*Journal of Soil Salinity and Water Quality 4(1), 34-38, 2012*

# Economics of zero tillage and conventional methods of rice and wheat production in Haryana

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**ABSTRACT**

Adoption of zero tillage technology by farmers in India has occurred mainly in the rice-wheat crop production system. It was adopted primarily for the wheat crop. The spread of technology was rapid in the north-western states which are relatively better endowed with respect to irrigation, mechanization and relatively large size of land holdings. In India, widespread adoption of zero tillage method of cultivation was started in Haryana state. It is emerged as a way to achieve enhanced productivity and profitability while protecting natural resources and environment. In this study, an attempt has been made to analyze the comparative economics of zero tillage and conventional methods of rice and wheat cultivation in Haryana state. The study revealed that the net return was higher in zero tillage mainly due to reduction in operational cost by 14% than conventional method of rice cultivation. In case of wheat, both yield and net returns were significantly higher in zero tillage by 5.54% and 24.72%, respectively. The respective saving of human labour, machine labour and irrigation were 12.95%, 41.75% and 17.60% in rice production by zero tillage method. Similarly, use of human labour, machine labour and irrigation were saved by 13.93%, 45.88% and 15.98%, respectively in zero tillage than conventional method of wheat production. Zero tillage technology enabled farmers to increase returns and save crucial inputs cost. Hence, this technology promises to be an important alternative for generating higher farm income and saving of scarce resources in resource starved regions.

***Key words:*** conventional tillage, resource conservation, rice and wheat production, zero tillage

## Introduction

Zero tillage technology was adopted primarily for wheat crop mainly in rice-wheat crop production system in India. The spread of zero tillage technology was rapid in the north-western states which are relatively better endowed with respect to irrigation, mechanization and relatively large size of land holdings. The cost saving is the main driver behind its spread (Erenstein, 2009). This technology is emerged as a way to achieve enhanced productivity and profitability while protecting natural resources and environment in the Indo-Gangetic Plains of India. Rice-wheat is the major cropping system in this region. Major rice-wheat growing states in Indo-Gangetic Plains are Punjab, Haryana, Uttar Pradesh, Himachal Pradesh, Bihar, and West Bengal.

In India, widespread adoption of zero tillage method of cultivation was started in Haryana state. Resource conserving technologies such as zero tillage, surface seeding and raised bed in both rice and wheat have been found beneficial in terms of reducing cultivation cost and energy consumption and improving farmers income (Gupta and Seth, 2007). Savings in input cost, fuel consumption and irrigation water use have been reported due to zero tillage in wheat (Malik *et al.,* 2002, 2003, Bhushan *et al.,* 2007). Moreover, farmers in Haryana started zero tillage a decade back particularly in wheat and recently in rice due to rising fuel prices and labour shortage as inputs cost saving alternative to sustain the crop production. Zero tillage technology versus conventional methods of rice cultivation has not been evaluated widely in farmer's field. Hence, the present study was undertaken with the objective to compare the economics of zero tillage and conventional methods of rice and wheat cultivation in rice-wheat crop production system.

## Material and methods

In an attempt to reduce the production costs and increase the total factor productivity, both state and central governments have taken several initiatives to popularize zero tillage technology. The Haryana state was selected purposively for this study as farmers are rapidly adopting zero tillage technology in rice and wheat cultivation. Karnal district was selected purposively due to widespread adoption of zero tillage method of cultivation. The mean annual rainfall of the area varies from 650 to 950 mm, about 80% of which is received during June to September. The soils are generally sandy loam to clay loam in texture and low to medium in organic matter content.

Groundwater and canal irrigation are main source of irrigation. The average temperature ranges from a minimum of 2.8°C in January to 45°C in May.

From Karnal district, three villages were selected for the study. The primary data were collected from 20 farmers who adopted zero tillage technology in rice. The equal numbers of farmers were selected for collection of primary data regarding conventional tillage of rice cultivation. Similar procedure was adopted for wheat production. Hence, primary data were collected during 2010-2011 from 80 farmers with the help of pre-tested interview schedule by survey method. Data were analyzed using partial budget technique, input-output ratio and percentage analysis.

The cost of cultivation was calculated by taking into account the cost of seed, fertilizers, pesticides, hiring charges of human labour and machine labour for land preparation, irrigation, fertilizer application, spraying of plant protection chemicals, harvesting, threshing, bagging and transportation to nearest market. Over-head costs include depreciation charges on equipments and interest on working capital. The cost of irrigation was calculated by multiplying the time required to irrigate the farm with cost of electricity or per hour diesel consumption. Electricity rates were as per state electricity boards. The cost human labour, machine labour and diesel cost were taken as actual expenditure incurred by farmers. Gross income was the total money received by farmers on the sale of crop output after deducting the transportation cost. Net income was calculated as the difference between gross income and total cost.

