Indian Journal of Agricultural Sciences **80** (12): 1092–4, December 2010

Economic analysis of adoption of zero tillage technology in wheat cultivation in trans-gangetic plains of India

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Received: 12 June 2009; Revised accepted: 30 August 2010

Key words: Economic Analysis, Wheat, Zero Tillage and Trans-Gangetic Plain

Zero tillage is one of the most used Resource Conserving Technologies (RCTs) (Gupta 2007) employed for saving precious resources, which gives more economic production (Hobbs *et al*. 2002). Adoption of zero tillage resulted in high crop yield (Nagrajan *et al*. 2002), lower production cost and saving in water and energy (Reifschneider 2007). It not only promotes input-use efficiency but also strengthens natural resource base (Hobbes *et al.* 1997, Laxmi and Mishra 2007). Of late, its importance has increased in the backdrop of continued threat to agriculture sustainability. For a long period, the wheat productivity has stagnated at a particular level (Mehla *et al*. 2000). Due to these reasons various organizations including international institutions are engaged in promoting this agricultural technology. The zero tillage is defined as planting crops in previously unprepared soil by opening narrow slots or trenches of the smallest width and depth needed for proper coverage of the seeds (Laxmi and Mishra 2007). Timely sowing can be ensured through the zero tillage. It has been observed that an average delay in sowing of wheat after first half of November resulted in productivity loss of 35 kg/ha/day in rice (*Oryza sativa* L.) wheat (*Triticum aestivum* L. emend. Fiori & Paol.) growing region in Haryana (Mehla *et al.* 2000).

Trans-Gangetic Plains (Punjab and Haryana) contributed 20.90% area and produced 32.53% wheat in 2007–08 (GOI 2009). At present, grain production is facing serious problem of resource degradation (Sinha *et al.* 1998), which can be tackled through introduction of zero tillage. The present study is an attempt to look into the economics of zero tillage in the region.

Based on a part of PhD thesis of first author submitted to IARI, New Delhi during 2007

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The study is based on primary data pertaining to 2005–06 which has been collected from farmers' fields using random sampling method in Trans-Gangetic Plains (TGP) of India (Punjab and Haryana). Two districts each from Haryana (Karnal and Kaithal) and Punjab (Ludhiana and Patiala) were selected for the study. Since, the main focus of the study was on zero tillage, more respondents (120 farms) were interviewed in this category compared to conventional farms (80 farms). Rate of interest was charged as per the commercial banks' rate applicable to agricultural loan. Different depreciation rates have been taken according to the nature of the fixed assets.

A comparison between zero tilled and conventionally tilled wheat (Table 1) indicates that most of the input requirements were less zero tillage. Zero tillage saved entire preparatory tillage. Besides this, the average irrigation requirement in zero tillage was 4.53 (unit) as against 5.11 (unit) irrigations in the conventional tillage. This finding is in line with that of Mehla *et al.* (2000). Besides, the pre-sowing irrigation was totally saved in zero tillage. Nagrajan *et al.* (2002) reported similar findings. Most of the farmers reported that the duration of irrigation pump operation was less in zero tillage as compared to the conventional tillage, which may be due to high percolation rate in the latter case on account of good tilth. Although, this parameter has not been covered in the study, nevertheless, from the existing evidences, it may be concluded that adoption of zero tillage saved the water in the TGP of India. This is in line with the findings of Mehla *et al.* (2000), Hobbs *et al.* (2002) and Gupta (2007). Labour was grouped into human and mechanical labour. Adopter reported a saving of 30.28% human labour and 35.11% mechanical labour in zero tillage. Seed requirement in both the situation of crop cultivation was almost similar with little positive bias towards zero tillage. Farmers perceived that less tilling in zero tillage necessitated the higher seed rate. On the other hand, better field preparation in conventional tillage insured good tilling, which could compensate even less germination. Thus, the fear of less tilling in zero tillage

Table 1 Pattern of input use and output realized from wheat cultivation

(/ha)

Operations	Adopter			Non-adopter		
	Punjab	Haryana	Overall	Punjab	Haryana	Overall
Irrigation (no.)	4.52	4.55	4.53	5.13	5.05	5.11
Ploughing (no)	0.00	0.00	0.00	4.38	3.93	4.15
Harrowing (no)	0.00	0.00	0.00	4.52	4.15	4.32
Leveling (no)	1.30	1.40	1.35	1.78	1.78	1.78
Human labour (man-day)	50.24	49.15	49.67	72.11	71.76	71.93
Mechanical labour (hr)	44.43	44.85	44.61	69.14	68.30	68.75
Herbicide (litre)	3.16	3.08	3.12	4.20	4.14	4.18
Seed (kg)	116.46	117.38	116.91	111.57	117.57	114.56
FYM (tonnes)	8.15	8.27	8.21	9.39	9.39	9.39
Plant nutrient (kg)	213.40	204.25	208.82	285.89	280.16	282.99
Grain yield (kg)	4949.74	4872.99	4905.11	4628.35	4616.00	4623.41

Table 2 Cost and returns of wheat cultivation on sample farms

(₹/ha)

