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STUDY ON ECONOMICS OF CROPPING SYSTEMS AS INFLUENCED BY ORGANIC NUTRIENT MANAGEMENT IN HILLY AREAS OF NE REGION

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ABSTRACT

The experiment was carried out at the experimental farm of ICAR, Nagaland Centre, Medziphema during 2015-16 and 2016-17 with the objectives to study the economics of cropping systems under organic nutrient management. The experiment was in SPD with three replications. The main plot treatments consisted of four combinations of two cropping systems (C), viz.,rice-greengram-toria and maize-greengram-toria and two organic nitrogen management (N), viz., 75 % RD through vermicompost and 100 % RD through vermicompost and the sub-plot treatments consisted of two organic phosphorus management practices (P)., viz., 75 % RD through vermicompost and 100 % RD through vermicompost in greengram. Inglongkiri (upland rice), RCM-76 (maize), Pratap (greengram) and TS-36 (toria) were used as the crop varieties under study.The study revealed that application of 100 % N through vermicompost showed significant effect on yield and yield attributes both in rice and maize which showed significant carry over influence on the following greengram and toria crops. It was observed that the sub plot factor showed significant effect with the application of 100 % P as compared to the application of 75 % P in greengram. The economic analysis of the first *kharif* crops revealed that the highest economic return was obtained from maize crop with the application of 100 % N through vermicompost. The highest gross return was obtained in greengram following maize with 100 % N through vermicompost and 100 % P through vermicompost in greengram. However, the system economic analysis revealed that maize-greengram-toria system gave the highest economic returns as compared to the rice-greengram-toria system with a B:C ratio of 1.81 and 1.61 during 2015 and 2016 respectively.

(Key words: Cropping systems, vermicompost, economics)

INTRODUCTION

The agricultural production system NEH region is pre-dominantly rainfed and mono-cropped at subsistence level. Slash and burn agriculture is still practiced in almost all states on steep slopes with reduced cycle of 2-3 years against 10-15 years in the past. Thus, in the north-eastern region which is mostly consisted of hills, crop production is subjected to adverse and harsh geo-physical and agro-climatic conditions.

Oilseeds and pulses are receiving more attention owing to higher prices due to increased demand. To fulfill the demand of cereal, pulses, and oilseeds of ever-increasing population, inclusion of oilseeds and pulses in cropping sequence was found more beneficial than cereal alone (Kumar *et al.,* 2008). The short duration pulse crop could very well be introduced in rice and maize-based cropping sequence during summer for maximizing the net return and restoring the soil fertility. Because, inclusion of legume crop during summer in the system increases the organic carbon and available N, P and K in the soil (Sharma *et al.,* 2004). An intensive cropping system which is not only highly productivity and profitable but also stable over time and maintains soil fertility, is of great importance in present scenario.

The high input agriculture has led to self-sufficiency in food-grains but it has posed several new challenges. The need for conversion of intensive agriculture into organic agriculture is now widely felt. Hence, conversion of modern chemically intensive agriculture to a more sustainable form of agriculture like organic farming appears

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to be a viable option for maintaining the desirable agricultural production in future (Modgal *et al.,* 1995).

Thus, the present investigation was undertaken to assess the economics between rice and maize based cropping system with an efficient organic nutrient so as to obtain maximum income.

MATERIALS AND METHODS

The present investigation was carried out during 2015-2016 and 2016-2017 at the experimental farm of ICAR, Nagaland Centre, Medziphema where the climatic condition of the experimental area is sub-tropical humid. The annual average rainfall varies from 1500 mm to 2000 mm which is mainly received during April to October and from November to March the weather is generally dry. The mean summer temperature ranges between 19°C to 35°C, while in winter it rarely goes below 5°C.