## Results and discussion

### *Socio-economic features*

Farmers in the study area grow crops and maintain livestock on their farms. The rice is grown during *kharif* season. In *rabi* season, wheat, mustard, vegetables and berseem are grown. The crop and livestock enterprises contribute 82% and 5%, respectively, to the total household income. Many farmers supplement their household income by engaging themselves or their family members in off farm activities. The average age of respondent farmers was in the range of 34-41 years, indicating that they were relatively young age group. Farmers have 10-15 years of farm experience in farming. The size of land holdings was in the range of 2-10 hectares, indicating medium to large land holdings. Maximum farmers are literate and average family size is 7 family members per household.

### *Cost and return estimation of rice production*

The profitability of both the methods of rice cultivation in the study area was analyzed by computing per hectare cost and returns. Cost and returns of zero tillage and conventional methods of rice production is presented in Table 1. The average operational cost per hectare was accounted to Rs. 30,876 in zero tillage method and Rs. 35,905 in conventional tillage method. The lower operational cost in zero tillage was due to lower expenses incurred mainly on human and machine labour, and irrigation than in conventional tillage method. Gross return per hectare was almost same in both the method of cultivation. However, net return accounted to Rs. 61,366 in zero tillage and Rs. 55,164 in conventional tillage. The net income was higher in zero tillage due to lower operational cost being Rs. 30,876 per hectare as compared to Rs. 35,905 in conventional tillage. The higher input-output ratio of 2.99 was observed in zero tillage as against 2.54 in conventional tillage.

### *Input use in rice production*

The benefits in zero tillage method were mainly due to lower expenses on human labour, machine labour and irrigation which gave enough incentives to the farmers to adopt zero tillage even if output is marginally lower than conventional tillage method. As shown in Table 2, on an average farmers saved 12.95%, 41.75%, 4.64%, 10.99%

**Table 1.** Cost and return of rice production

| Particulars | Conventional Tillage (Rs/ha) | Zero Tillage (Rs/ha) | % change |
|---|---|---|---|
| Human labour | 12781 | 11955 | -6.91 |
| Machine labour | 7632 | 4446 | -71.66 |
| Seeds | 552 | 1169 | 52.78 |
| Fertilizer | 3507 | 3645 | 3.79 |
| Plant protection chemicals | 4863 | 4636 | -4.90 |
| Irrigation | 3458 | 2648 | -30.59 |
| Overhead Cost | 3112 | 2377 | -30.92 |
| Total Operation Cost | 35905 | 30876 | -16.29 |
| Gross Income | 91069 | 92242 | 1.27 |
| Net Income | 55164 | 61366 | 10.11 |
| Input-Output Ratio | 2.54 | 2.99 | - |

**Table 2.** Input use in rice production

| Particulars | Conventional Tillage | Zero Tillage | % change |
|---|---|---|---|
| Human labour (man days/ha) | 65.83 | 57.30 | -12.95 |
| Machine labour (h/ha) | 12.72 | 07.41 | -41.75 |
| Seeds (kg/ha) | 12.60 | 23.84 | 89.22 |
| Fertilizer (kg/ha) | 398.91 | 380.38 | -04.64 |
| Plant protection chemicals (g/ha) | 2741.70 | 2440.36 | -10.99 |
| Irrigation (h/ha) | 61.75 | 50.88 | -17.60 |

**Table 3.** Comparison of cost and return in conventional and zero tillage methods of rice production

| Particulars | Conventional tillage (Rs/ha) | Zero tillage (Rs/ha) | % change |
|---|---|---|---|
| Yield (qtl/ha) | 55.70 | 55.08 | -1.11 |
| Operation Cost | 35905 | 30876 | -14.01 |
| Gross Income | 91069 | 92242 | 1.29 |
| Net Income | 55164 | 61366 | 11.24 |

and 17.60% cost per hectare on human labour, machine labour, fertilizer, plant protection chemicals and irrigation, respectively, in zero tillage than in conventional tillage of rice cultivation.

***Comparative economics of rice production***

The rice yield with zero tillage was slightly lower than conventional tillage. All farmers opined that weed management is a challenging task in zero tillage. A study conducted at CSSRI research farm revealed that lower yield was obtained in zero tillage as compared to the conventional tillage due to high weed manifestation (Singh et al., 2010). Therefore, the major challenge for farmers in direct seeded rice is effective weed management. Failure in weed control would result to very low yield (Moody and Mukhopadhyay, 1982; Moody, 1983). Many studies have indicated that the potential for direct seeded rice as a replacement of transplanted rice, if weeds are controlled effectively (Singh *et al.,* 2001; Singh, 2005). The gross return (Table 3) was higher in conventional tillage by 1.29%. But higher net return was obtained in zero tillage by 11.24% than conventional tillage. This was mainly due to reduction in the operational cost by 14.01% in zero tillage.

***Cost and return estimation of wheat production***

Cost and return estimation of zero tillage and conventional methods of cultivation of wheat are presented in Table 4. Gross return in zero tillage and conventional tillage were Rs. 68,504 and Rs. 65,036 per hectare, respectively. