022-23, respectively at Agricultural Research Station, Karimnagar, Northern Telangana Zone of Telangana state. The soil of experimental site was sandy loam with pH of 7.7, Electrical conductivity 0.23 dSm⁻¹, low in organic carbon (0.30 %), low in available nitrogen (180 kg ha⁻¹) and medium in phosphorus (53 kg ha⁻¹) and high in potassium (315kg ha⁻¹). The experiment was laid out with eight cropping systems in Randomized Block Design (RBD) with three replications. The experiment consists of eight cropping system treatments viz, T₁: Green gram – Maize, T₂: Vegetable Cowpea – Maize, T₃: Okra – Maize, T₄: Redgram – Sweet corn, T₅: Maize – Sunflower T₆: Maize – Onion, T₇: Maize – Groundnut, T₈: Maize – Mustard. The required amount of N, P and K fertilizers were applied through urea, SSP and Muriate of potash, respectively. Other cultural operations and plant

protection measures were followed as per the recommendations. Crop received 603 mm (31 rainy days) and 746 mm (44 rainy days) rainfall during the crop growth period in 2021-22 and 2022-23, respectively. The recorded data were subjected to statistical analysis as prescribed by Gomez and Gomez. The interpretation of the treatment effects were made on the basis of Fisher's critical difference at p=0.05 level. All the *kharif* crops were sown and the following sequence crops during *rabi* were taken up as and when the preceding *kharif* crops were harvested in the respective plots.

Final crop yield were recorded and gross return (Rs ha⁻¹) were calculated on the basis of prevailing market price of the produce. To compare the performance of different cropping sequences, economic yield of all the crops were converted into maize equivalent yield (MEY) based on prevailed market price using the formula:

$$\text{MEY (of a crop)} = Y_x (P_x)/P_j$$

Where, Y_x is the yield of crop x (t/ha of economic harvest),

P_x is the price of crop x, and P_j is the price of rice

The benefit: Cost ratios (BC ratio) for different sequences were calculated by dividing gross return by cost of cultivation. Profitability of the system was calculated by dividing the net return ha⁻¹ in a sequence by 365 days. The production efficiency value was calculated by dividing the total grain production ha⁻¹ in a sequence with total duration of crops in a sequence (Tomar and Tiwari, 1990). Land use efficiency (LUE) was calculated by taking total duration of crops in a sequence and dividing by 365 (Samant, 2015). The data was statistically analyzed applying the techniques of analysis of variance and the significance of different sources of variations were tested by error mean square of Fisher Snedecor's 'F' test at probability level 0.05.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads.

Productivity and economics of crops and cropping systems

Kharif Maize equivalent yield (MEY):

The maize equivalent yield (MEY) is an important indicator to compare the productivity of diverse cropping systems by converting the yield of different crops into a common unit based on their market price. The performance of different *kharif* crops in terms of

MEY during *kharif* 2021 and 2022 revealed significant variation among the crops (Table 1).

Among the *kharif* crops evaluated, okra recorded a significantly higher maize equivalent yield (MEY), producing 19,773 kg ha⁻¹ in 2021 and 13,096 kg ha⁻¹ in 2022, which was markedly superior to all other crops. The higher MEY of okra can be primarily attributed to its higher economic value, prolonged harvesting period, and comparatively better yield potential under the prevailing agro-climatic conditions. Although okra produces a relatively lower biological yield than cereal crops, the substantially higher market price of its tender pods significantly enhanced its maize equivalent yield, thereby improving overall system productivity. Similar results have been reported by earlier researchers, who documented superior system productivity in vegetable-based cropping systems due to their price advantage, frequent harvesting, and intensive crop management practices (Kumar *et al.*, 2018; Singh and Sharma, 2019; Reddy *et al.*, 2020). Studies by Meena *et al.* (2021) and Patel *et al.* (2022) also observed higher maize equivalent yields with okra-based systems compared to cereal-based systems, emphasizing the role of market-driven returns in determining cropping system productivity.