The experiment was laid out in split plot design with three replications. The treatments included cropping system (C), *viz*., rice-greengram (C_1) and maize-greengram (C_2), organic N management (N), *viz*., 75 % RD through vermicompost (N_1) and 100 % RD through vermicompost (N_2) and organic phosphorus management (P) in the sub plot viz., 75 % RD through vermicompost (P_1) and 100 % RD through vermicompost (P_2) in greengram.

Observations on yield parameters of rice such as tillers hill^{-1}, grains panicle^{-1}, panicle length (cm), panicle weight (g), test weight (g), seed yield (q ha^{-1}) and stover yield (q ha^{-1}) were taken in case of rice. Parameters in maize such as, grains cob^{-1}, plants m^{-1}, cob length (cm), test weight (g), seed yield (q ha^{-1}) and stover yield (q ha^{-1}) were recorded. Data on parameters such as number of pods plant^{-1}, number of seeds pod^{-1}, test weight (g), seed yield (q ha^{-1}) and stover yield (q ha^{-1}) were recorded in case of greengram. For toria number of branches plant^{-1}, number of siliqua plant^{-1}, number of seeds siliqua^{-1}, seed yield (q ha^{-1}) and stover yield (q ha^{-1}) were recorded.

RESULTS AND DISCUSSION

Yield attributing characters and yield of rice and maize,

It was observed that the yield and yield attributes of rice and maize was significantly higher with the application of 100 % RD of N as compared to the application of 75 % RD of N through vermicompost (Table 1(i) to (iv)).

Yield attributing characters and yield of greengram

The Table 2 (i) and Table 2 (ii) represents the effect of the main plot factor *i.e.,* cropping system (C) and organic N management (N) on the yield attributes which were found to be significant. The data showed that in C_2 as compared to C_1, greengram produced significantly more number of pods plant^{-1}, seeds pod^{-1}, test weight, seed and stover yield and HI. And, N_2 was observed to significantly improved upon these yield attributes in greengram compared to N_1.

Effect of organic phosphorus management (P)

The data shown in Table 2(i) and Table 2 (ii) indicates the significant effect of P on yield attributes of greengram. The data revealed that application of 100 % P through vermicompost (P_2) in greengram resulted in significantly more number of pods plant^{-1}, number of seeds pod^{-1}, test weight, seed and stover yield and HI as compared to the application of 75 % P through vermicompost in greengram. Mohini *et al*. (2018) also reported that with the application of P (60 kg P ha^{-1}) resulted in higher yield as compared to the application of P 30 and 40 kg ha^{-1}.

Residual effect on yield and yield attributes of toria

Data in Table 3(i) and 3(ii) shows the residual effect of the main plot and sub-plot factors on the toria crop which showed that significantly higher residual effect on yield and yield attributes with the application of 100 % N through vermicompost (N_2) and 100 % P through vermicompost (P_2) in first *kharif* and greengram respectively. However, it was found that the response of toria following greengram and maize showed better performance in terms of yield as compared to toria following greengram and rice.

Economics of the treatments

During first *kharif* crops (rice and maize)

Table 4 shows the comparative economics of the treatments in first *kharif* crops (rice and maize) during 2015 and 2016. It was observed that the highest gross return (Rs. 224600.00 ha^{-1} and Rs.227883.33 ha^{-1} during 2015 and 2016, respectively) and net return (Rs.165100.00 ha^{-1} and Rs. 168383.33 ha^{-1} during 2015 and 2016, respectively) were obtained under maize-greengram and 100 % RD through vermicompost (C_2N_2). Similarly, under rice crop, the highest gross return (Rs.92160 ha^{-1}and Rs.101100 ha^{-1} during 2015 and 2016, respectively) and net return (Rs.46390 ha^{-1}and Rs.55330 ha^{-1} during 2015 and 2016, respectively) were obtained with rice-greengram and 100 % RD through vermicompost (C_1N_2). However, the highest benefit-cost ratio was achieved from rice-greengram and 75 % RD through vermicompost (C_1N_1) which was recorded at 1.07 and 1.24 during 2015 and 2016, respectively and maize-greengram with 75 % RD through vermicompost (C_2N_1) recording a B:C ratio of 2.78 and 3.33 during 2015 and 2016, respectively. Verma *et al*. (2003); Singh *et al.* (2007) and Kumar *et al.* (2007) also reported similar findings, where they found that application of 100 % RD through vermicompost was more beneficial in terms of yield and economic return in maize.