Particulars	Adopter			Non-adopter		
	Punjab	Haryana	Overall	Punjab	Haryana	Overall
Variable cost						
Human labour	5 145	5 165	5 155	6 221	6 268	6 243
Machine labour	3 736	3 855	3 796	4 733	4 738	4 736
Irrigation	1 228	1 226	1 228	1 231	1 223	1 226
Seed	1 423	1 416	1 421	1 443	1 443	1 443
FYM	877	813	845	875	885	880
Fertilizer	3 561	3 084	3 321	3 542	3 634	3 589
Plant protection	2 348	2 357	2 352	2 455	2 460	2 457
Interest on working capital	1 100	1 075	1 087	1 231	1 238	1 236
Fixed cost						
Rental value of land	3 813	3 736	3 773	3 805	3 771	3 788
Interest on fixed assets	3 336	3 161	3 247	3 301	2 637	2 970
Depreciation on fixed assets	2 780	2 634	2 706	2 642	2 110	2 375
Total cost	29 347	28 521	28 932	31 479	30 375	30 943
	(21 32*)	(1 854*)	(2 011*)			
Yield (kg/ha)	4 950	4 873	4 913	4 628	4 616	4 621
Gross returns	37 054	3 6545	36 792	34 336	33 935	34 136
	(2 718*)	(2 610*)	(2 656*)			
Net returns	7 707	8 024	7 861	2 857	3 561	3 193
	(4 850*)	(4 463*)	(4 670*)			

*Indicates significance at 1% probability level and based on t-test
Figures in the parentheses represent mean difference

wheat forced the farmers to apply little higher seed rate.

Adopters of zero tillage applied 208.82 kg/ha plant nutrients (NPK) as against the non-adopter's 282.99 kg/ha. Higher plant nutrients applied by the conventional farmers may be due to poor placement of fertilizer. Besides this, the zero tillage farmers (adopters) applied more diammonium phosphate to promote the tilling as against the non-adopters, who preferred urea. Since, urea costs less than the diammonium phosphate, the non-adopters, who were also resource poor resorted to apply it in a large quantity. On the other hand, the adopter farmers applied diammonium phosphate, which had lesser N content but more $P_2O_{5,}$ which helped in healthy crop growth. Farmyard manure application was entirely governed by the conventional practices in the region.

From the perusal of Table 2, it is evident that net return for the TGP region was ₹ 7 861/ha for adopters as against ₹ 3 193/ha for non-adopters. The higher net return for adopter farms was due to cost reduction (mainly variable cost) as well as higher gross return, which accrued on account of

higher productivity. Irrigation has no bearing on cost reduction as the electric pumps operate at flat rate in both the states.

Adopter farms received higher gross returns (₹36 792/ha) in comparison to the conventional farms (₹ 34 136/ha). The adopter's wheat yield was higher by 292 kg/ha. Yadav *et al.*, (2002) estimated around 200 kg/ha higher yield with zero tillage than that of conventional tillage. Singh and Kharub (2001) reported higher yield of zero tillage wheat in varying proportion in different wheat growing regions of the country. Many farmers opined that higher yield is due to timely sowing of wheat through zero tillage as well as due to less crop lodging. In recent years there has been a high-speed storm during the harvesting season of wheat in the Trans-Gangetic Plain of India, which caused huge crop lodging problem. The cost of wheat cultivation on adopter farm was ₹28 932/ha as against ₹30 943/ha on non-adopter farms, hence a saving of ₹2 011/ha. This finding is similar to that of Singh *et al.* (2002) who reported saving of ₹1 350/ha due to adoption of zero tillage in Sone command in Bihar. The higher saving in cost of cultivation might have been influenced by temporal and spatial differences. The overall observation found the net return for adopter at ₹7 861/ha as against ₹3 193/ha for the non-adopter farm, which is almost double. Hence, zero tillage in wheat cultivation was also showing the considerable amount of profit, besides promoting the conservation of the precious resources. Since, the economic return was not too much, which can alone drive the technology adoption.

Zero tillage wheat requires lesser amount of critical inputs, which constitutes more than 40% of the total cost. Therefore cutting on these items has significant bearings for the farmers whose net earnings are shrinking day by day. Although, there are some apprehensions among a section of researchers that continuous use of zero tillage may lead to soil compaction and thereby cause damage to soil fertility in the long run. However, this has not been widely established. For further spread of the technology, it is warranted that the Government should undertake proactive initiatives to provide the implement on hiring basis or form self-help groups which can manage these at village or panchayat level, so that the small and marginal farmers could also get benefit of improved cultivation practices.

SUMMARY

A study on the zero tillage in Trans-Gangetic Plain of India (Punjab and Haryana) was undertaken during 2005–06 based on the farm level primary data. There was a net gain in zero tillage of ₹ 4670/ha compared to conventional tillage. This gain is caused by a reduction in cost of cultivation by ₹ 2 011/ha and an increase in yield by 281 kg/ha. The zero tillage saves 30.95% of human labour and 35.11% of mechanical labour, besides saving 4.15% time for ploughing, 4.32% time for harrowing, 0.43% time for leveling, about 74 kg plant nutrient (NPK) and 0.58% irrigation. However, for further spread of the zero tillage, people's participation is needed.

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