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Research Article

ASSESSMENT OF RICE-BASED CROPPING SYSTEMS FOR MAXIMIZING PRODUCTIVITY AND PROFITABILITY IN KAMRUP DISTRICT OF ASSAM

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Abstract: The A field experiment was conducted for 2 consecutive years during 2013–14and 2014–15, at KVK, Kamrup, Assam, India to assessed 6 rice-based cropping systems under irrigated medium land acid soil situation of Kamrup district of Assam. From the mean of 2 years data, it was observed that the highest land use efficiency of 78.63 % was observed in rice - tomato cropping sequences followed by rice-lentil sequence with 78.08 %.The rice-tomato cropping sequences provided the most employment generation (350 man days ha^{-1}) followed by rice - cabbage sequence (290 man days ha^{-1}). The highest rice equivalent yield (290.04 q ha^{-1}) was recorded in tomato grown during *rabi* after sali paddy followed by cabbage with 176.54 q ha^{-1}. Winter rice–tomato sequence showed 537.09%and 254.72% increase in REY, respectively, over the predominant cropping systems of Assam (winter rice–fallow with REY54.02 q ha^{-1}) and second (winter rice– rapeseed with REY 75.70 q ha^{-1}). The system productivity efficiency was significant with the highest value in winter rice–tomato (119.94 kg ha^{-1} day^{-1}), followed by winter rice–cabbage sequences (89.31 kg ha^{-1} day^{-1}). The economic efficiency was significant with the highest value in winter rice–tomato (998.20 ha^{-1} day^{-1}), followed by winter rice–cabbage sequences (668.37 ha^{-1} day^{-1}). Nutrient-use productivity of the systems varied from 38.44 to 96.96 kg ha^{-1} kg^{-1} of nutrient applied and significantly highest nutrient use productivity was recorded in winter rice–tomato sequence. The highest gross return (395.86 x103 ha^{-1}) and net return (286.48 x103 ha^{-1}) were recorded in case of winter rice–tomato sequence. The highest benefit:cost ratio (3.84) was recorded in winter rice-pumpkin sequence. The highest relative economic efficiency (847.04%) over predominant cropping system winter rice-fallow was recorded in winter rice-tomato followed by 515.31% in winter rice-pumpkin cropping sequence.

Keywords: Diversification, cropping sequence, Rice equivalently yield, land use efficiency, Production efficiency and relative economic efficiency

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Introduction

Agriculture is the main income source for over 70 percent of the rural population of Assam which contributes about 17 percent of the state domestic product. The average operational holding of Assam is 1.11 ha and more than 75 percent farmers are small and marginal. The predominant cropping systems are mainly rice based like rice-fallow, rice-rice, rice-rapeseed (Toria), jute-rice and rice-vegetables *etc*. Rice in NER of India grown in varied ecosystems and the predominant cropping sequences are winter rice–fallow–autumn rice and winter rice–toria–fallow, where the diversification index is heavily influenced by rice. Besides, at farmer's level, potential productivity and monetary benefits act as guiding principles while opting for a particular crop/cropping system. Therefore, intensification and diversification of cropping system with the proper use of available limited irrigation facility will provide higher yield as well as better net returns under the climatic conditions of Assam [1]. In cropping system; inclusion of pulse, oilseed and vegetable is more beneficial than cereals after cereals [3, 4]. As it is difficult to replace the rice by any other crop in the rainy season due to soil and climatic condition of NER of India, only option left is during winter (*rabi*) and summer season for intensification and diversification of rice-based cropping system. An intensification of cropping sequence is essential in the existing farming situation. Non- rice crop like oilseeds, pulses and vegetables are receiving more attention owing to higher price due to increased demand. Inclusion of these crops in a sequence changes the economics of the cropping sequences [7]. In recent years double and triple cropping are more focusing points for increasing farmers income, so diversification and intensification of cropping systems with remunerative and efficient crops like pulses, oilseeds and vegetables has great scope to generate maximum net profit per unit investment per unit time to farmers. So, keeping in view there is a need of identification of a suitable rice based cropping sequence to enhance the system productivity, profitability and cropping intensity of the state.

