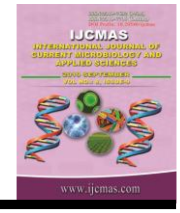
Int.J.Curr.Microbiol.App.Sci (2019) *8*(9): 1106-1119

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 8 Number 09 (2019)**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2019.809.128

Economics of Direct Seeded Rice and Transplanted Rice Influenced by Tillage and Weed Management Practices under Rice - Maize Cropping System Based on Conservation Agriculture

Sakshi Bajaj[1], M. C. Bhambri[1] and G. K. Shrivastava[2*]

[1]Department of Agronomy, IGKV, Raipur, India
[2]Dean Students' Welfare, IGKV, Raipur, India
**Corresponding author*

Keywords

Energy, Economics, Tillage practices, weed management, Rice

Article Info

Accepted:
14 August 2019
Available Online:
10 September 2019

A B S T R A C T

A field study was conducted during *kharif* and *rabi* season of 2015 - 16 and 2016 - 17 at the Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur. Fifteen treatment combinations (viz., five tillage practices and three weed management) were tested in split plot design with three replications to assess the productivity of rice under rice – maize cropping system, to evaluate conventional tillage - transplanted rice options as compared to conventional tillage - direct seeded rice with an objective to improved yield also comparison between zero tillage - direct seeded rice superior over to conventional tillage - direct seeded rice during second year. Labour saving 95 % and cost saving 32 and 40 % were observed in conventional tillage - direct seeded rice and zero tillage - direct seeded rice, respectively as compared to conventional tillage transplanted rice. Tillage and weed management practices had significant effect on rice yield. Yield of conventional tillage - transplanted rice was significantly higher (44 and 35 %, respectively) than conventional tillage - direct seeded rice and zero tillage - direct seeded rice. The B: C ratio was highest in zero tillage - direct seeded rice (2.21) as compared to conventional tillage - direct seeded rice (1.61) and conventional tillage - transplanted rice (1.58). Conventional tillage - transplanted rice compulsory more input energy and produced more output energy. Conventional tillage - transplanted rice obtained maximum energy use efficiency and energy productivity during both the years it was similar zero tillage - direct seeded rice during second year. The study showed that the conventional practices of puddle transplanted rice could be replaced with zero tillage - direct seeded rice to save labour and energy cost.

Introduction

Cropping system in the Chhattisgarh plains are primarily rainfed, single cropped, double cropped and rice based, with wheat, maize, rice, lathyrus, gram grown during the winter season. The stagnation of productivity growth in these intensive cropping systems has led a strong support for conservation agriculture based technologies to rebuild soil health

(Gupta *et al.,* 2007 and Hobbs 2007). Conservation agriculture has emerged as an effective strategy to enhance sustainable agriculture worldwide. Conservation agriculture is aimed at maintaining or improving crop yields while improving the soil resource base, minimizing inputs and increasing profitability (Baker and Saxton, 2007). There has been widespread adoption of these practices in large-scale commercial farming around the world and possibilities for use of CA in smallholder farming are now emerging (Johansen *et al.,* 2012). Conservation agriculture based technologies such as zero, reduced tillage coupled with effective weed management practices facilitates timely sowing, increased yield, lower production costs and boost income. Weeds are the one of the biggest constraints of the adoption of conservation agriculture. Reduction in tillage intensity or frequency has an influence on weed management. Implementation of conservation agriculture has often caused yield reduction because reduced tillage failed to control weed interference. Crop yields can be similar for both conventional as well as in conservation tillage systems if weeds are controlled and crop stands are uniform (Mahajan *et al.,* 2002). Energy input: output relationships in cropping systems vary with the crops grown in succession, crop establishment methods, type of soils, nature of tillage operations for seedbed preparation, nature and amount of organic manure and chemical fertilizers, plant protection measures, harvesting and threshing operations, yield levels and biomass production (Singh *et al.,* 1997). Increasing modernization, in general, involves larger inputs of energy in crop production. It has been observed that in rice cultivation, traditional production practices involve a minimum input of energy (Freedman 1980). Now a days, energy usage in agricultural activities has been intensified in response to continued growth of human population, tendency for an overall improved standard of living and limited supply of arable land. Consequently, additional use of energy causes problems threatening public health and environment (Rafiee *et al.,* 2010). However, increased energy use in order to obtain maximum yields may not bring maximum profits due to increasing production costs. In addition, both the natural resources are rapidly decreasing and the amount of contaminants on the environment is considerably increasing (Esengun *et al.,* 2007). The relation between agriculture and energy is very close. Agricultural sector itself is an energy user and energy supplier in the form of bio-energy (Alam *et al.,* 2005). Agriculture is both a producer and consumer of energy. It uses large quantities of locally available non-commercial energy, such as seed, manure and animate energy, as well as commercial energies, directly and indirectly, in the form of diesel, electricity, fertilizer, plant protection, chemicals, irrigation water, machinery etc. Efficient use of these energies helps to achieve increased production and productivity and contributes to the profitability and competitiveness of agriculture sustainability in rural living (Singh *et al.,* 2002).

