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Impact assessment of Resource Conservation Technologies (RCTs) in wheat crop on yield and net returns. A case study from S. E. Part of Bihar

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Abstract: *The study focus on the rain fed zone in South Eastern part of Bihar (Jamui & Lakhisarai). The average rainfall of this district is 1101 mm. but for last three years (2009 – 10, 2010 -11 and 2011 – 12) the average rainfall recorded was 836.7 mm. in the year 2011. This area received 1212.46 mm. rainfall, out of which 80% is received during monsoon and slightly more than 10% in winter season and the rest in summer season. Wheat is grown in cold and dry weather during November and harvested in March (Rabi season) whereas rice is grown during the warm humid /semi humid monsoon season during June -July (Kharif season). Wheat is the second most important crop grown over 19,000 hectares in Jamui and 28098 hectares in Lakhisarai district with an the average productivity of 2015 kg/ ha., which is quite low than national productivity rate. Delayed planting of wheat because of late harvesting of rice of long duration rice varieties is the main bottle neck in harvesting higher yield of wheat in S.E. part of Bihar, especially under narrow winter window causing terminal heat stress to wheat crop.*

The present case study was carried on resource conservation technologies in wheat crop on yield and net returns in 36 villages of two districts of S.E. part of Bihar. Zero tillage support the farmers for early sowing of crop, save cost, irrigation water and in this way crop is protected from terminal heat stress during milking stages. The results have clearly shown that grain yield of wheat in CT method (27.4 q ha^{-1}) was lower than ZT method (40.2 q ha^{-1}). cost benefit ratio in ZT wheat is 1.7 and net return recorded is Rs. 31,510 ha^{-1} whereas in CT method cost benefit ratio is 0.43 and net returns is 10,370 ha^{-1}. The study showed that the RCTs improved the crop stand, better crop establishment and yield 20 - 45% higher under different soil types and wheat regimes as compared with planting under conventional system.

INTRODUCTION

The rice – wheat rotation is one of the largest agricultural production system in S.E. part of Bihar (Jamui & Lakhisarai). Delayed planting of wheat after late harvest of long duration puddled transplanted rice varieties and terminal heats are the main bottle neck in harvesting for higher yield of wheat in S.E. part of Bihar. These problems are often force the farmers to go with resource conservation technologies (RCTs). Chauhan *et al.* (2000) also reported 12 -16 tillage operations in Haryana for broadcast sowing of wheat. Delayed wheat sowing after mid Nov. in Trans of Indo – Gangetic plains and late November in middle IGP results in grain yield losses of one percent day^{-1} (Hobbs *et al.*, 1997). The zero till technology facilitates timely planting of wheat in rice harvested fields and also uses residual moisture for wheat germination (Sheikh *et al.* 2000). The ZT in India was evolved 15 years ago (Malik *et. all.*, 2002). Cereal Systems Initiative for South Asia (CSISA) has been promoting various resource conservation technologies (RCTs) for tillage and crop establishment of rice, wheat and other crops grown in rice – wheat system. RCTs include Zero Tillage, furrow irrigated raised bed system (FIRBS), laser

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land leveling, crop residue management, improved method of herbicide application and improved cultivars etc. RCTs have been introduced in the S.E. part of Bihar to reduce the cost of cultivation, save on precious resources like water, seed, fertilizer, energy and time, improve the quality of soil resource base and enhance productivity.

Zero tillage planting of wheat was found effective in hastening planting wheat at least 10 to 15 days earlier at residual moisture. Zero till seeding of wheat also allowed band application of basal fertilizer which insure placement of the phosphatic fertilizers right in the seed zone and also allows a saving of 25% in the seed rate to obtain sufficient plant stand as compared to traditional broadcasting. The result of 666 demonstrations conducted during rabi season (2011 – 12) on wheat crop indicated that zero tillage wheat reduce the cost of cultivation by Rs. 3000 – 3300 ha^{-1} corresponding saving in diesel consumption of 50 – 53 liter for field operations and 18 – 20 liter for irrigation for diesel pump operated irrigated systems. The expansion in area of RCTs in S.E. part of Bihar has been observed. During the season we covered more than 3300 acres of area under resource conservation technologies on wheat crop. These technologies help the farmers produce more food at less cost, significantly raise farmers profits , improve efficiency of natural resource use and provide significant environmental benefits. Farmers have shown interest to adopt these technologies for various reasons and under different farming conditions and situations.