Materials and Methods

Over the period 2013-14 and 2014-15 an experiment of 2 year duration was carried out at the farm of KVK, Kamrup, AAU, Kahikuchi, located at Kamrup district of Assam (26.1073N, 91.6089E), at an elevation of 46.0 m above mean sea level to evaluate six rice based cropping sequences intensified with pulses, oilseeds and vegetables for enhancing productivity and profitability. The experiment was composed of two phases. In phase (a), Rice was grown during the *kharif* season *i.e*., June-November followed by five winter crops (phase b), grown during the *rabi* season *i.e.,* November-February. The experiment was undertaken in irrigated medium land situation which is in general sandy clay loamwith acidic (PH 5.3) in reaction and medium in organic carbon content (0.68%). It was medium in available N (275.3 kg/ha), P (28.7 kg/ha) and K (142.6 kg/ha).The bulk density (Core sampler method) varied from1.38 to 1.49 Mg/m^3). The cultural practices followed in crops are given in [Table-1] which is as per the recommended packages. The treatments comprised of six rice based cropping sequences *viz*. Winter rice-Fallow; Winter rice-Rapeseed; Winter rice-Lentil; Winter rice-Pumpkin; Winter rice-Tomato and Winter rice-Cabbage. The experiment was laid out in Randomized Block Design (RBD) with four replications. For comparison between different cropping systems, the yields of all the crops in the sequences were converted into rice equivalent yield (REY). The REY of the systems were calculated in terms of winter rice using the following formula:

Table-1 Details of variety and agricultural operation for different crops in different cropping systems

Crop	Variety	Sowing	Harvesting	Other operation	No of irrigation	N:P_2O_5:K_2O (kg/ha)
Rice	Ranjit	3rd June	9th-13th November	Application of pre-emergence herbicide + mechanical weeding.	4	60:20:40
Rapeseed	TS-67	24th November	27th Feb to 2nd March	Spraying of Dimethoate 30EC against aphid.	2	60:40:40
Lentil	KLS-218	24th November	2ndto 5th April	Seed treatment with *Trichoderma viride*.	2	10:35:15
Pumpkin	Arjuna F_1	20th Nov.	15th to 31st March	Use of pheromone trap against fruit fly.	2	75:60:60
Tomato	S-22	*24th Nov.	5th Feb. To 10th March	Use of paddy straw mulch and need based spraying of pesticides	6	75:80:80
Cabbage	Rareball	*24th Nov.	25th Jan. to 10 Feb.	Need base application of pesticides	5	120:60:60

*Seeds sown in nursery on 21st Oct.

Table-2 Cropping sequence, System duration and Land use efficiency (%)

Treatments	Cropping sequences		System duration (days)	Land utilization index (%)	Man days ha^{-1}
	Kharif	*Rabi*			
T1	Rice	Fallow	155	42.47	125
T2	Rice	Rapeseed	250	68.49	200
T3	Rice	Lentil	285	78.08	215
T4	Rice	Pumpkin	280	76.71	208
T5	Rice	Tomato	287	78.63	350
T6	Rice	Cabbage	258	70.68	290

Table-3 Mean crop yield, rice-equivalent yield and other parameters under different cropping systems (mean of 2 years)

Treatments	Mean crop yield (q ha^{-1})		Rice Equivalent Yield (q ha^{-1})		Productivity efficiency (kg ha^{-1} day^{-1})	Economic efficiency (₹ ha^{-1} day^{-1})	Nutrient use productivity (kg ha^{-1} kg^{-1} of nutrient applied)
	Kharif	*Rabi*	*Rabi*	Total			
Rice-Fallow	54.03	-	-	54.03	34.85	195.19	59.50
Rice-Rapeseed	54.08	7.11	21.62	75.70	30.28	152.32	38.44
Rice-Lentil	54.38	6.68	29.04	83.42	29.27	161.60	55.23
Rice-Pumpkin	54.21	126.28	164.71	218.91	78.18	664.74	69.50
Rice-Tomato	54.18	333.55	290.04	344.22	119.94	998.20	96.96
Rice-Cabbage	53.88	290.03	176.54	230.42	89.31	668.37	64.00
SEm(±)	-	-	-	2.02	0.72	8.32	0.57
C.D(p=0.05)	-	-	-	4.31	1.54	17.73	1.20