Efficient use of energy resources in agriculture is one of the principal requirements for sustainable agricultural productions. Therefore, energy saving has been a crucial issue for sustainable development in agricultural systems. Development of energy efficient agricultural systems with low input energy is the demand for current agriculture production system. Efficiency is defined as the ability to produce the outputs with a minimum resource level required (Sherman, 1988). In production, efficiency is a normative measure and is defined as the ratio of weighted sum of outputs to inputs or as the actual output to the optimal output ratio. Efficient use of these energies helps to achieve increased production and productivity and contributes to the profitability and competitiveness of agriculture sustainability in rural living (Singh *et al.*, 2008).

Materials and Methods

Location, Climate and Soil

The experiment was conducted at the Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur during 2015-16 and 2016-17. The experiment farm is situated at latitude of 21^o4 N and longitude of 81^o35 E at an elevation of 290.2 m above mean sea level. The soil was sandy loam in texture, neutral in reaction (pH 7.5), low in organic carbon (0.46 %), available nitrogen (220 kg ha^{-1}), and available phosphorus (22 kg ha^{-1}) contents and high in potassium (320 kg ha^{-1}).

During the experimental period the average rainfall during the rice season of 2015 (816.6 mm) and second year rice crop received 1135 mm rainfall during *kharif* season 2016.

Experimental Design and treatment details

The field trial was arranged as split plot design with each plot consisted of 3.6 × 9.2 m. The treatment included (i) *i.e* CT (DSR) – CT (ii) *i.e* CT (DSR) – ZT (iii) *i.e* ZT (DSR) – ZT (iv) *i.e* CT (TPR) – ZT (v) *i.e* CT (TPR) – CT as main plot and three methods of weed management practices (i) oxadiargyl 90 g ha^{-1}, PE + pinoxsulam 22.5g ha^{-1} PoE for rice and atrazine 1.0 kg ha^{-1} PoE for maize (ii) pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1} PE + bispyribac 25g ha^{-1}, PoE for rice and halosulfuron 60 g ha^{-1} PoE for maize (iii) unweeded control as sub plots in split plot design with three replications. Recommended agronomic management practices were followed as per the local regional specific condition.

Observation Recorded

Energy calculation

In order to calculate input: output ratios and other energy indicators, the data were converted into output and input energy levels using equivalent energy values for each commodity and input. Energy equivalents shown in Table 1 were used for estimation.

Energy use efficiency (q MJ X 10^3)

$$\text{Energy use efficiency} = \frac{\text{Total produce (q) (q MJ X } 10^3)}{\text{Energy input (MJ X} 10^3)}$$

Energy productivity (kg MJ ha^{-1})

$$\text{Energy productivity (kg MJ ha}^{-1}) = \frac{\text{Mean grain yield (kg ha}^{-1})}{\text{Total energy input, MJ}}$$

Energy output: input ratio

$$\text{Energy output: input ratio} = \frac{\text{Energy output (MJha}^{-1})}{\text{Input ratio (MJha}^{-1})}$$

Economic analysis

Gross return (Rs ha^{-1})

Gross return (Rs ha^{-1})

= Crop yield (q ha^{-1}) x Price of yield (Rs q^{-1})

Net return (Rs ha^{-1})

Net return (Rs ha^{-1})

= Gross return (Rs ha^{-1}) - Cost of cultivation (Rs ha^{-1})

Benefit: cost ratio

$$\text{Benefit: cost ratio} = \frac{\text{Net return (Rs ha}^{-1})}{\text{Cost of cultivation (Rs ha}^{-1})}$$

Statistical analysis

The data obtained in respect of various observations were statistically analyzed by the method described by Gomez and Gomez (1984). The significance of "F" and "t" was tested at 5% level of significance.

Results and Discussion

Grain yield of rice

Data related to grain yield of rice are presented in Table 1. Among tillage practices the highest grain yield of rice (mean viz., 4.45 t ha-1) was recorded under CT (TPR) - CT which was statistically at par with the CT (TPR) - ZT (mean viz., 4.29 t ha-1) during both the years and also in mean data. The results are in support with Mann *et al*. (2002) and Ramzan and Rehman, (2006). In case of DSR, CT (DSR) - CT and CT (DSR) - ZT gain more yield compare to ZT (DSR) - ZT during first year. However in second year, the highest grain yield of rice was recorded under ZT (DSR) - ZT compare to CT (DSR) - CT and CT (DSR) – ZT due to more weed infestation. Regarding weed management practices, sequential application of oxadiargyl 90 g ha-1 PE fb pinoxsulam 22.5 g ha-1 PoE (mean viz., 4.77 t ha-1) produced significantly higher rice grain yield over remaining treatments. The unweeded control exhibited significantly lower grain yield (mean viz., 1.28 t ha-1) of rice during both the years as well as in mean data of two years. Among the various combinations of tillage and weed management practices, CT (TPR) - CT with oxadiargyl 90 g ha-1 PE fb pinoxsulam 22.5 g ha-1 PoE produced the highest grain yield of rice, which was significantly higher than rest of the treatment combinations. The reason behind this result might be due to proper weed free environment for growth and development of crop under transplanted condition (Surendra *et al*., 2001) (Table 2).

Economics of rice

The data with respect to cost of cultivation, gross return, net return and benefit cost ratio are presented in Table 2 and 3.

Cost of cultivation (₹ ha^{-1})

The maximum cost of cultivation (₹ 34019) was found in CT (TPR) - CT. Whereas the lowest cost of cultivation was noticed under ZT (DSR) – ZT system (₹ 20308).

Among the weed management practices cost of cultivation was higher in application of pyrazosulfuron + pretilachlor 10 kg ha^{-1} (G) PE *fb* bispyribac 25 g ha^{-1} PoE (₹ 28652) followed by weed management practices through oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE (₹ 28000). However, the minimum cost of cultivation was recorded in unweeded control (₹ 24327).

Gross return (₹ ha^{-1})

Data on gross return emphasized that among tillage practices the higher gross return was recorded under CT (TPR) - CT (₹ 87644) which was at par with CT (TPR) – ZT (₹ 84006).

In case of weed management practices the higher gross return (₹ 96397) was recorded under oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE followed by pyrazosulfuron + pretilachlor 10 kg ha^{-1} (G) PE *fb* bispyribac 25 g ha^{-1} PoE (₹ 85965) in both the years.

However, minimum gross return was recorded under unweeded control due to low grain yield as well as high weed infestation. Significantly maximum gross return was obtained under combination of CT (TPR) - CT with oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE. (₹ 110302).

Table.1 Energy co-efficient value of experimental inputs and outputs (MJ)

S. No	Input/ output form	Units	Energy coefficient (MJ)	Remarks
1.	Labour			
	Adult man	Man hour^{-1}	1.96	
	Adult woman	Women hour^{-1}	1.57	
2.	Chemical fertilizer			
	N	Kg ha^{-1}	60.0	
	P_2O_5	Kg ha^{-1}	11.30	
	K_2O	Kg ha^{-1}	06.70	
3.	Chemicals			
	Superior chemical (Herbicides)	Kg^{-1}	120	Chemical requires dilution at the time of application
4.	Irrigation	1000 lt^{-1}	0.63	
5.	Diesel	Litre^{-1}	56.31	
6.	Seed	Kg^{-1}	14.70	
7.	Straw	Kg^{-1}	12.50	

Mittal *et al.*, (1985).

Table.2 Grain yield, straw yield and harvest index of rice as influenced by tillage and weed management practices in rice - maize cropping system

Treatment	Grain yield (t ha^{-1})		
	2015	2016	Mean
Tillage practices			
T_1	2.98	3.20	3.09
T_2	2.88	3.01	2.95
T_3	2.83	3.76	3.30
T_4	4.15	4.43	4.29
T_5	4.37	4.53	4.45
SEm±	**0.09**	**0.10**	**0.08**
CD (P=0.05)	**0.31**	**0.32**	**0.25**
Weed management			
W_1	4.77	5.19	4.98
W_2	4.27	4.56	4.42
W_3	1.28	1.61	1.45
SEm±	**0.05**	**0.05**	**0.04**
CD (P=0.05)	**0.15**	**0.15**	**0.12**
T×W	**S**	**S**	**S**

NS: Non- significant; **T_1:** CT (DSR) - CT, **T_2:** CT (DSR) - ZT, **T_3:** ZT (DSR) - ZT, **T_4:** CT (TPR) - ZT, **T_5:** CT (TPR) – CT; **W_1:** Oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE, **W_2:** Pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1}PE *fb* bispyribac-Na 25 g ha^{-1} PoE, **W_3:** Unweeded control

Table.3 Grain yield and straw yield of rice as influenced by the interaction of tillage and weed management practices in rice -maize cropping system (Mean of 2015 and 2016)