During second crop greengram

Table 5 shows the comparative economics of the treatments in greengram during 2015 and 2016. It was observed that the highest gross return (Rs.168200 ha^{-1} and Rs.136350 ha^{-1} during 2015 and 2016, respectively) was obtained from maize-greengram with 100 % RD through vermicompost and 100 % P through vermicompost ($C_2N_2P_2$). However, there was variation in the net return where application of 100 % P through vermicompost in greengram

obtained the highest net return which recorded an amount of Rs.76420 ha^{-1}during 2015 but during the year 2016, the highest net return of Rs. 46100 ha^{-1} was obtained from the application of 75 % P through vermicompost in greengram which was due to reduction in the yield of greengram during the second year. Rs.168383.33 ha^{-1} during 2015 and 2016, respectively, were obtained under maize crop with application of 100 % N through vermicompost with live mulching with cowpea. Narendra *et al.* (2009) and Sitaram *et al.* (2013) also reported similar findings, where application of 100 % RD through vermicompost was found to be superior to control in terms of yield and economic return.

Similar returns were also observed under rice crop where the highest gross return (Rs.152950 $ha^{-1}$and Rs.121800 ha^{-1} during 2015 and 2016, respectively) was obtained in rice-greengram system with 100 % RD through vermicompost and 100 % P through vermicompost ($C_1N_2P_2$). However, the net return with the application of 75 % P through vermicompost in greengram obtained the highest which recorded an amount of Rs.74450 $ha^{-1}$and Rs.35900 ha^{-1} during 2015 and 2016 respectively.

Under maize-greengram cropping system, the B:C ratio was observed to be highest with 75 % RD through vermicompost and 75 % P through vermicompost which was recorded at 1.03 and 0.62 during 2015 and 2016 respectively ($C_2N_2P_1$). Similar result was also found under rice-greengram cropping system where the highest B:C ratio (1.01 and 0.49 during 2015 and 2016 respectively) was recorded from 100 % RD through vermicompost and 75 % RD through vermicompost ($C_1N_2P_1$) which was mainly due to higher cost of vermicompost which increased the cost of cultivation. When we compared the B:C ratio between the rice-greengram and maize-greengram, it was found that that B:C ratio under maize-greengram was the highest during both the years.

During third crop toria

Table 6 shows the comparative economics of the treatments during the toria crop. It was observed that the highest gross return of Rs.25528 ha^{-1} and Rs.24028 ha^{-1}, net return of Rs. 13350 ha^{-1} and Rs.11850 ha^{-1} and B:C ratio of 2.64 and 2.45 during 2015 and 2016, respectively, was obtained from maize-greengram-toria system with the application of 100 % N through vermicompost in maize crop and 100 % P through vermicompost in greengram ($C_2N_2P_2$). This might be due to higher crop yield as a result of the residual effect on the succeeding toria crop.

A similar returns under rice-greengram-toria system where the highest gross return of Rs.21500 $ha^{-1}$and Rs.20000 ha^{-1}, net return of Rs. 17378 ha^{-1} and Rs.15878 ha^{-1} were also observed. The B:C ratio of 2.13 and 1.95 during 2015 and 2016, respectively, was obtained from maize-greengram-toria system with the application of 100 % N through vermicompost in maize crop and 100 % P through vermicompost in greengram ($C_2N_2P_2$). This might be due to higher crop yield as a result of the residual effect on the succeeding toria crop.