Table-4 Economics of different cropping systems (Mean of 2 years)

Treatments	Cost of cultivation (x10^3 ₹ ha^{-1})	Gross return (x10^3 ₹ ha^{-1})	Net return (x10^3 ₹ ha^{-1})	B:C ratio	Relative economic efficiency (%)
Rice-Fallow	31.88	62.13	30.25	1.95	-
Rice-Rapeseed	48.98	87.05	38.08	1.78	25.88
Rice-Lentil	49.88	95.93	46.06	1.92	52.26
Rice-Pumpkin	65.63	251.75	186.13	3.84	515.31
Rice-Tomato	109.38	395.86	286.48	3.62	847.04
Rice-Cabbage	92.54	264.98	172.44	2.86	470.05
SEm	-	2.53	2.32	0.03	-
C.D (p=0.05)	-	4.95	4.95	0.07	-

MSP (Rs./qt.): Rice grain-1150/-; Rapeseed- 3500/-; Lentil-5000/-; Pumpkin-1500/-; Tomato-1000/- and Cabbage-700/-

$$REY = \Sigma Yi \times Pi / P(p)$$

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

Productivity values in terms of $kgha^{-1}day^{-1}$ was calculated by dividing the production of the sequence by 365 days and profitability in terms of Rs. $ha^{-1}day^{-1}$ was obtained by dividing net returns of the sequence by total duration of the sequence [5]. The Nutrient use productivity (NUP) was estimated dividing the rice equivalent yield (q ha^{-1}) of different cropping systems by the total amount of N, P and K applied. The economics and the rice-equivalent yield were computed as per market prices during crop season. Land utilization index (%) was estimated as a percentage of number of days during which the crops in a sequence occupy the main field during a year to the total number of days in a year, *i.e.*, 365 [7]. Production efficiency (PE) was expressed as the ratio of system productivity in kg/ha rice yield to total duration of the system in days [7]. The relative economic efficiency (REE) of the system was calculated and expressed in percentage[6].

$$REE = \frac{B - A}{A} \times 100$$

Where, A = Net return of existing system

B = Net return of diversified cropping system

In order to compare the treatments, the mean data of two years of experimentation were taken and the analysis of variance (ANOVA) technique was carried out following randomized block design. The significance of the treatment effect was determined using F-test at 5% level. The mean differences between treatments were compared using critical difference (CD) computed at 5% level of probability(P=0.05).

Results and Discussion

Land use efficiency and employment generation

The Land use efficiency (%) of all the six cropping sequences are presented in [Table-2] and the highest land use efficiency of 78.63 % was observed in rice tomato cropping sequences with greater combined yield followed by rice-Lentil sequence with 78.08 % which had given relatively lower yield due to its longer duration with less return [6]. The rice-Tomato cropping sequences provided the most employment generation (350 man days ha^{-1}) followed by rice - Cabbage sequence (290 man days ha^{-1}).

Rice equivalent yield of *rabi* crops and cropping system

The average of two years rice equivalent yield (q ha^{-1}) of all the *rabi* crops and cropping system are presented in [Table-3]. The highest rice equivalent yield (290.04 q ha^{-1}) was recorded in tomato grown during *rabi* after Sali paddy followed by cabbage with 176.54 q ha^{-1}. On the other hand, different rice based cropping sequences significantly influenced the average rice equivalent yield (q ha^{-1}) of the system. The highest REY was recorded in winter rice–tomato sequence, followed by winter rice–cabbage as compared to the other cropping sequences.