Treatment	Grain yield (t ha^{-1})			
	Weed management			
	W$_1$	W$_2$	W$_3$	Mean
Tillage practices				
T$_1$	4.58	4.09	0.59	3.09
T$_2$	4.35	4.02	0.47	2.95
T$_3$	4.65	4.09	1.15	3.30
T$_4$	5.60	4.88	2.39	4.29
T$_5$	5.73	4.99	2.64	4.45
Mean	4.98	4.42	1.45	3.62
T within W				
SEm±				**0.08**
CD (P=0.05)				**0.26**
W within T				
SEm±				**0.09**
CD (P=0.05)				**0.28**

NS: Non- significant
T$_1$: CT (DSR) - CT, **T$_2$:** CT (DSR) - ZT, **T$_3$:** ZT (DSR) - ZT, **T$_4$:** CT (TPR) - ZT,
T$_5$: CT (TPR) - CT
W$_1$: Oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE,
W$_2$: Pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1}PE *fb* bispyribac-Na 25 g ha^{-1} PoE, **W$_3$:** Unweeded control

Table.4 Cost of cultivation, gross return, net return and benefit: cost ratio of rice as influenced by tillage and weed management practices under rice - maize cropping system

Treatment	Cost of cultivation (₹ ha^{-1})			Gross return (₹ ha^{-1})			Net return (₹ ha^{-1})			B:C (Net)		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
Tillage practices												
T_1	23445	23171	23308	57861	63686	60760	34416	40514	37452	1.47	1.75	1.61
T_2	23445	23171	23308	55553	60172	57866	32108	37000	34558	1.37	1.60	1.48
T_3	20445	20171	20308	55229	75328	65161	34783	55157	44853	1.70	2.73	2.21
T_4	34087	33951	34019	80218	87867	84006	46130	53915	49986	1.35	1.59	1.47
T_5	34087	33951	34019	84523	90770	87644	50435	56818	53624	1.48	1.67	1.58
SEm±				**1710**	**1546**	**1223**	**1710**	**1546**	**1223**	**0.06**	**0.07**	**0.05**
CD (P=0.05)				**5577**	**5042**	**3989**	**5577**	**5042**	**3989**	**0.20**	**0.21**	**0.17**
Weed management												
W_1	28108	27892	28000	91052	101821	96397	62945	73929	68397	2.24	2.65	2.44
W_2	28756	28544	28652	81637	90332	85965	52877	61788	57313	1.84	2.16	2.00
W_3	24439	24215	24327	27341	34541	30901	2902	10326	6574	0.12	0.43	0.27
SEm±				**838**	**849**	**665**	**838**	**849**	**665**	**0.03**	**0.03**	**0.02**
CD (P=0.05)				**2471**	**2504**	**1962**	**2471**	**2504**	**1962**	**0.09**	**0.09**	**0.07**
T×W				**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

NS: Non- significant
T_1: CT (DSR) - CT, **T_2:** CT (DSR) - ZT, **T_3:** ZT (DSR) - ZT, **T_4:** CT (TPR) - ZT, **T_5:** CT (TPR) - CT
W_1: Oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE, **W_2:** Pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1}PE *fb* bispyribac-Na 25 g ha^{-1} PoE, **W_3:** Unweeded control

Table.5 Gross return, net return and benefit: cost ratio of rice as influenced by tillage and weed management practices in rice -maize cropping system (Mean of 2015 and 2016)

Treatment	Gross return (₹ ha^{-1})				Net return (₹ ha^{-1})				B:C (Net)			
	Weed management											
	W_1	W_2	W_3	Mean	W_1	W_2	W_3	Mean	W_1	W_2	W_3	Mean
Tillage practices												
T_1	89387	79511	13384	60760	65071	54543	-7259	37452	2.68	2.18	-0.35	1.61
T_2	84339	78448	10813	57866	60023	53481	-9830	34558	2.47	2.14	-0.48	1.48
T_3	90721	80151	24612	65161	69406	58183	6970	44853	3.26	2.65	0.40	2.21
T_4	107237	94431	50349	84006	72211	58752	18996	49986	2.06	1.65	0.61	1.47
T_5	110302	97283	55347	87644	75275	61604	23993	53624	2.15	1.73	0.77	1.58
Mean	96397	85965	30901	71088	68397	57313	6574	44095	2.44	2.00	0.27	1.63
T within W												
SEm±				**1336**				**1336**				**0.05**
CD (P=0.05)				**4107**				**4107**				**0.16**
W within T												
SEm±				**1488**				**1488**				**0.05**
CD (P=0.05)				**4389**				**4389**				**0.16**

T_1: CT (DSR) - CT, **T_2:** CT (DSR) - ZT, **T_3:** ZT (DSR) - ZT, **T_4:** CT (TPR) - ZT, **T_5:** CT (TPR) - CT
W_1: Oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE, **W_2:** Pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1}PE *fb* bispyribac-Na 25 g ha^{-1} PoE, **W_3:** Unweeded control

