RESEARCH ARTICLE

EFFECT OF CROPPING SEQUENCES INFLUENCE THE FARMER ECONOMICAL CONDITION UNDER IRRIGATED SITUATION OF MAHAKOSHAL REGION

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Abstract: A field experiment was conducted at the Instructional Research Farm, Department of Agronomy, College of Agriculture, Jawaharlal Nehru KrishiVishwaVidyalaya, Jabalpur (M.P.) under irrigated condition.During the two consecutive years of 2018-19 and 2019-20 entitled Effect of cropping sequences influence the farmer economical condition under irrigated situation of MahakoshalRegion.Ten cropping systems *viz.* rice – wheat, rice – chickpea, green gram – chickpea – green gram, green gram – lentil – black gram, rice – potato – maize for cob, rice – *toria* (early *rabi*) wheat (late *rabi*), sorghum for fodder – egyptian clover (fodder and seed), rice bean for fodder – egyptian clover for fodder – sorghum for fodder, maize for cob – vegetable pea – okra, soybean – marigold – vegetable cowpea were evaluated in the study. The rice – potato – maize for cob cropping system recorded the highest cost of cultivation, gross monetary return,net monetary returns and relative economic efficiency (Rs. 122.09; Rs. 253.52;Rs. 131.43 $ha^{-1}$and 125.42 %), over the other different cropping systems.

Keywords: B: C ratio, Cost of cultivation, Gross returns, Net returns, Relative economic efficiency

INTRODUCTION

Crop intensification is needed in order to produce more food per unit area per unit time (Kumar *et al.*, 2021a), so as to assure food security for the burgeoning Indian population, expected to exceed 1.60 billion people in 2050. Traditional cropping system needs to be retailored for the intensification in time, space and advance technology dimensions as well as for natural resource management. Efforts should be us made to integrated utilize all the available natural and artificial resources to augment productivity in a cropping system and total productivity. Most of the research in the past has confined to the individual crops but now it has been realized that the focus should be us move towards different cropping system. In Kymore Plateau and Satpura hills agroclimatic zone of Madhya Pradesh rice-wheat and rice-chickpea cropping system is predominant under adequate irrigation water situation (Jain and Kushwaha, 2020). As a whole, cultivation of both rice and wheat crop in a sequence is costly, time consuming, energy exhaustive and tedious, besides their poor market value of the produce. Consequently, the socio-economic status of the farmers associated with rice based cropping system areas is quite low (Jain and Kushwaha, 2020). Agricultural profits are key source of income to ruralpopulation (Ma and Maystadt, 2017) and diversification plays a pivotalrole in sustaining agriculture and agriculture based livelihood (BigstenandTengstam, 2011; Jayne *et al.*, 2010).
Continues cultivation of cereal based (rice – wheat) cropping system (Saravanakumar *et al.*, 2020) in this region cerate the lot of problems showed low in the system productivity, multiple nutrient deficiency unattended intervening periods (Bhatt and Kukal 2014a,b; Bhatt and Kukal 2015a,b,c), soil degradation (Bhandari *et al.*, 2002), atmospheric pollution, deterioration in soil physical properties (Tripathi, 1992), decline productivity, crop yield (Yadav, 1998), resurgences of weed, insect, pest and disease, over mining of nutrients, reduction in organic carbon, reduction in water table and water logging (Humphreys *et al.*, 2010 and Jat *et al.*, 2021). Crop diversification shows lot of promises in alleviating these problems besides, fulfilling basic needs for cereals, pulses, oilseeds and vegetables as well as regulating farm income & crop yield (Li *et al.*, 2001), besides withstanding weather aberrations, controlling price fluctuation, ensuring balanced food supply, conserving natural resources, reducing the chemical fertilizer and pesticide loads, ensuring environmental safety and creating employment opportunity (Singh, 2001). Inrecent years double and triple cropping are more focusing points for increasingfarmers income (Yang *et al.*, 2018), so diversification and intensification of cropping systems withremunerative and efficient crops like pulses, oilseeds and vegetables has greatscope to generate maximum net profit per unit investment per unit time to farmers. (Kalita *et al.*, 2019: Painkra *et al.*, 2020).