On the other hand, green gram recorded the lowest MEY, with values of 2,512 and 2,482 kg ha⁻¹ during 2021 and 2022, respectively. The lower MEY of green gram may be ascribed to its lower seed yield, short duration, and comparatively lower market price than commercial crops like okra. Although green gram contributes to soil fertility through biological nitrogen fixation and plays an important role in sustainable farming, its economic yield in terms of maize equivalent was considerably lower.

Rabi Maize equivalent yield (MEY)

During *rabi* 2021–22 and 2022–23, significant differences were observed among the *rabi* crops grown after maize with respect to maize equivalent yield (MEY) (Table 2). Among the various crop sequences evaluated, onion raised after maize recorded the highest maize grain equivalent yield, registering 16,830 kg ha⁻¹ during 2021–22 and 12,624 kg ha⁻¹ during 2022–23, which was significantly superior to all other *rabi* crops.

The substantially higher MEY obtained with the maize–onion cropping system can be attributed to the higher bulb yield of onion coupled with its premium market price. Onion, being a high-value vegetable crop, offers greater economic returns even with moderate biological yield. Moreover, better utilization of residual soil moisture and nutrients left by the

preceding maize crop, along with intensive crop management practices, might have contributed to enhanced productivity and equivalent yield.

In contrast, mustard recorded the lowest maize equivalent yield (MEY), with values of 2,595 and 2,697 kg ha⁻¹ during *rabi* 2021–22 and 2022–23, respectively. The lower MEY of mustard can be attributed to its relatively lower seed yield and comparatively lower market price than vegetable crops. Although mustard plays an important role in oilseed production, soil fertility improvement, and crop diversification, its contribution to overall system productivity in terms of maize equivalent yield remained limited. The present findings are in close agreement with the observations of Rana *et al.* (2011), who reported that maize-based crop sequences involving vegetable crops produced significantly higher equivalent yields and economic returns compared to cereal–cereal and cereal–oilseed cropping systems. Similar trends were also reported by Kumar and Rana (2014) and Meena *et al.* (2018), who observed lower system productivity in maize–mustard sequences compared to maize–vegetable systems due to lower price realization and yield potential of mustard.

Economic evaluation of *Kharif* maize based cropping system

The economic performance of maize under different *kharif* maize-based cropping systems was evaluated in terms of gross returns, net returns and benefit–cost (B:C) ratio, and the results are presented in Table 2.

Gross Returns (Rs. ha⁻¹)

Significant variation in gross returns was observed among the different *kharif* crops viz., green gram, vegetable cowpea, okra, red gram and maize during both the years of study (2021 and 2022). Among all the cropping systems, okra recorded the highest gross returns, amounting to Rs. 3,69,760 ha⁻¹ during 2021 and Rs. 2,56,944 ha⁻¹ during 2022, which were considerably higher than those obtained from other crops.

The superior gross returns from okra can be attributed to its higher maize equivalent yield, continuous harvesting of marketable pods, and higher market price compared to cereals and pulse crops. The decline in gross returns during 2022 compared to 2021 might be due to year-to-year variations in yield levels, market price fluctuations, or climatic factors influencing crop performance.

Net Returns (Rs. ha⁻¹)

Similar to gross returns, net returns were also significantly influenced by the choice of *kharif* crop. Among the different maize-based cropping systems, okra recorded the highest net returns of Rs. 2,84,678 ha⁻¹ during 2021 and Rs. 1,71,862 ha⁻¹ during 2022, surpassing all other crops.

The higher net returns in okra were mainly due to substantially higher gross returns despite relatively higher cost of cultivation. The increased profitability indicates that the additional investment in vegetable crops like okra is economically justified. In contrast, crops such as green gram, red gram and maize recorded lower net returns due to their lower yield potential and comparatively lower market prices.

Benefit–Cost Ratio (B:C Ratio)

The benefit–cost ratio, which reflects the economic efficiency of cropping systems, followed a trend similar to that of gross and net returns. Among the *kharif* crops evaluated, okra recorded the highest B:C ratio, with values of 4.35 during 2021 and 3.02 during 2022, indicating superior profitability and efficient utilization of resources.

