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Effect of Conservation Agriculture on Productivity and Energetic of Maize-wheat Cropping System

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Abstract—*A field experiment was conducted at Birsa Agricultural University, Ranchi, Jharkhand during 2015-16 and 2016-17 in sandy soil to study the effect of conservation agriculture on productivity and energetic of maize – wheat cropping system. The treatments comprised of five tillage sequences viz. conventional-conventional(CT – CT), conventional – zero (CT – ZT), zero – zero (ZT –ZT), zero – zero with crop residue (ZT – ZT+R) and zero tillage along with crop residues in both the seasons (ZT+R – ZT+R) in main plots , while three weed control methods viz, recommended herbicides in maize (atrazine @ 1 kg/ha pre-emergence) and wheat (isoproturon @ 0.75 kg/ha +2,4-D @ 0.5 kg/ha post emergence), IWM in maize (pendimethaline @1 kg/ha + intercrop black gram) and in wheat (isoproturon @ 0.75 kg/ha +2,4-D @ 0.5 kg/ha post emergence + mechanical weeding at 40 DAS) and weedy check respectively in sub plots. The experiment was laid out in strip plot design with three replications. The result revealed that CT – CT sequence recorded 63.11,65.21and 72.85, 74.64 percent significantly higher gross energy output and net energy output of maize-wheat system compared to minimum observed under ZT – ZT sequence i.e. 174803, 185956 and 146076, 157228 MJ/ha during both the years respectively while integrated weed management recorded higher gross energy output, net energy output and energy use efficiency of maize-wheat system compare to recommended herbicides and weedy check during both the years.*

Keywords*: Energy, Maize-wheat cropping system, conservation agriculture, weed management.*

1. INTRODUCTION

Maize-wheat is ranked first among different maize based cropping systems in India. Conventional crop production system results in higher cost of production and energy consumption. Yield of different crops can be increased up to 30 % by using optimal level of energy input (Chaudhary *et al*., 2006). In present methods of crop production, major portion of energy (25-30 %) is utilized for field preparation and crop establishment which can be minimized by reducing the tillage operations. Zero tillage technique is an ecological approach for soil surface management and seed bed preparation resulting in less energy requirement, better crop residue management (Jain *et al*., 2007). Continuous tillage in both i.e. *kharif* and *rabi* is found to have detrimental effect in soil structure and health and energy requirement is quite high (Gupta *et al*., 2007). Thus, the present work was undertaken to determine effect of conservation agriculture on productivity and energetic of maize-wheat cropping system.

2. MATERIALS AND METHODS

A field experiment was conducted at Birsa Agricultural University, Ranchi, Jharkhand during 2015-16 and 2016-17 in sandy soil to study the effect of conservation agriculture on productivity and energetic of maize – wheat cropping system. The treatments comprised of five tillage sequences viz. conventional-conventional(CT – CT), conventional – zero (CT – ZT), zero – zero (ZT –ZT), zero – zero with crop residue (ZT – ZT+R) and zero tillage along with crop residues in both the seasons (ZT+R – ZT+R) in main plots , while three weed control methods viz, recommended herbicides in maize (atrazine @ 1 kg/ha pre-emergence) and wheat (isoproturon @ 0.75 kg/ha +2,4-D @ 0.5 kg/ha post emergence), IWM in maize (pendimethaline @1 kg/ha + intercrop black gram) and in wheat (isoproturon @ 0.75 kg/ha +2,4-D @ 0.5 kg/ha post emergence + mechanical weeding at 40 DAS) and weedy check respectively in sub plots. The experiment was laid out in strip plot design with three replications. Experimental soil was sandy-loam in texture having pH 5.5, organic carbon 4.2 g/kg soil, available N 240 kg/ha, available P 19.00 kg/ha and available K 187 kg/ha. The variety of maize (composetive swan) and wheat (‘K-9107’) respectively. For calculating the energy input and output from different power sources, viz. labour, fuel, machinery, fertilizer, seeds, pesticides, irrigation and crop yield standard energy coefficients were used as suggested by Devsenapati *et al.*, (2008). Net energy production was calculated by subtracting the energy input from the output.