Comparative economic analysis of the cropping system

The comparative economics of the treatments in respect of cropping system has been presented in Table 7. It revealed that the higher gross return (Rs.418328 $ha^{-1}$and Rs.388261.33 ha^{-1} in 2015 and 2016, respectively) and net return (Rs.258898 $ha^{-1}$and Rs.228831.33 ha^{-1}) was obtained from maize-greengram-toria sequence due to application of 100 % N through vermicompost in the maize and 100 % P through compost in greengram as compared to rice-greengram-toria system. However, the B:C ratio was observed to be the highest with the application of 100 % N through vermicompost in maize and 75 % P through vermicompost in greengram which was recorded at 1.81 and 1.61 during 2015 and 2016 respectively.

The system economics revealed that during both the years, maize-greengram-toria cropping system (C_2) was found better than rice-greengram-toria system (C_1) under the effects of organic N and P management in rainfed condition with respect to gross, net returns, and B:C ratio.

Therefore, it may be concluded that the productivity and profitability of maize-greengram-toria cropping system is better than the rice-greengram-toria cropping system under organic nutrient management in rainfed condition of north-east hilly region. Under this situation, application of vermicompost on the basis of 100 % N as recommended for the first cereal crop followed by the application of vermicompost on the basis by 75 % P_2O_5 as recommended for the second pulse crop like greengram sustains profitable production of the third oilseed crop toria of the system. An organic cropping system under rainfed situation may also be profitable.

Table 1(i). Effect of cropping system and organic N management on yield parameters of rice

Treatment	Tillers hill^{-1}		Grains panicle^{-1}		Panicle length(cm)		Panicle weight(g)		Test weight(g)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
C_1N_1	7.75	8.87	115.28	126.35	26.80	27.88	4.65	5.87	17.43	19.43
C_1N_1	9.38	10.24	132.00	144.57	28.29	31.27	5.65	7.54	19.98	21.54
C_1N_2	8.81	9.45	125.59	137.59	27.28	29.48	5.56	6.45	19.28	21.14
C_1N_2	10.64	11.44	148.33	162.54	30.34	35.28	6.24	8.88	20.68	22.87

Table 1(ii). Effect of cropping system and organic N management on yield of rice

Treatments	Seed yield(q ha^{-1})		Stover yield (q ha^{-1})		Harvest Index (%)	
	2015	2016	2015	2016	2015	2016
C_1N_1	15.17	16.27	29.59	30.27	33.92	34.59
C_1N_1	17.44	18.87	33.06	35.47	35.05	35.00
C_1N_2	16.74	17.88	31.03	33.47	34.56	34.73
C_1N_2	20.48	22.47	35.02	37.24	36.90	37.62

Table 1(iii). Effect of cropping system and organic N management on yield parameters of maize

Treatments	Grains cob^{-1}		Plants m^{-2}		Cob length(cm)		Test weight(g)	
	2015	2016	2015	2016	2015	2016	2015	2016
C_2N_1	410.00	425.63	6.76	7.24	18.51	20.47	71.34	72.14
C_2N_1	475.96	489.57	7.85	8.14	20.28	22.51	89.07	90.87
C_2N_2	441.05	452.27	7.14	7.84	20.07	21.47	75.34	76.44
C_2N_2	507.13	534.24	7.98	8.37	20.30	23.45	90.49	92.24

Table 1(iv). Effect of cropping system and organic N management on yield of maize

Treatments	Seed yield (q ha^{-1})		Stover yield (q ha^{-1})		Harvest Index (%)	
	2015	2016	2015	2016	2015	2016
C_2N_1	30.36	31.27	60.25	63.47	32.27	32.98
C_2N_1	39.45	41.12	73.58	75.58	35.03	35.09
C_2N_2	35.92	36.47	71.22	73.78	32.58	33.07
C_2N_2	44.92	45.58	79.26	81.24	35.97	36.57

C_1-Rice-greengram-toria, C_2-Maize-greengram-toria, N_1- 75% N as vermicompost, N_2- 100% N as vermicompost