The higher B:C ratio of okra suggests that each rupee invested returned more profit compared to other crops, making it the most economically viable option among the maize-based *kharif* cropping systems. The comparatively lower B:C ratios observed during 2022 could be attributed to increased input costs or reduced market prices, which affected overall profitability.

Economic evaluation of *Rabi* maize based cropping system

The economic performance of *rabi* maize-based cropping systems was assessed in terms of gross returns, net returns and benefit–cost (B:C) ratio, and the results are presented in Table 4. The analysis revealed considerable variation in economic returns among the different *rabi* crops grown after maize during both the years of experimentation.

Gross Returns (Rs. ha⁻¹)

Among the different *rabi* crops evaluated viz., maize, sweet corn, onion, sunflower, mustard and groundnut, onion recorded the highest gross returns, amounting to Rs. 3,14,730 ha⁻¹ during 2021 and Rs. 2,47,680 ha⁻¹ during 2022, which were significantly superior to those obtained from other crops.

The higher gross returns from onion can be attributed to its higher bulb yield and premium market price compared to cereal, oilseed and pulse crops. Additionally, onion efficiently utilized the residual

nutrients and soil moisture left by the preceding maize crop, contributing to enhanced productivity. The comparatively lower gross returns during 2022 may be due to inter-annual variability in climatic conditions, yield levels or market price fluctuations.

Net Returns (Rs. ha⁻¹)

Net returns also differed significantly among the *rabi* maize-based cropping systems. Onion recorded the highest net returns, with values of Rs. 2,34,524 ha⁻¹ during 2021 and Rs. 1,66,704 ha⁻¹ during 2022, outperforming all other *rabi* crops.

Despite the relatively higher cost of cultivation involved in onion production, the substantially higher gross returns resulted in superior net returns. Other crops such as maize, mustard and sunflower recorded lower net returns due to their lower yield potential and comparatively lower market value, while groundnut and sweet corn showed moderate returns.

Benefit–Cost Ratio (B:C Ratio)

The benefit–cost ratio, an indicator of economic efficiency and profitability, followed a trend similar to that of gross and net returns. Among the *rabi* crops, onion recorded the highest B:C ratio, with values of 3.92 during 2021 and 3.06 during 2022, indicating its economic superiority over other cropping systems.

The higher B:C ratio in onion suggests that investment in onion cultivation yielded higher returns per unit cost, making it the most profitable *rabi* crop in the maize-based cropping system. The reduction in B:C ratio during 2022 may be attributed to higher input costs and/or lower market prices, which affected overall profitability.

Land use efficiency (%)

Land use efficiency (LUE) is an important parameter that indicates the extent of utilization of land over a given period of time under different cropping systems. Higher land use efficiency reflects better use of available land resources through longer crop occupation, thereby contributing to improved system productivity.

Among the different maize-based cropping systems, red gram – sweet corn cropping system recorded the highest land use efficiency, with values of 63.6% during 2021–22 and 66.6% during 2022–23. The higher land use efficiency in this system can be attributed to the longer duration of red gram, which occupies the land for an extended period, followed by sweet corn. This resulted in prolonged land coverage and reduced fallow periods, thereby maximizing land utilization.

The okra–maize cropping system ranked next in terms of land use efficiency, recording comparatively higher values during both the years of study. The improved land use efficiency under this system may be due to the continuous harvesting nature of okra, which keeps the land productive for a longer duration, followed by maize cultivation. Similarly, the maize–onion cropping system also exhibited higher land use efficiency during both years, owing to the successful inclusion of a vegetable crop with relatively longer field duration and intensive management.

The variation in land use efficiency between the two years might be due to differences in crop duration caused by seasonal climatic variations, sowing and harvesting dates, or management practices. Overall, cropping systems involving long-duration and vegetable crops showed higher land use efficiency compared to systems dominated by short-duration crops.

The results clearly indicate that intensification and diversification of maize-based cropping systems, particularly through the inclusion of pulses and vegetable crops, can significantly enhance land use efficiency. Higher land use efficiency not only improves overall productivity but also contributes to sustainable use of land resources.

System productivity, System profitability and production efficiency:

System productivity, system profitability and production efficiency are important indicators for evaluating the overall performance and sustainability of cropping systems. These parameters integrate yield, economic returns and crop duration, thereby providing a comprehensive assessment of the efficiency of different maize-based cropping systems.

Among the different maize-based cropping systems evaluated, the okra–maize cropping system recorded the highest system productivity, with values of 27,760 kg ha⁻¹ during 2021–22 and 21,676 kg ha⁻¹ during 2022–23. The superior system productivity of this cropping system can be attributed to the higher maize equivalent yield of okra during kharif season combined with good productivity of maize during rabi, resulting in enhanced total system yield.

Correspondingly, the okra–maize cropping system also registered the highest system profitability, recording Rs. 1,007 ha⁻¹ day⁻¹ during 2021–22 and Rs. 741 ha⁻¹ day⁻¹ during 2022–23. Higher daily profitability indicates efficient utilization of land and resources throughout the year. The inclusion of okra, a high-value vegetable crop with continuous harvesting

and higher market price, significantly contributed to increased economic returns on a per-day basis.

Similarly, production efficiency, expressed as yield per unit area per day, was highest under the okra–maize cropping system, with values of 123.4 kg ha⁻¹ day⁻¹ during 2021–22 and 99.9 kg ha⁻¹ day⁻¹ during 2022–23. The higher production efficiency reflects better synchronization of crop duration and productivity, indicating that this system effectively converted time and land resources into higher yield.

The maize–onion cropping system ranked second for all the system efficiency parameters. It recorded system productivity of 24,918 and 19,158 kg ha⁻¹, system profitability of Rs. 875 and Rs. 624 ha⁻¹ day⁻¹, and production efficiency of 112.8 and 87.1 kg ha⁻¹ day⁻¹ during 2021–22 and 2022–23, respectively. The relatively high performance of this system can be attributed to the high economic value and yield potential of onion, which substantially improved overall system returns despite its higher cost of cultivation.

The comparatively lower values of system productivity and efficiency observed during 2022–23 across cropping systems may be due to inter-annual variations in climatic conditions, market price fluctuations, and yield differences.

The present findings are in close conformity with the results reported by Chaudhary *et al.* (2001), who observed that diversified cropping systems produced higher productivity and profitability compared to traditional maize–wheat cropping sequences. The results clearly highlight the advantage of crop diversification and inclusion of high-value vegetable crops in maize-based cropping systems.

Overall, the study indicates that okra–maize and maize–onion cropping systems are highly efficient, productive and profitable, and their adoption can significantly enhance farm income and resource-use efficiency under similar agro-climatic conditions.

Economics of maize based cropping system

Economic evaluation of different crop sequences is of paramount importance from the farmer's point of view, as it determines the feasibility and adoptability of any cropping system evolved through research. The economic analysis of the treatments comprised cost of cultivation, gross monetary returns, net monetary returns and benefit–cost (B:C) ratio on a per hectare basis, as influenced by different maize-based cropping systems.

Economics of Kharif Crops

Among the different kharif crops evaluated viz., green gram, vegetable cowpea, okra, red gram and maize, okra recorded the highest economic returns, registering gross returns of Rs. 3,13,352 ha⁻¹, net returns of Rs. 2,27,500 ha⁻¹ and a B:C ratio of 3.66, which were superior to all other kharif crops.

The higher profitability of okra can be attributed to its higher maize equivalent yield, continuous harvesting pattern and higher market price. Although okra involves relatively higher cost of cultivation, the additional investment was well compensated by substantially higher returns, resulting in enhanced net income and benefit–cost ratio. In contrast, pulse and cereal crops recorded lower returns due to lower yield potential and comparatively lower market prices.