Table.6 Total input energy, total output energy, energy output-input ratio, energy use efficiency and energy productivity of rice as influenced by tillage and weed management practices in rice - maize cropping system

Treatment	Total input energy ha^{-1} (MJ X 10^{-3})			Total output energy ha^{-1} (MJ X 10^{-3})			Energy output- input ratio			Energy Use Efficiency (q MJ X 10^{-3})			Energy Productivity (kg MJ ha^{-1})		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
Tillage practices															
T$_1$	11.7	11.6	11.6	93.4	99.1	96.2	8.0	8.5	8.3	5.9	6.3	6.1	0.25	0.27	0.26
T$_2$	11.7	11.6	11.6	89.1	94.0	91.5	7.6	8.1	7.8	5.7	6.0	5.8	0.25	0.26	0.25
T$_3$	10.3	10.2	10.2	89.6	117.8	103.7	8.7	11.5	10.1	6.5	8.6	7.5	0.28	0.37	0.32
T$_4$	12.7	12.4	12.5	128.9	136.2	132.6	10.3	11.0	10.6	7.6	8.2	7.9	0.33	0.35	0.34
T$_5$	12.7	12.4	12.5	135.7	142.2	139.0	10.8	11.5	11.1	8.1	8.6	8.4	0.35	0.37	0.36
SEm±				**2.80**	**1.91**	**1.71**	**0.23**	**0.17**	**0.15**	**0.18**	**0.12**	**0.11**	**0.01**	**0.01**	**0.01**
CD (P=0.05)				**9.13**	**6.21**	**5.59**	**0.74**	**0.55**	**0.50**	**0.58**	**0.40**	**0.37**	**0.03**	**0.03**	**0.02**
Weed management															
W$_1$	11.8	11.6	11.7	144.4	156.1	150.3	12.3	13.5	12.9	9.1	10.0	9.5	0.40	0.45	0.43
W$_2$	11.9	11.7	11.8	129.8	139.8	134.8	11.0	11.9	11.4	8.1	8.9	8.5	0.36	0.39	0.37
W$_3$	11.7	11.6	11.6	47.7	57.6	52.7	4.0	4.9	4.4	3.0	3.8	3.4	0.11	0.14	0.12
SEm±				**1.41**	**1.22**	**0.96**	**0.12**	**0.10**	**0.08**	**0.09**	**0.08**	**0.06**	**0.004**	**0.005**	**0.004**
CD (P=0.05)				**4.15**	**3.59**	**2.84**	**0.35**	**0.31**	**0.24**	**0.26**	**0.23**	**0.18**	**0.01**	**0.01**	**0.01**
T×W				**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

NS: Non- significant

T$_1$: CT (DSR) - CT, **T$_2$:** CT (DSR) - ZT, **T$_3$:** ZT (DSR) - ZT, **T$_4$:** CT (TPR) - ZT, **T$_5$:** CT (TPR) - CT

W$_1$: Oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE, **W$_2$:** Pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1}PE *fb* bispyribac-Na 25 g ha^{-1} PoE, **W$_3$:** Unweeded control

Table.7 Total output energy, energy output-input ratio, energy use efficiency and energy productivity of rice as influenced by tillage and weed management practices in rice - maize cropping system (Mean of 2015 and 2016)

Treatment	Total output energy ha^{-1} (MJ X 10^{-3})				Energy output- input ratio				Energy Use Efficiency (q MJ X 10^{-3})				Energy Productivity (kg MJ X 10^{-3})			
	Weed management															
	W_1	W_2	W_3	Mean	W_1	W_2	W_3	Mean	W_1	W_2	W_3	Mean	W_1	W_2	W_3	Mean
Tillage practices																
T_1	140.5	124.4	23.8	96.2	12.1	10.6	2.1	8.3	9.0	7.9	1.6	6.1	0.39	0.35	0.05	0.26
T_2	131.9	123.3	19.4	91.5	11.4	10.5	1.7	7.8	8.4	7.8	1.3	5.8	0.37	0.34	0.04	0.25
T_3	142.5	126.4	42.2	103.7	14.0	12.2	4.2	10.1	10.4	9.1	3.1	7.5	0.46	0.40	0.11	0.32
T_4	165.5	147.1	85.0	132.6	13.2	11.6	6.8	10.6	9.8	8.6	5.1	7.9	0.45	0.39	0.19	0.34
T_5	171.1	152.8	93.0	139.0	13.7	12.1	7.5	11.1	10.1	9.0	5.9	8.4	0.46	0.39	0.23	0.36
Mean	150.3	134.8	52.7	112.6	12.9	11.4	4.4	9.6	9.5	8.5	3.4	7.1	0.43	0.37	0.12	0.31
T within W																
SEm±				**1.90**				**0.16**				**0.12**				**0.01**
CD (P=0.05)				**5.83**				**0.51**				**0.38**				**0.02**
W within T																
SEm±				**2.15**				**0.18**				**0.14**				**0.01**
CD (P=0.05)				**6.34**				**0.54**				**0.40**				**0.02**