Winter rice–tomato sequence showed 537.09 and 254.72% increase in REY, respectively, over the predominant cropping systems of Assam (winter rice–fallow with REY54.02 q ha^{-1}) and second (winter rice– rapeseed with REY 75.70 q ha^{-1}). This was due to the fact that the higher yield (290.04 q ha^{-1}) was obtained with tomato along with the relatively better price of the produce (10/- Rs. kg^{-1}). Similar results were also reported by Baishya *et al*.[1].

Productivity efficiency, Economic efficiency and nutrient use productivity of the systems

The effect of different rice-based cropping sequences on productivity efficiency (kg ha^{-1} day^{-1}), economic efficiency (ha^{-1} day^{-1}) and nutrient-use productivity (kg ha^{-1} kg^{-1} of nutrient applied) are presented in [Table-3]. Data showed that the effect on system productivity efficiency was significant with the highest value in winter rice–tomato (119.94 kg ha^{-1} day^{-1}), followed by winter rice–cabbage sequences (89.31 kg ha^{-1} day^{-1}). The economic efficiency was significant with the highest value in winter rice–tomato (998.20 ha^{-1} day^{-1}), followed by winter rice–cabbage sequences (668.37 ha^{-1} day^{-1}). Nutrient-use productivity of the systems varied from 38.44 to 96.96kg ha^{-1} kg^{-1} of nutrient applied and significantly highest nutrient use productivity was recorded in winter rice–tomato sequence. The lowest productivity efficiency and nutrient use productivity were found in winter rice–rapeseed sequence, which was one of the most predominant cropping systems of Assam. This was due to high yield as well as better price obtained from vegetable crops. These results confirm the findings of [2].

Economics of rice-based cropping system

The gross returns, net returns and benefit: cost ratio was significantly affected by rice-based cropping systems [Table-4]. The highest gross return (395.86 x103 ha^{-1}) and net return(286.48 x103 ha^{-1}) were recorded in case of winter rice–tomato sequence which were significantly superior over all other cropping sequences. This might be owing to higher production of tomato in this sequence. On the other hand, the highest benefit: cost ratio (3.84) was recorded in winter rice-pumpkin sequence which was statically significant over all other cropping sequences which might be attributed to higher production and more remunerative price of pumpkin as well as comparatively less cost of production. The relative economic efficiency (REE) was recorded and presented in [Table-4]. The highest relative economic efficiency (847.04%) over predominant cropping system winter rice-fallow was recorded in winter rice-tomato sequence followed by 515.31% in winter rice-pumpkin. The lowest relative economic efficiency (25.88%) over predominant cropping system winter rice-fallow was recorded in winter rice-rapeseed sequence.

Conclusion

Hence, it can be concluded that under irrigated condition of Kamrup district of Assam the existing rice based cropping system can effectively be diversified with inclusion of vegetables like Pumpkin, tomato and Cabbage during *rabi* season which were viable systems in productivity and economical point of view. Among all the tested cropping sequences, winter rice-tomato is the viable sequence in terms of productivity whereas; the winter rice-pumpkin sequence is the viable sequence in terms of economical point of view.

Application of research: The present field investigation was undertaken to increased cropping intensity by converting monocropped area into double cropped.

Research Category: 1,2 Keywords

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References

[1] Baishya A., Gogoi B., Hazarika J., Hazarika J.P., Bora A.S., Das A.K., Bora M. and Sutradhar P. (2016) *Indian Journal of Agronomy,* 61 (3), 274-280.
[2] Kalita B., Barman P.D. and Nath B.C. (2015) *Journal of Agri Search,* 2 (4), 311-313.
[3] Kumpawat B.S. (2001) *Indian Journal of Agronomy* 46(3),421–424.
[4] Raskar B.S. and Bhoi P.G. (2001) *Indian Journal of Agronomy* 46 (1), 17–22.
[5] Rautaray S.K. (2005) *Indian Journal of Agronomy* 50, 13–15.
[6] Samanta T.K. (2015) *International Journal of Agriculture Sciences,* 7(11), 0975 – 9107.
[7] Tomar S.S. and Tiwari A.S. (1990) *Indian Journal of Agronomy,* 35 (1), 30–35.