Economics of Rabi Crops

Similarly, among the different rabi crops viz., maize, sweet corn, onion, sunflower, mustard and groundnut, onion proved to be the most remunerative crop, recording gross returns of Rs. 2,76,578 ha⁻¹, net returns of Rs. 2,00,614 ha⁻¹ and a B:C ratio of 3.49, which were significantly higher than those obtained from other rabi crops.

The superior economic performance of onion was mainly due to its high bulb yield and premium market value, which resulted in higher gross and net returns despite comparatively higher production costs. The inclusion of onion as a rabi crop effectively enhanced the profitability of maize-based cropping systems.

Economics of Maize-Based Cropping Systems (System Level)

At the system level, significant differences were observed among the maize-based cropping systems in terms of system gross returns, system net returns and benefit–cost ratio. Among the different cropping systems, the okra–maize cropping system recorded the highest economic returns, with system gross returns of Rs. 4,72,067 ha⁻¹, system net returns of Rs. 3,18,995 ha⁻¹ and a B:C ratio of 3.09.

This was followed by the maize–onion cropping system, which recorded system gross returns of Rs. 4,20,932 ha⁻¹, system net returns of Rs. 2,73,506 ha⁻¹ and a B:C ratio of 2.86. The higher profitability of

these systems can be attributed to the inclusion of high-value vegetable crops, which significantly improved total system productivity and economic returns compared to cereal-based systems.

The results clearly indicate that maize–vegetable based cropping systems were considerably more profitable than traditional maize–maize sequence, owing to higher market prices and better resource utilization.

The present findings are in close agreement with the results reported by Rana *et al.* (2010), Rana *et al.* (2011), Saroch *et al.* (2005) and Sharma *et al.* (2008), who also reported higher net returns and benefit–cost ratios from maize-based diversified and vegetable-inclusive cropping systems compared to conventional cereal-based sequences.

Overall, the study concludes that diversification of maize-based cropping systems with vegetable crops such as okra and onion significantly enhances economic returns, making these systems more profitable, efficient and farmer-friendly under similar agro-climatic conditions.

Conclusion

Based on the findings of the two-year study, it can be concluded that under the agro-climatic conditions of the Northern Telangana Zone of Telangana, the okra–maize cropping system proved to be the most profitable, followed by the maize–onion cropping system, as evidenced by higher net returns and benefit–cost ratio. These cropping systems also recorded higher system productivity, production efficiency and economic returns, indicating their superiority over other maize-based cropping systems.

The inclusion of high-value vegetable crops such as okra and onion in maize-based cropping systems significantly enhanced overall productivity and profitability, thereby making these systems more productive, sustainable and remunerative. Hence, adoption of okra–maize and maize–onion cropping systems can be recommended for improving farm income and efficient resource utilization under similar agro-ecological conditions of the region.

Table 1 : Yield and Maize grain equivalent yield of different *Kharif* crops as influenced by maize based cropping Systems during *Kharif* 2021 &2022.

Treatments	<i>Kharif</i> crop yield (kg/ha)			Maize grain equivalent yield (kg ha ⁻¹)		
	2021	2022	Pooled mean	2021	2022	Pooled mean
Green gram – Maize (Green gram seed yield)	648	628	638	2512	2482	2499
Vegetable Cowpea – Maize (Cowpea pod yield)	5370	2762	4066	8615	4224	6421
Okra – Maize (Okra capsule yield)	18488	8565	13526	19773	13096	16441
Redgram – Sweet corn (Redgram seed yield)	833	2052	1443	2806	6904	4859
Maize – Sunflower (Maize grain yield)	7069	6728	6899	7069	6728	6899
Maize – Onion (Maize grain yield)	8088	7006	7547	8088	7006	7547
Maize – Groundnut (Maize grain yield)	7807	7346	7576	7807	7346	7576
Maize – Mustard (Maize grain yield)	8041	7284	7662	8041	7284	7662
SEM _±				340	571	305
CD (<i>p</i> =0.05)				1041	1747	933

Table 2 : Economics of different *Kharif* crops as influenced by maize based cropping Systems during *Kharif* 2021 &2022.