T_1: CT (DSR) - CT, **T_2:** CT (DSR) - ZT, **T_3:** ZT (DSR) - ZT, **T_4:** CT (TPR) - ZT, **T_5:** CT (TPR) - CT
W_1: Oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE, **W_2:** Pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1}PE *fb* bispyribac-Na 25 g ha^{-1} PoE, **W_3**

Net return (₹ ha^{-1})

Net return through tillage practices was higher under CT (TPR) - CT was ₹ 50435 and ₹ 56818 in 2015 and 2016, respectively. Significantly maximum net return recorded under CT (TPR) - CT which was at par with CT (TPR) - ZT during both the years also at par with ZT (DSR) – ZT during 2016. In case of weed management practices significantly maximum net return recorded under oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE followed by pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1} PE fb bispyribac-Na 25 g ha^{-1} PoE. Difference between net return through chemical control method was marginal. On the basis of two years mean the maximum net return was observed in oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE (₹ 68397). However, in unweeded control net return was only ₹ 2902 during 2015 and ₹ 10326 during 2016; net return was found negative which shows that the weed infestation was highly influenced the yield of the rice crop. Maximum net return was obtained under combination of CT (TPR) - CT with oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE (₹ 75275).

Benefit: Cost ratio (Net)

In case of tillage and weed management practices higher B: C ratio was revealed that in 2016 comparison to 2015. Significantly higher B: C ratio was found in ZT (DSR) - ZT (2.21). Among the weed management practices it was significantly higher in oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE (2.44) and lowest B: C ratio was found in unweeded control. Interaction of tillage and weed management practices was significantly influenced by benefit cost ratio. Significantly maximum B: C ratio was found under combination of ZT (DSR) - ZT with oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE and it was negative in unweeded control with the combination of CT (DSR) - CT (-0.35) and CT (DSR) - ZT (-0.48). Gathala *et al.*, (2011) reported about 79 - 95 per cent reduction in tillage and crop establishment costs under ZT direct-seeded system than in CT based system.

Huge water inputs, labour costs and labour requirements for TPR have reduced profit margins (Pandey and Velasco, 2005). The farmer saves about Rs 1400 $acre^{-1}$ in cultivation cost. Direct seeding (both wet and dry), on the other hand, avoids nursery raising, seedling uprooting, puddling and transplanting, and thus reduces the labour requirement (Pepsico International, 2011). Kashid *et al.*, (2015) reported that sequential application of herbicides recorded higher net returns and B: C ratio. Sequential application of herbicides to manage weeds in rice based cropping system was the most profitable practice in terms of net returns and B: C ratio (Pandey *et al.*, 2005 and Surin *et al.*, 2012).

The highest benefit: cost ratio was obtained with oxadiargyl 75 g ha^{-1} *fb* bispyribac 30 g ha^{-1} (3.06) which was at par with oxadiargyl 75 g ha^{-1} *fb* penoxsulam 25 g ha^{-1} (3.00) Kiran and Subramanyam (2010).

Energy of rice

Data with respect to total input energy MJ, total output energy MJ and output-input energy is presented in Table 4 and 5.

Total input/output energy ha^{-1} (MJ X 10^{-3})

Energy inputs required to the different treatments of tillage and weed management practices were estimated. Input energy was highest (12.5 MJ X 10-3) in CT (TPR) - CT/ZT followed by CT (DSR) - CT/ZT (11.6 MJ X 10-3). However, the minimum energy required in ZT (DSR) - ZT (10.2 MJ X 10-3) due to skip ploughing. The input energy was high in transplanted puddled rice due to high consumption of diesel as compared to DSR. In case of weed management practices highest input energy was found under pyrazosulfuron + pretilachlor 10 kg (G) ha-1 PE fb bispyribac-Na 25 g ha-1 PoE (11.8 MJ X 10-3) due to higher dose of herbicide compared to oxadiargyl 90 g ha-1 PE fb pinoxsulam 22.5 g ha-1 PoE and unweeded control. Output energy was significant with respect to interaction of tillage and weed management practices. Output energy was maximum in the combination of CT (TPR) - CT with oxadiargyl 90 g ha-1 PE fb pinoxsulam 22.5 g ha-1 PoE.(171.1 MJ X 10-3).