MATERIALS AND METHODS

A field experiment was conducted during 2018 - 19 to 2019 – 20 at the Instructional Research Farm, Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya,

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Jabalpur, Madhya Pradesh, India. The soil of experimental field was sandy loamin texture with pH 7.8, electrical conductivity 0.50 dSm^{-1}, and organic carbon (6.9 g kg^{-1}), available nitrogen (227 kg ha^{-1}), available phosphorus (9.4 $kgha^{-1}$) and available potassium (302 kg ha^{-1}) content. The varieties ofdifferent crops and their duration in the field, recommendedfertilizer dose applied and planting spacing. Certified seeds ofdifferent crops were used in the experiment. Before sowing, seeds of all the crops were treated with Carbendazim + Mancozeb @ 2-3 g kg^{-1} seed to protect thecrops from seed and soil borne diseases. The experiment was laid out ina randomized block design with 10 treatments of different cropping systems and replicatedthriceon a fixed site. (T_1) rice – wheat, (T_2) rice – chickpea, (T_3) greengram – chickpea – greengram, (T_4) greengram – lentil – blackgram, (T_5) rice – potato – (cob) maize, (T_6) rice – *toria* (late) wheat, (T_7) sorghum (f) – Egyptian clover (fodder + seed), (T_8) ricebean (f) – Egyptian clover (f) – sorghum (f), (T_9) maize (cob) – vegetable pea – okra, (T_{10}) soybean – marigold – vegetable cowpea. Net returns were the differencebetween the gross returns of a system and total cost of cultivation of the component crops. Different economic indicators were calculatedbased on the existing price of the inputs and outputs. The cost of cultivation of various sequenceswas worked out based on the most recent standardrate of different crops. The yield of different componentcrops in the sequence was converted intogross return in rupees based on current marketprice. Net return for each crop sequence was calculatedby deducting the cost of cultivation for thegross return. Benefit: cost ratio is obtained by followingrelation (Kumar *et. al.,* 2015**).** Relative economic efficiency (REE) as economic gains over of the system in relation to the existingsystems was calculated by the formula suggested by Yadav*et. al.,* (2017b).

$$\text{Benefit/Cost (B: C ratio)} = \frac{\text{Gross monetary returns}(Rsha^{-1})}{\text{Cost of cultivation } (Rsha^{-1})}$$

RESULTS

Rice equivalent yield

In general, all the intensified cropping systems weremore productive over the farmer's practices (Rice – Wheat) of the region. While comparing the totalproductivity of intensified cropping systems in terms of maize grain equivalent yield, significantly higher rice – potato – maize for cob estimated highest (13.35 t ha-1) as compared to other systems. The rabi crops mostly influenced the rice equivalent yield of the systems because rice was the grain crop and contribution of zaid crops was marginal. The higher production potential of potato and better market price were instrumental for attaining higher rice equivalent yield by the top ranked cropping sequence. (Khaurb *et al.,* 2003), (Upadhyay *et al.*,2007), (Kalita *et al.*,2018). Further, less prices of cereals in the prevailing markets while vegetable crops fetched higher value in the market. Kumar *et al.,* (2008), Upadhyay *et al.,* (2011), Kumar *et al.,* (2015), also recorded the similar results and reported that inclusion of vegetable crops in rice- based cropping sequences increase the rice equivalent yield.

Cost of cultivation

The cost of cultivation increased with increase in number of crops included in the cropping system. Further, cost of cultivation was high in all time vegetable involving cropping sequences over sorghum fodder – egyptian clover (fodder + seed) crops sequence because of higher cost of inputs required by vegetables crop production. Rice – potato - maize (cob) Rs. 122.09 x 10^3 ha^{-1}sequenceproved to be most expensive in terms of total cost of cultivation. Inclusion of potato in the cropping sequence increased the cost of cultivationdue to more seed rate, fertilization and human labour requirement, as it is a labour intensive crop. Similar results were reported by Avasrhe *et al.,* (2020), Prasad *et al.,* (2013) and Mall *et al.,* (2014).