Table 2(i). Effect of cropping system, organic N and P management on yield parameters of greengram

Treatments	Numbers of pods plant^{-1}		Number of seeds pod^{-1}		Test weight (g)	
Cropping System	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
C_1-Rice-greengram	28.70	23.03	9.84	7.55	34.39	31.37
C_2-Maize-greengram	31.33	26.78	10.16	8.32	35.76	32.76
Organic N management in 1st *kharif* crop (N)						
N_1- 75% N as vermicompost	28.74	23.88	9.78	7.71	34.21	31.19
N_2-100% N as vermicompost	31.28	25.92	10.22	8.13	35.94	32.93
SEm (±)	0.76	0.60	0.14	0.13	0.51	0.51
CD(P=0.05)	1.63	1.28	0.30	0.29	1.09	1.10
Organic P management in 2nd *kharif* crop (P)						
P_1- 75% P as vermicompost	27.72	22.89	9.67	7.61	33.85	30.83
P_2- 100% P as vermicompost	32.30	26.92	10.33	8.23	36.30	33.295
SEm(±)	0.41	0.52	0.19	0.12	0.39	0.43
CD(P=0.05)	0.87	1.12	0.41	0.27	0.83	0.93
Interactions	NS	NS	NS	NS	NS	NS
CV (%)	8.81	8.37	5.00	6.07	5.05	5.57
	4.75	7.32	6.81	5.56	3.90	4.73

Table 2(ii). Effect of cropping system, organic N and P management on yield of greengram

Treatments	Seed yield (q ha^{-1})		Stover yield (q ha^{-1})		Harvest Index (%)	
Cropping system (C)	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
C_1-Rice-greengram	9.21	6.78	19.30	17.01	29.71	27.73
C_2-Maize-greengram	9.54	7.49	22.26	19.37	32.28	28.64
Organic N management in 1st *kharif* crop (N)						
N_1- 75% N as vermicompost	9.16	6.87	20.38	17.77	31.70	27.78
N_2-100% N as vermicompost	9.59	7.40	21.18	18.61	30.29	28.59
SEm (±)	0.12	0.14	0.37	0.28	0.42	0.36
CD (P=0.05)	0.26	0.30	0.81	0.60	0.903	0.78
Organic P management in 2nd *kharif* crop (P)						
P_1- 75% P as vermicompost	8.98	6.71	19.92	17.46	29.62	27.29
P_2- 100% P as vermicompost	9.77	7.56	21.64	18.92	32.37	29.08
SEm (±)	0.15	0.12	0.50	0.39	0.48	0.38
CD (P=0.05)	0.31	0.26	1.06	0.83	1.02	0.82
Interactions	NS	NS	NS	NS	NS	NS
CV (%)	4.58	6.96	6.30	5.41	4.71	4.48
	5.52	5.89	8.38	7.42	5.39	4.70

NS- Not significant

Table 3(i). Effect of cropping system, organic N and P management on yield parameters of toria

Treatments	Number of branches plant^{-1}		Number of siliqua plant^{-1}		Number of seeds siliqua^{-1}		Test weight (g)	
Cropping system (C)	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
C_1-Rice-greengram-Toria	4.06	3.51	132.75	127.69	9.91	9.16	2.73	2.52
C_2-Maize-greengram-Toria	4.10	3.59	165.62	164.30	11.69	10.73	2.95	2.75
Organic N management in 1st *kharif* crop (N)								
N_1- 75% N as vermicompost	4.05	3.52	144.21	139.92	10.56	9.60	2.77	2.55
N_2-100% N as vermicompost	4.10	3.58	154.15	152.06	11.04	10.29	2.91	2.72
SEm (±)	0.01	0.005	3.03	2.16	0.18	0.02	0.02	0.008
CD (P=0.05)	0.04	0.010	6.50	4.63	0.39	0.05	0.06	0.016
Organic P management in 2nd *kharif* crop (P)								
P_1- 75% P as vermicompost	4.03	3.49	134.77	132.36	9.99	9.24	2.70	2.48
P_2- 100% P as vermicompost	4.13	3.61	163.55	159.63	11.61	10.65	2.98	2.79
SEm (±)	0.02	0.008	2.43	2.02	0.23	0.04	0.03	0.009
CD (P=0.05)	0.05	0.017	5.15	4.33	0.50	0.09	0.07	0.019
Interaction	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	1.57	2.23	7.05	5.14	5.98	4.43	3.41	4.89
	2.26	3.82	5.65	4.80	7.60	7.28	4.08	5.73