	Gross returns (Rs. ha ⁻¹)			Net returns (Rs. ha ⁻¹)			B:C ratio		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Green gram – Maize (Green gram seed yield)	46980	48708	47844	2642	4370	3121	1.06	1.10	1.07
Vegetable Cowpea – Maize (Cowpea pod yield)	161100	82870	121985	115067	36837	75567	3.50	1.80	2.64
Okra – Maize (Okra capsule yield)	369760	256944	313352	284678	171862	227500	4.35	3.02	3.66
Redgram – Sweet corn (Redgram seed yield)	52479	135463	93971	4141	87125	44863	1.09	2.80	1.90
Maize – Sunflower (Maize grain yield)	132190	132011	132101	65740	65561	64881	1.99	1.99	1.97
Maize – Onion (Maize grain yield)	151246	137461	144353	84796	71011	77518	2.28	2.07	2.16
Maize – Groundnut (Maize grain yield)	145991	144122	145057	79541	77672	78222	2.20	2.17	2.17
Maize – Mustard (Maize grain yield)	150367	142911	146639	83917	76461	79804	2.26	2.15	2.19

2021: Price of Green gram: Rs. 72.50/- , Price of Vegetable Cowpea: Rs. 30.0 kg⁻¹, Price of Okra : Rs. 30 kg⁻¹ , Price of Red gram: Rs. 63.0 kg⁻¹ , Price of Maize: Rs. 18.7 kg⁻¹,

2022: Price of Green gram: Rs. 77.55/- , Price of Vegetable Cowpea: Rs. 30.0 kg⁻¹, Price of Okra : Rs. 30 kg⁻¹ , Price of Red gram: Rs. 66.0 kg⁻¹ , Price of Maize: Rs. 19.62 kg⁻¹,

Table 3 : Grain Yield and Maize grain equivalent yield of different *Rabi* crops as influenced by maize based cropping Systems during *Rabi* 2021-22 &2022-23.

Treatments	<i>Rabi</i> crop yield (kg/ha)			Maize grain equivalent yield (kg ha ⁻¹)		
	2021-22	2022-23	Pooled mean	2021-22	2022-23	Pooled mean
Green gram – Maize (Maize grain yield)	8897	7284	8090	8897	7284	8091
Vegetable Cowpea – Maize (Maize grain yield)	7645	7394	7519	7645	7393	7519
Okra – Maize (Maize grain yield)	7987	8566	8277	7987	8566	8277
Red gram – Sweet corn (Sweet corn yield)	78180 (number)	79167 (number)	78674 (number)	8362	8070	8216
Maize - Sunflower (Sunflower seed yield)	1483	1142	1312	4770	3725	4248
Maize – Onion (Onion bulb yield)	10491	8256	9374	16830	12624	14727
Maize – Groundnut (Groundnut seed yield)	2777	2562	2669	8242	7638	7940
Maize – Mustard (Mustard seed yield)	961	971	966	2595	2697	2646
SEM _±				274	344	
CD (<i>p</i> =0.05)				841	1054	

Table 4 : Economics of different *Rabi* crops as influenced by maize based cropping Systems during *Rabi* 2021-22 & 2022-23.

	Gross returns (Rs. ha ⁻¹)			Net returns (Rs. ha ⁻¹)			B:C ratio		
	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean
Green gram – Maize (Maize grain yield)	166374	142911	154643	99924	74921	87423	2.50	2.10	2.30
Vegetable Cowpea – Maize (Maize grain yield)	142961	145061	144011	76511	77071	76791	2.15	2.13	2.14
Okra – Maize (Maize grain yield)	149357	168072	158714	82907	100082	91494	2.25	2.47	2.36
Red gram – Sweet corn (Sweet corn yield)	155867	158333	157100	88017	88943	88480	2.30	2.28	2.29
Maize - Sunflower (Sunflower seed yield)	89202	73086	81144	38139	21253	29696	1.74	1.41	1.58
Maize – Onion (Onion bulb yield)	314730	247680	276578	234524	166704	200614	3.92	3.06	3.49
Maize – Groundnut (Groundnut seed yield)	154132	149861	151997	77416	71290	74353	2.01	1.91	1.96
Maize – Mustard (Mustard seed yield)	48530	52902	50716	4954	8556	6755	1.11	1.19	1.15