3. RESULTS AND DISCUSSION

Maize: Data on gross energy output, net energy output and energy use efficiency by maize as influenced by tillage sequences and weed control methods during 2015 and 2016(Table 1). Tillage significantly affected gross energy output, net energy output and energy use efficiency by maize during both the years. CT – CT sequence being similar to ZT+R – ZT+R recorded 87.25 and 94.31; 125.04 and 133.37

and 105.56 and 98.96 percent significantly higher gross energy output, net energy output and energy use efficiency compared to minimum observed under ZT – ZT sequence i.e. 28704 and 29959 MJ/ha; 18465 and 19719 MJ/ha and 1.80 and 1.93 during both the years respectively. ZT+R – ZT+R sequence recorded 46.36 percent significantly reduced specific energy compared to maximum observed under ZT – ZT sequence i.e. 5884MJ/t during 2016. Different tillage sequences did not influence specific energy during 2015.

Table 1: Energetic of maize production as influenced by tillage and weed control methods

Treatment	Energy inputs (MJ/ha)	Gross energy output(MJ/ha)		Net Energy outputs (MJ/ha)		Energy use efficiency		Specific energy (MJ/t)	
Tillage method		2015	2016	2015	2016	2015	2016	2015	2016
CT-CT	12193	53747	58212	41554	46019	3.41	3.77	3867	3211
CT-ZT	12193	46447	47761	34254	35568	2.81	2.92	5479	3974
ZT-ZT	10240	28704	29959	18465	19719	1.80	1.93	5291	5884
ZT-ZT+R	10240	33771	34320	23531	24080	2.30	2.35	4490	4536
ZT+R - ZT+R	10688	50269	52894	39581	42206	3.70	3.84	3913	3156
S Em±	-	2007	1649	2007	1649	0.18	0.14	495	152
CD(P=0.05)	-	6545	5378	6545	5378	0.58	0.47	1615	496
Weed control									
W1(RH)	11101	43424	43727	32323	32626	2.91	2.94	3942	3866
W2(IWM)	12071	58845	59335	46774	47265	3.88	3.92	3384	3152
W3(WC)	10160	25494	30825	15334	20665	1.51	2.03	6499	5439
S Em±		1509	1151	1509	1151	0.13	0.10	397	86
CD(P=0.05)		5922	4517	5922	4517	0.53	0.39	1558	337

Weed control methods influenced gross energy output by maize significantly during both the years. Integrated weed management recorded higher gross energy output, net energy output and energy use efficiency compare to recommended herbicides and weedy check to the tune of 35.51 and 35.69; 44.71 and 44.87; and 25.13 and 25.64 percent 130.83 and 92.49; 205.03 and 128.72 and 90.91 and 64.43 percent during 2015 and 2016 respectively. IWM recorded reduced specific energy compare to weedy check to the tune of 47.93 and 42.05 percent during 2015 and 2016 respectively.

Wheat: Tillage significantly affected gross energy output, net energy output, energy use efficiency and specific energy of wheat during both the years (Table 2). CT – CT sequence being similar to ZT+R – ZT+R and CT – ZT recorded 35.07 and 33.51; 58.89 and 50.20 and 50.86 and 37.77 percent significantly higher gross energy output, net energy output and energy use efficiency respectively compared to minimum observed under ZT – ZT sequence i.e. 41684 and 43898 MJ/ha ; 22570 and 25410 MJ/ha and 1.16 and 1.35 during both the years respectively. CT- ZT tillage sequence was similar to CT-CT and ZT+R –ZT+R during 2015-16 and ZT+R –ZT+R tillage sequence was similar to CT-ZT during 2016-17. The reduction was 24.03 and 21.83 percent compared to maximum specific energy required to produce wheat under ZT-ZT+R tillage sequence i.e. 8110 and 7383 MJ/t during 2015-16 and 2016-17 respectively.

Table 2: Energetic of wheat production as influenced by tillage and weed control methods

Treatment	Energy inputs (MJ/ha)	Gross energy output(MJ/ha)		Net Energy outputs (MJ/ha)		Energy use efficiency		Specific energy (MJ/t)	
Tillage method		2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
CT-CT	20440	56302	58607	35861	38167	1.75	1.86	6209	6328
CT-ZT	18487	51303	51045	32816	32558	1.77	1.76	6161	6151
ZT-ZT	18487	41684	43898	23197	25410	1.25	1.37	7463	7106
ZT-ZT+R	19345	41915	45512	22570	26166	1.16	1.35	8110	7383
ZT+R - ZT+R	19345	51543	54088	32198	34743	1.66	1.80	6494	5771
S Em±		1985	986	1985	986	0.10	0.05	324	141
CD(P=0.05)		6473	3217	6473	3217	0.33	0.17	1057	461
Weed control									
W1(RH)	19301	49003	48583	29702	29281	1.54	1.52	6741	6659
W2(IWM)	19333	56141	61752	36809	42419	1.90	2.18	5842	5319
W3(WC)	19030	40504	41555	21474	22526	1.13	1.18	8080	7665
S Em±		1308	1654	1308	1654	0.07	0.09	249	272
CD(P=0.05)		5132	6492	5132	6492	0.27	0.34	977	1066