Energy output:input ratio

Maximum output: energy was recorded under CT (TPR) - CT. However, it was at par with CT (TPR) - ZT during both the years. Significantly lower output energy produced by CT (DSR) - ZT. Due to yield was low comparison to rest of the treatments. In case of weed management practices significantly maximum output energy was recorded under oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE followed by pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1} PE *fb* bispyribac-Na 25 g ha^{-1} PoE during both the years. The lowest output energy was recorded under unweeded control due to weedy condition yield was very low in unweeded control which reflects on output energy. As compared to the chemical treatments output energy was 63.0 per cent less under unweeded control. This situation clearly indicates that the weeds are the major factor in production system. Energy was consumed by the weed for their growth and development in place of rice plant. Maximum energy output: input ratio was observed under CT (TPR) - CT and which was at par with CT (TPR) - ZT during both the years. However, the minimum output - input energy was produced by CT (DSR) - ZT. Among the weed management practices maximum energy output: input ratio was recorded under oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE it was followed by pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1} PE *fb* bispyribac-Na 25 g ha^{-1} PoE. Output: input ratio was almost 65.2 per cent less in unweeded control as compared to the best treatment oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE and 60.9 per cent less with pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1} PE *fb* bispyribac-Na 25 g ha^{-1} PoE. Energy output: input ratio was recorded maximum in the combination of ZT (DSR) - ZT with oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE.

Energy Use Efficiency (q MJ X 10^{-3})

Significantly, higher energy use efficiency *viz* 8.1 and 8.6 was recorded under CT (TPR) - CT during 2015 and 2016 respectivly. It was similar ZT (DSR) - ZT. However, it was at par with CT (TPR) - ZT during both the years.

However, it was found minimum under CT (DSR) - ZT. In case of weed management practices oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE was recorded maximum energy use efficiency 9.1 and 10.0 during 2015 and 2016 respectivly followed by pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1} PE fb bispyribac-Na 25 g ha^{-1} PoE. However, it was found minimum under unweeded control. Difference between chemical control in respect to energy use efficincy was not very vast in respect to produce biological yield (q MJ ha^{-1}) by the per unit input energy which supports chemical control (oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE) in rice production system. Energy use efficiency was significant with respect to interaction of tillage and weed management practices. Energy use efficiency was recorded maximum in the combination of ZT (DSR) - ZT with oxadiargyl 90 g ha^{-1}, PE *fb* pinoxsulam 22.5 g ha^{-1}, PoE.

Energy Productivity (kg MJ ha^{-1})

Energy productivity is an important indicator for more efficient use of energy although higher energy productivity does not mean in general, more economic feasibility (Mohammadi and Omid, 2010). Energy productivity (kg MJ ha^{-1}) was recorded significant maximum in CT (TPR) - CT which was at par with CT (TPR) - ZT in both the years during the investigation. Also at par with ZT (DSR) - CT. However, the energy productivity was significantly higher in oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE as compared to pyrazosulfuron + pretilachlor 10 kg (G) ha^{-1} PE fb bispyribac-Na 25 g ha^{-1} PoE. But difference was very marginal. Energy productivity was significant with respect to interaction of tillage and weed management practices. Energy productivity (kg MJ ha^{-1}) was maximum in the combination of ZT (DSR) - ZT with oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE and CT (TPR) - CT with oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE which behaved similarly.

The study concludes that with respect to benefit: Cost ratio and energy use efficiency ZT (DSR) – ZT with oxadiargyl 90 g ha^{-1} PE *fb* pinoxsulam 22.5 g ha^{-1} PoE recorded highest benefit: Cost ratio and energy use efficiency compare to other combination of tillage and weed management.

References

Alam, L., Wright, F. and Hons, M. 2005. Tillage impacts on soil aggregation and carbon and nitrogen sequestration under wheat cropping sequences. Soil and Tillage Research, 84: 67-75.

Baker, C.J. and Saxton, K.E. 2007. No-tillage seeding in conservation agriculture, 2nd edn. CAB International and FAO. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. pp. 326.

Esengun, K., Erdal, G., Gündüz, O. and Erdal, H. 2007. An economic analysis and energy use in stake - tomato production in Tokat province of Turkey. Renewable Energy32: 1873-1881.

Gathala, M.K., Ladha, J.K., Kumar, V., Saharawat, Y.S., Kumar, V., Sharma, P.K., Sharma, S. and Pathak, H. 2011. Tillage and crop establishment affects sustainability of South Asian rice-wheat system. Journal of American Society of Agronomy, 103: 1-10.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for Agriculture Research. 2nd edition. John Willey and Sons. New York.

Gupta, R.K. and Seth, A. 2007. A review of resources conserving technologies for sustainable management of the rice-wheat cropping system of Indo –Gangetic plains. Crop Protection. 26: 436-447.

Hobbs, P.R. 2007. Conservation Agriculture: What is it and why is it important for future sustainable food production. The Journal of Agricultural Science, 1-15.