Table 3(ii). Effect of cropping system, organic N and P management on yield of toria

Treatment	Seed yield (q ha^{-1})		Stover yield (q ha^{-1})		Harvest Index (%)	
Cropping system (C)	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
C_1-Rice-greengram-Toria	3.02	2.77	8.75	7.31	25.49	27.33
C_2-Maize-greengram-Toria	3.62	3.37	8.99	7.50	28.56	30.75
Organic N management in 1st *kharif* crop (N)						
N_1- 75% N as vermicompost	3.25	3.00	8.77	7.32	26.61	28.59
N_2-100% N as vermicompost	3.39	3.14	8.97	7.49	27.44	29.49
SEm (±)	0.06	0.06	0.08	0.01	0.38	0.40
CD (P=0.05)	0.14	0.14	0.18	0.03	0.82	0.86
Organic P management in 2nd *kharif* crop (P)						
P_1- 75% P as vermicompost	3.14	2.89	8.70	7.27	26.16	28.05
P_2- 100% P as vermicompost	3.49	3.24	9.04	7.54	27.89	30.03
SEm (±)	0.04	0.04	0.11	0.01	0.30	0.34
CD (P=0.05)	0.10	0.10	0.25	0.03	0.65	0.72
Interaction	NS	NS	NS	NS	NS	NS
CV (%)	6.86	7.36	3.34	3.36	4.93	4.81
	5.14	5.35	4.63	3.59	3.89	4.06

NS-Not significant

Table 4. Economics of the treatments in rice and maize

Treatments	Total cost of production (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		Per day net return (Rs. ha^{-1})		B:C ratio	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
C_1N_1	37800	37800	68265	73215.00	30465	35415.00	83.47	97.03	0.81	0.94
C_1N_1	37850	37850	78480	84930.00	40630	47080.00	111.32	128.99	1.07	1.24
C_1N_2	45720	45720	75330	80475.00	29610	34755.00	81.12	95.22	0.65	0.76
C_1N_2	45770	45770	92160	101100.00	46390	55330.00	127.10	151.59	1.01	1.21
C_2N_1	47450	47450	151800	156348.34	104350.00	108898.34	285.89	298.35	2.19	2.30
C_2N_1	47500	47500	179600	205583.33	132100.00	158083.33	410.27	433.11	2.78	3.33
C_2N_2	59450	59450	197250	182350.00	137800.00	122900.00	329.18	336.71	2.32	2.07
C_2N_2	59500	59500	224600	227883.33	165100.00	168383.33	452.33	461.32	2.77	2.83

Cropping system

C_1: Rice-greengram-toria

C_2: Maize-greengram-toria

Organic N management

N_1: 75% N through vermicompost

N_2: 100% N through vermicompost

Price (Rs.)