Gross monetary return

Therice – potato – maize for cob recorded the highest gross monetary return of Rs. 253.52 x 10^3 ha^{-1}followed bymaize for cob – vegetable pea – okra for vegetable of Rs. 211.98x 10^3 ha^{-1}.This might be due to the better market price of potato in *rabi* and maize for cob in z*aid*seas on. Sharma *et al.,* (2019), Rai and Tiwari (2012) and Tiwari *et al.,* (2015) were also recorded the optimum the diversification and intensification of rice based cropping system with potato could give the maximum GMR as compared to other crop sequences.

Net monetary return

Among the various systems, rice–potato-maize (cob) realized the highest net returns Rs. 131.43 x 10^3 ha^{-1}followed bygreen gram – chickpea – green gramRs. 102.56x 10^3 $ha^{-1}$and proved superior over rest of thesequences because of the highest gain of gross return under the above sequences. The inclusion of vegetable crop in a crop sequence boost up the profitability because of higher production better market price ultimately fetched higher net monetary return, Singh *et al.,* (2017) who observed that the inclusion of vegetable crop like potato in a cropping sequence besides, increasing the systemproductivity fetched higher market price thereby, increased the netreturns. The findings are in accordance with the findings of Jat *et al.,* (2012).

Benefit cost ratio

The cropping sequences sorghum fodder – egyptian cloverfor (fodder & seed) fetched the highestbenefit cost ratio of 2.57 followed byricebean fodder – egyptian clover for fodder – sorghum fodder (2.19). Earlier studies carried out by Sharma (2009), Rana *et al.,* (2011) and Avasrhe *et al.,* (2000) inferred that

diversified cropping sequence offers special advantages and minimize the probability of low income for small and marginal farmers.

Relative economic efficiency

The various systems, rice–potato-maize for cob realized that the relative economic efficiency (125.42 %), followed by green gram – chickpea – green gram (78.90 %) over the rice – chickpea cropping sequence. Inclusion of more number of crops in exiting croppingsequences resulted in higher productivity, which ultimately turned in higher economic outputover routine cropping sequences (Mukherjee, 2010; Prasad, 2014).

Table 1. Gross monetary return, Net monetary return, Benefit cost ratio and Relative economic efficiency under different cropping sequences

Cropping sequences		Rice equivalent yield (t ha^{-1})	Cost of cultivation (Rs.x 10^3 ha^{-1})	Gross monetary return (Rs.x 10^3 ha^{-1})	Net monetary return (Rs. x 10^3 ha^{-1})	Benefit cost ratio	Relative economic efficiency (%)
T_1	Rice – Wheat	7.16	70.24	127.71	57.47	1.82	0.00
T_2	Rice – Chickpea	6.73	68.43	119.92	51.49	1.75	-48.51
T_3	Green gram – Chickpea – Green gram	11.59	104.06	206.62	102.56	1.99	78.90
T_4	Green gram – Lentil – Black gram	7.68	104.94	136.94	32.00	1.30	-44.00
T_5	Rice – Potato – Maize (cob)	14.22	122.09	253.52	131.43	2.08	125.42
T_6	Rice – *Toria* (early *rabi*) Wheat (late *rabi*)	7.41	98.63	132.15	33.52	1.34	-43.19
T_7	Sorghum (F) – Egyptian clover(F+S)	8.69	60.43	154.99	94.56	2.57	64.25
T_8	Rice bean (F) – Egyptian clover (F) - Sorghum (F)	9.06	73.96	161.62	87.66	2.19	51.49
T_9	Maize (cob) – Pea (V) - Okra	11.89	111.87	211.98	100.11	1.90	74.03
T_{10}	Soybean – Marigold – Cowpea (V)	10.68	105.31	190.38	85.07	1.81	46.72
SEm±		**0.93**	-	**0.66**	**0.76**	**0.87**	-
CD (*P*=0.05)		**2.77**	-	**1.95**	**2.30**	**2.60**	-

CONCLUSION

On the basis of present study it can be concluded that amongs different cropping sequencefor highest gross monetary returns, net monetary returns and relative economic efficiencyfarmers of Mahakoshal Regionwithsufficientresources can successfully adopt rice – potato - maize (cob). These cropping sequenceimprove the farmers social economical condition under present scenario of existing cropping sequence.

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