2021-22: Price of Maize: Rs. 18.70 kg⁻¹, Price of Sweet corn: Rs. 2/- cob⁻¹, Price of sunflower: Rs. 60.15 kg⁻¹, Price of Onion: Rs. 30 kg⁻¹, Price of ground nut: Rs. 55.50 kg⁻¹, Price of mustard :Rs. 50.5 kg⁻¹

2022-23: Price of Maize: Rs. 19.62 kg⁻¹, Price of Sweet corn: Rs. 2/- cob⁻¹, Price of sunflower: Rs. 64 kg⁻¹, Price of Onion: Rs. 30 kg⁻¹, Price of ground nut: Rs. 58.50 kg⁻¹, Price of mustard : Rs. 54.5 kg⁻¹

Table 5: Land use efficiency (%), System productivity (kg ha⁻¹), System profitability (Rs./ ha/day) and Production efficiency (kg ha⁻¹ day⁻¹) as influenced by maize based cropping systems during *Kharif & Rabi*, 2021-22 & 2022-2023.

Treatments	Land use efficiency (%)			System productivity (kg ha ⁻¹)			System profitability (Rs./ha/day)			Production efficiency (kg ha ⁻¹ day ⁻¹)		
	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean
Green gram – Maize	49.3	49.3	49.30	11409	9769	10589	281	215	248	63.4	54.3	58.8
Vegetable Cowpea – Maize	60.5	58.6	59.55	16260	11622	13941	525	310	417	73.6	54.3	63.9
Okra – Maize	61.6	59.5	60.55	27760	21676	24718	1007	741	874	123.4	99.9	111.6
Red gram – Sweet corn	63.6	66.6	65.10	11168	14981	13075	252	478	365	48.1	61.7	54.9
Maize - Sunflower	55.6	55.6	55.60	11839	10454	11146	285	234	259	58.3	51.5	54.9
Maize – Onion	60.5	60.3	60.40	24918	19158	22039	875	624	749	112.8	87.1	99.9
Maize – Groundnut	59.7	58.4	59.05	16050	14984	15517	430	406	418	73.6	70.3	72.0
Maize – Mustard	54.2	54.0	54.10	10636	9980	10308	244	231	237	53.7	50.6	52.2
SEm±				558	717	401	28	39	22	2.6	3.3	1.80
CD (p=0.05)				1708	2195	1227	87	118	66	8.0	10.0	5.6

Table 6 : Economics of different maize based cropping systems during 2021-22 & 2022-23

Treatments	Gross returns (Rs. ha ⁻¹)			Net returns (Rs. ha ⁻¹)			B:C ratio		
	2021-22	2022-23	Pooled Mean	2021-22	2022-23	Pooled Mean	2021-22	2022-23	Pooled Mean
Green gram – Maize	213354	191619	202487	102566	78521	90544	1.93	1.69	1.81
Vegetable Cowpea – Maize	304062	227931	265997	191579	113138	152359	2.70	1.99	2.35
Okra – Maize	519117	425016	472067	367585	270404	318995	3.43	2.75	3.09
Red gram – Sweet corn	208346	293796	251071	92158	174528	133343	1.79	2.46	2.13
Maize - Sunflower	221393	205098	213246	103880	85275	94578	1.88	1.71	1.80
Maize – Onion	465976	375887	420932	319320	227691	273506	3.18	2.54	2.86
Maize – Groundnut	300123	293983	297053	156957	148192	152575	2.10	2.02	2.06
Maize – Mustard	198897	195813	197355	88871	84247	86559	1.81	1.76	1.79

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