Rice: Rs.45 kg^{-1}

Maize: Rs.50 kg^{-1}

Table 5. Economics of the treatments in greengram

Treatments	Total cost of production (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		Per day net return (Rs. ha^{-1})		B:C ratio	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
$C_1N_1P_1$	73900	73900	119750.00	79250.00	45850.00	5350.00	125.62	14.66	0.62	0.07
$C_1N_1P_2$	91780	91780	132400.00	92400.00	40620.00	620.00	111.29	1.70	0.44	0.01
$C_1N_1P_1$	73900	73900	140150.00	103950.00	66250.00	30050.00	181.51	82.33	0.90	0.41
$C_1N_1P_2$	91780	91780	151050.00	116050.00	59270.00	24270.00	162.38	66.49	0.65	0.26
$C_1N_2P_1$	73900	73900	122900.00	87900.00	49000.00	14000.00	134.25	38.36	0.66	0.19
$C_1N_2P_2$	91780	91780	138550.00	102700.00	46770.00	10920.00	128.14	29.92	0.51	0.12
$C_1N_2P_1$	73900	73900	148350.00	109800.00	74450.00	35900.00	203.97	98.36	1.01	0.49
$C_1N_2P_2$	91780	91780	152950.00	121800.00	61170.00	30020.00	167.59	82.25	0.67	0.33
$C_2N_1P_1$	73900	73900	124550.00	93000.00	50650.00	19100.00	138.77	52.33	0.69	0.26
$C_2N_1P_2$	91780	91780	135050.00	105050.00	43270.00	13270.00	118.55	36.36	0.47	0.14
$C_2N_1P_1$	73900	73900	141650.00	111650.00	67750.00	37750.00	185.62	103.42	0.92	0.51
$C_2N_1P_2$	91780	91780	155100.00	123150.00	63320.00	31370.00	173.48	85.95	0.69	0.34
$C_2N_2P_1$	73900	73900	130741.67	100741.67	56841.67	26841.67	155.73	73.54	0.77	0.36
$C_2N_2P_2$	91780	91780	139700.00	109700.00	47920.00	17920.00	131.29	49.10	0.52	0.20
$C_2N_2P_1$	73900	73900	150000.00	120000.00	76100.00	46100.00	208.49	126.30	1.03	0.62
C_2N_2P2	91780	91780	168200.00	136350.00	76420.00	44570.00	209.37	122.11	0.83	0.49

Cropping system

C_1: Rice-greengram-toria

C_2: Maize-greengram-toria

Organic N management

N_1: 75% P through vermicompost

N_2: 100% P through vermicompost

Organic P management

P_1: Control (No mulching)

P_2: Live mulching with cowpea

Price (Rs.)

Greengram : Rs. 150 Kg^{-1}

Table 6. Economics of the treatments in toria

Treatments	Total cost of production (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		Per day net return (Rs. ha^{-1})		B:C ratio	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
$C_1N_1P_1$	8150	8150	16753.33	15253.33	8603.33	7103.33	23.57	19.46	1.06	0.87
$C_1N_1P_2$	8150	8150	17400.00	15900.00	9250.00	7750.00	25.34	21.23	1.13	0.95
$C_1N_1P_1$	8150	8150	18006.67	16506.67	9856.67	8356.67	27.00	22.89	1.21	1.03
$C_1N_1P_2$	8150	8150	18933.33	17433.33	10783.33	9283.33	29.54	25.43	1.32	1.14
$C_1N_2P_1$	8150	8150	16920.00	15420.00	8770.00	7270.00	24.03	19.92	1.08	0.89
$C_1N_2P_2$	8150	8150	17440.00	15940.00	9290.00	7790.00	25.45	21.34	1.14	0.96
$C_1N_2P_1$	8150	8150	18100.00	16595.33	9950.00	8445.33	27.26	23.14	1.22	1.04
$C_1N_2P_2$	8150	8150	21500.00	20000.00	13350.00	11850.00	36.58	32.47	1.64	1.45
$C_2N_1P_1$	8150	8150	17606.67	16106.67	9456.67	7956.67	25.91	21.80	1.16	0.98
$C_2N_1P_2$	8150	8150	20746.67	19246.67	12596.67	11096.67	34.51	30.40	1.55	1.36
$C_2N_1P_1$	8150	8150	22180.00	20680.00	14030.00	12530.00	38.44	34.33	1.72	1.54
$C_2N_1P_2$	8150	8150	24380.00	22880.00	16230.00	14730.00	44.47	40.36	1.99	1.81
$C_2N_2P_1$	8150	8150	18640.00	17140.00	10490.00	8990.00	28.74	24.63	1.29	1.10
$C_2N_2P_2$	8150	8150	21800.00	20300.00	13650.00	12150.00	37.40	33.29	1.67	1.49
$C_2N_2P_1$	8150	8150	22953.33	21453.33	14803.33	13303.33	40.56	36.45	1.82	1.63
C_2N_2P2	8150	8150	25528.00	24028.00	17378.00	15878.00	47.61	43.50	2.13	1.95