Johansen, C., Haque, M.E., Bell, R.W., Thierfelder, C. and Esdaile, R.J. 2012. Conservation agriculture for small holder rain fed farming: conservation agriculture for small holder rain fed farming: Opportunities and constraints of new mechanized seeding systems. Field Crops Research, 132: 18-32.

Kashid, N.V., Barhate, K.K. and Bodake, P.S. 2015. Management of weeds in direct-seeded rice. Indian Journal of Weed Science, 47(2): 110–112.

Kiran, Y.D. and Subramanian, D. 2010. Performance of pre and post emergence herbicides on weed flora and yield of transplanted rice. Indian Journal of Weed Science, 42 (3-4): 229-231.

Mahajan, G. Brar, L.S. and Walia, U.S. 2002. *Phalaris minor* response in wheat in relation to planting dates, tillage and herbicides. Indian Journal of Weed Science, 34: 213-215.

Mann, R.A., Ashraf, M. and Ramzan, M. 2002. Crop Establishment with Resource Conservin Technologies in Rice- Wheat Cropping System.PARC-RWC. 2003. Proceedings of the NationalWorkshop on Rice- Wheat Systems, Islamabad,Pakistan.11-12 Dec 2002. Pakistan AgriculturalResearch Council, Islamabad, Pakistan andRice-Wheat Consortium for the Indo-GangeticPlains, New Delhi, India. pp: 13-19

Mohammadi, A. and Omid, M. 2010. Economical analysis and relation between energy inputs and yield of greenhouse cucumber production in Iran. Applied Energy, 87: 191-196.

Pandey, I.B., Sharma, S.L., Tiwari, S. and Mishra, S.S. 2005. Economics of tillage and weed-management system for wheat (*Triticum aestivum*) after lowland rice (*Oryza sativa*).). Indian Journal of Agronomy, 50(1): 44-47.

Pandey, S. and Velasco, L. 2005. Trends in crop establishment methods in Asia and research issues. In "Rice Is Life: Scientific Perspectives for the 21st Century" (K. Toriyama, K.L. Heong, and B. Hardy, Eds.), pp. 178-181. International Rice Research Institute, Los Banos, Philippines and Japan International Research Center for Agricultural Sciences, Tsukuba, Japan.

Pepsico International 2011. Direct seeding of paddy- the work of pepsico reported in indiawaterportal. http:// www.indiawaterportal.org/post/6 754

Rafiee, S., Mousavi, A.S.H. and Mohammadi, A. 2010. Modeling and sensitivity analysis of energy inputs for apple production in Iran. Energy, 35: 330-332.

Ramzan, M. and Rehman, H.M. 2006. Second Semi- Annual Technical Report. ADB-IRRI Project on Enhancing Farmer's Income and Livelihood Through Integrated Crop and Resource Management in the Rice-Wheat Systems in South Asia, pp: 51.

Sherman, H.D. 1988. Service organization productivity management. The Society of Management Accountants of Canada, Hamilton, Ontario.

Singh, G., Singh, O.P., Kumar, V. and Kumar, T. 2008. Effect of methods of establishment and tillage practices on productivity of rice (*Oryza sativa* L.) - wheat (*Triticum aestivum*) cropping system in lowlands. Indian Journal of Agricultural Sciences, 78(2): 163-166.

Singh, M.K., Pal, S.K., Thakur, R. and Verma, U.N. 1997. Energy input-output relationship of cropping systems. Indian Journal of Agricultural Science, 67(6): 262-266.

Singh, Y., Bhardwaj, A.K., Singh, S.P., Singh, R.K., Chaudhary, D.C., Saxena, A., Singh, V., Singh, S.P. and Kumar, A. 2002. Effect of rice establishment methods, tillage practices in wheat and fertilization on soil physical properties and rice–wheat system productivity on a silty loam Mollisol of Uttaranchal. Indian Journal of Agricultural Sciences, 72: 200-205. Surendra, S., Sharma, S.N., Rajendra, P., Singh, S. and Prasad, R. 2001. The effect of seeding and tillage methods on productivity of rice–wheat cropping system. Soil and Tillage Research,61:125–131.

Surin, S.S., Singh, M.K., Upasani, R.R., thakur, R. and Pal, S.K. 2012. Productivity and profitability of rice-wheat sequence under conservation tillage. Indian Journal of Weed Science, 44(3): 172-175.

How to cite this article:

Sakshi Bajaj, M. C. Bhambri and Shrivastava G. K. 2019. Economics of Direct Seeded Rice and Transplanted Rice Influenced by Tillage and Weed Management Practices under Rice - Maize Cropping System Based on Conservation Agriculture. *Int.J.Curr.Microbiol.App.Sci.* 8(09): 1106-1119. doi: https://doi.org/10.20546/ijcmas.2019.809.128