METHODOLOGY

The case study conducted in 36 villages of two districts of S.E. part of Bihar along with 766 farm families under RCTs and was compared to CT method. Delayed planting of wheat after late harvesting of long duration of rice varieties is the main problem in harvesting higher yield of wheat in the S.E. part of Bihar especially under narrow winter window causing terminal heat stress to wheat crop. The long turnaround time often reflects intensive tillage operations, soil moisture problem, unavailability of draft and mechanical power for ploughing and the urgency to store the rice crop before preparing land for wheat cultivation. Conventional tillage practice for wheat are very intensive and involve multiple passes of the tractor to accomplish plowing, harrowing, planking and seeding operations. Farmers perceive the need for intensive tillage due to difference in soil management practices for rice and wheat being grown under anaerobic and aerobic conditions respectively. In this season at the time of harvesting moisture was available and there was scope of wheat seeding through ZT seed drill. The present study comprised on RCTs in wheat crop in S.E. part of Bihar. We complied review information cost of cultivation, yield, net returns cost benefit ratio and economics aspects of ZT and CT method. The available information tends primarily to report on technical aspects of ZT and CT method at the plot level. It was observed that the farmers saved Rs. 2,700 Rs. 1,200, Rs. 720 and Rs. 860 in tillage, seeds, fertilizer and irrigation respectively. In total they saved Rs. 5,140 in cost of cultivation as compared to conventional method.

RESULT AND DISCUSSION

The surveyed 766 plots of ZT and CT in S.E. part of Bihar under different soil types and wheat regimes was compared with planting under CT system. The results confirm that ZT significantly reduce cost, save irrigation water, reduce weed problem, better crop establishment and significantly higher grain yields were obtained with ZT technology when wheat was sown at the recommended time, i.e. early to mid November. For the late planted sites there was no significant yield difference between ZT and conventional tillage planted wheat. Over study highlights that the current conventional tillage practices do not deviate much from the earlier study whereas broadcasting of seed still prevails. The results showed that the ZT technology improved the crop stand, yielded 20-45% higher and saved 22% irrigation water under different soil types and wheat sowing regimes as compared to planting under conventional system. The adoption rate of ZT technology in farmer's field by analyzing survey results in adoption rate of ZT wheat are increasing every year.

The result of present case study reveals that highest grain yield was recorded in ZT wheat (40.2

Table 1
Demonstration of different methods of wheat cultivation and economics:

Method	*No.of Sites*	*Range of sowing date*	*Variety used*	*Av.Grain yield (q./ha.)*	*Yield gain over control (q./ha.)*	*Cost of cultivation (Rs./ha.)*	*Saving in tillage (Rs./ha.)*	*Net benefit (Rs./ha.)*	*B:C ratio*
Bed planted Wheat	05	16.11.12 to 06.12.12	Raj-4120DBW-39,PBW-502	**50.8**	23.4	18,176	5,704	34,954	2.4
ZT Wheat (equal row)	427	19.11.12 to 05.01.12	PBW 343, 443,502,154 711, HD 2733, Lok-1	**40.2**	12.8	18,740	5,140	21,140	1.7
ZT Wheat (paired row)	34	18.11.12 to 20.12.12	PBW 343, 443,502,154,Lok-1	**41.8**	14.4	18,740	5,140	23,140	1.75
ZT Wheat (control traffic)	04	18.11.12 to 17.12.12	PBW 343, 443,502,154	**37.8**	10.4	18,740	5,140	18,140	1.5
ZT Wheat seeded by happy seeder	09	23.11.12 to 19.12.12	PBW-343, 443,502,373, 550 HUW-234	**43.6**	16.2	18,170	5,710	25,960	1.9
Conventational Method	15	28.11.12 to 05.01.13	PBW-343,154,373Lok-1, HD-2824UP- 262	**27.4**	–	23,880	–	–	0.43