Sequential weed control methods influenced gross energy output, net energy output, energy use efficiency and specific energy by wheat significantly during both the years. Integrated weed management recorded higher gross energy output, net energy output and energy use efficiency compare to recommended herbicides and weedy check to the tune of 14.57, 27.11; 23.93, 44.87 and 23.38, 43.42 and 38.61, 48.60 ; 71.41, 88.31 and 68.14, 84.75 percent during 2015-16, 2016-17. IWM recorded reduced specific energy compare to RH and weedy check to the tune of 13.34, 27.70 and 30.61, 16.70 percent during 2015-16, 2016-17 and pooled data respectively.

Maize-wheat system: Tillage significantly affected gross energy output, net energy output, energy use efficiency and specific energy of maize-wheat system during both the years (Table 3). CT – CT sequence recorded 63.11,65.21and 72.85, 74.64 percent significantly higher gross energy output and net energy output of maize-wheat system compared to minimum observed under ZT – ZT sequence i.e. 174803, 185956 and 146076, 157228 MJ/ha during both the years respectively. Jha *et al* (2011) and Ramesh *et al* (2014) also have reported significantly higher gross energy output under CT – CT tillage. ZT+R – ZT+R sequence being similar to CT – CT and CT – ZT during 2015-16 and also similar to CT – CT during 2016-17 recorded 52.27 and 62.22 percent significantly higher energy use efficiency of maize-wheat system compared to minimum observed under ZT – ZT sequence i.e. 5.07 and 5.43 during both the years respectively. CT – CT sequence being similar to ZT +R– ZT+R recorded 29.90 percent significantly reduced specific energy compared to maximum observed under ZT – ZT sequence i.e. 5987 MJ/t during 2015-16. ZT – ZT+R sequence being similar to CT – CT recorded 45.77 percent significantly reduced specific energy compared to maximum observed under ZT – ZT sequence i.e. 5917 MJ/t during 2016-17.

Table 3: Energetic of maize – wheat cropping system as influenced by tillage and weed control methods

Treatment	Energy inputs (MJ/ha)	Gross energy output(MJ/ha)		Net Energy outputs (MJ/ha)		Energy use efficiency		Specific energy (MJ/t)	
Tillage method		2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
CT-CT	32633	285123	307212	252490	274579	7.68	8.37	4609	4309
CT-ZT	30680	253278	260963	222598	230283	7.20	7.46	5002	4689
ZT-ZT	28727	174803	185956	146076	157228	5.07	5.43	5987	5917
ZT-ZT+R	29585	192898	204993	163313	175408	5.50	5.90	5847	5602
ZT+R-ZT+R	30034	264147	293030	234113	262996	7.72	8.70	4735	4059
S Em±		7597	7102	7597	7102	0.25	0.23	225	123
CD(P=0.05)		24772	23158	24772	23158	0.82	0.74	734	401
Weed control									
W1(RH)	30402	237295	243776	206893	213374	6.76	6.99	4932	4868
W2(IWM)	31403	297169	315831	265766	284427	8.40	9.00	4192	3875
W3(WC)	29190	167685	191685	138495	162495	4.74	5.52	6586	6004
S Em±		3423	4722	3423	4722	0.12	0.15	179	131
CD(P=0.05)		13436	18537	13436	18537	0.46	0.60	701	513

Weed control methods influenced gross energy output, net energy output, energy use efficiency and specific energy by wheat significantly during both the years. Integrated weed management recorded higher gross energy output, net energy output and energy use efficiency of maize-wheat system compare to recommended herbicides and weedy check to the tune of 25.23, 29.56 , 28.46, 33.30 and 24.26, 28.76 and 77.22, 64.77 , 91.90, 75.04 and 77.22, 63.04 percent during 2015-16, 2016-17 respectively . IWM recorded reduced specific energy compare to RH and weedy check to the tune of 17.65, 23.34 and 57.11, 54.94 percent during 2015-16, 2016-17.

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