Cropping system

C_1: Rice-greengram-toria

C_2: Maize-greengram-toria

Organic N management

N_1: 75% N through vermicompost

N_2: 100% N through vermicompost

Organic p management

P_1: 75% P through vermicopost

P_2: 100% P through vermicopost

Price (Rs.)

Greengram : Rs. 150 Kg^{-1}

Table 7. Comparative economics of the cropping systems

Treatments	Total cost of production (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		Per day net return (Rs. ha^{-1})		B:C ratio	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
$C_1N_1P_1$	119850	119850	204768.33	167718.33	84918.33	47868.33	232.65	131.15	0.71	0.40
$C_1N_1P_2$	137730	137730	218065.00	181515.00	80335.00	43785.00	220.10	119.96	0.58	0.32
$C_1N_1P_1$	119900	119900	236636.67	205386.67	116736.67	85486.67	319.83	234.21	0.97	0.71
$C_1N_1P_2$	137780	137780	248463.33	218413.33	110683.33	80633.33	303.24	220.91	0.80	0.59
$C_1N_2P_1$	127770	127770	215150.00	183795.00	87380.00	56025.00	239.40	153.49	0.68	0.44
$C_1N_2P_2$	145650	145650	231320.00	199115.00	85670.00	53465.00	234.71	146.48	0.59	0.37
$C_1N_2P_1$	127820	127820	258610.00	227495.33	130790.00	99675.33	358.33	273.08	1.02	0.78
$C_1N_2P_2$	145700	145700	266610.00	242900.00	120910.00	97200.00	331.26	266.30	0.83	0.67
$C_2N_1P_1$	129500	129500	293956.67	265455.01	164456.67	135955.01	450.57	372.48	1.27	1.05
$C_2N_1P_2$	147380	147380	307596.67	280645.01	160216.67	133265.01	438.95	365.11	1.09	0.90
$C_2N_1P_1$	129550	129550	343430.00	337913.33	213880.00	208363.33	585.97	570.86	1.65	1.61
$C_2N_1P_2$	147430	147430	359080.00	351613.33	211650.00	204183.33	579.86	559.41	1.44	1.38
$C_2N_2P_1$	141500	141500	346631.67	300231.67	205131.67	158731.67	562.00	434.88	1.45	1.12
$C_2N_2P_2$	159380	159380	358750.00	312350.00	199370.00	152970.00	546.22	419.10	1.25	0.96
$C_2N_2P_1$	141550	141550	397553.33	369336.67	256003.33	227786.67	701.38	624.07	1.81	1.61
$C_2N_2P_2$	159430	159430	418328.00	388261.33	258898.00	228831.33	709.31	626.94	1.62	1.44

Cropping system

C_1: Rice-greengram-toria

C_2: Maize-greengram-toria

Organic N management

N_1: 75% N through vermicompost

N_2: 100% N through vermicompost

Organic P management

P_1:75% P through vermicompost

P_2:100% P through vermicompost

Price (Rs.)

Rice: Rs.45 kg^{-1}

Maize: Rs.50 kg^{-1}

Price (Rs.)

Toria: Rs.60 kg^{-1}

Price (Rs.)

Greengram: Rs.150 kg^{-1}

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