Unit rate of wheat @ Rs. 1,250.00/quintal

Table 2
Economics of CA practices in S.E. part of Bihar

S.No	*Particulars*	*Benefits rates over Conventional sown wheat (Rs. ha^{-1})*		*Total saving in covered area (wheat)(Rs.)*		*Benefits rates over Co- nventional sown Gram &lentil (Rs. ha^{-1})*		*Total saving in covered area (Gram lentil) (Rs.)*		
		ZT	*Bed*	*ZT (1162 ha.)*	*Bed (7.2 ha.)*	*ZT Gram*	*ZT Lentil*	*Gram (82 ha.)*	*Lentil (98 ha.)*	*Total saving (Rs.)*
1.	**Land preparation cost including sowing**	2,700	300	31,37,400	2,160	1,500	1,500	1,23,000	1,47,000	34,09,560
2.	**Saving in seed/fertilizer**	1,920	2,880	22,31,040	20,760	670	421	54,940	41,258	23,47,974
3.	**Saving in weeding (herbicide)**	400 (-)	–	4,64,800(-)	–	–	–	–	–	4,64,800(-)
4.	**Saving in irrigation**	860	1,864	9,99,320	13,420	330	330	27,060	32,340	10,72,140
5.	**Saving in labour**	330	660	3,83,460	4,752	–	–	–	–	3,88,212
6.	**Increase income due to additional yield**	16,000	29,250	1,85,92000	2,10,600	11,250	9,900	9,22,500	9,70,200	2,06,95300
	Total gains	21,410	34,954	2,48,78740	2,51,668	13,750	12,150	11,27,500	11,90,798	**2,74,48386**

Rs. Two crore seventy four lakhs fourty eight thousand three hundred eighty six only

Table 3
Cost of cultivation of Wheat : Cost of cultivation of different method of wheat seeding are given below

S.No.	Particulars	ZT (Rs./ha.)	BP (Rs./ha.)	ZTHP (Rs./ha.)	CT (Rs./ha.)
1.	Field preparation (ploughing & planking)	–	2,400.00	–	4,200
2.	Seeding	1,500	1,500	1,600.00	–
3.	Seed	@120kg/ha	@100kg/ha.	@120kg/ha	@160kg/ha
	Amount	3,600	3,000	3,600	4,800
4.	Fertilizer (Basal & Top)	3,460	3,100	3,460	4,180
5.	Pesticide (fungicide)	500	500	500	500
	Herbicide	400.00	–	–	–
6.	Irrigation	3700	2,696	3,700	4,560
7.	Labour (14 no.) @ 165/day for fertilizer application & other works	2,310	1,980	2,310	2,640
8.	Harvesting & Threesing (combine)	3,000	3,000	3,000	3,000
	Total	18,740	18,176	18,170	23,880

q./ha.) onwards lowest grain yield was found in conventional method (27.4 ha^{-1}). The total cost of cultivation in ZT wheat was Rs. 18,740 as compared to Rs. 23,880 ha^{-1}. In CT method there was saving of Rs. 5,140 in cost of cultivation and additional benefit was Rs. 21,140 due to adoption of ZT technology as compared to CT method. The cost benefit ratio calculated in ZT technology was 1.7 where in CT method it was 0.43. The results indicate that farmers use criteria other than water conservation to base their decisions. It appears that farmers should have been educated before hand to use less irrigation water while adopting resource conservation technologies.

CONCLUSION

The conclusion of this case study indicated the superiority of ZT over the CT in terms of cost of cultivation, irrigation water, productivity of crops, net returns, profitability and conserving natural resource. Among all tillage practices, the grain yield was significantly higher in BP, Happy seeder and ZT as compared to CT method due to more number of effective tillers m^{-2}, higher number of grains $spike^{-1}$ and higher ear head length. The study highlights that ZT has been primarily adopted by the larger and more progressive farmers. In survey, although they consistently suggest ZT indicators to be typically superior to conventional tillage. Thus, the farmers have highly appreciated of ZT technology due to cost saving and higher grain yield. In the end, ZT so far is primarily a cost – saving technology.

Data source – Data of 2012 -13 (CSISA report) Rabi is being presented under table shown below.

Lesson learnt: Some silent findings based on the field results are presented here under.

The lesson learnt from the study that ZT technology has several advantage over conventional tillage and some important ones include reduction in cost of cultivation, advances time of sowing, requires less water, reduce weeds problem (*phalaris minor*) and higher grain yield. ZT as a stepping stone to RCTs. The land productivity under zero tillage was higher than conventional tillage by 10-15%. Zero tillage is complementary resource conserving technologies that are profitable and socially attractive are needed. Based on the results of present study, it can be concluded that wheat can be successfully grown under zero tillage, bed planting and happy seeder (RCTs) consistently on long-term basis. However, continuation of such trail in future will provide an ampelopsis and chortunity to further generate data on soil health and change in weed flora. Women generally appreciated ZT technology. They acknowledged that after the adoption of ZT wheat there was less tension, which normally prevailed because of the hectic schedule of field operation under conventional method, and this has resulted in more peace at home. Women

also reported that, with ZT technology their drudgery was reduced and their male counterparts were helping them in animal care and children education. Zero tillage therefore offers high potential economics, environmental and social gains in the S.E. part of Bihar.

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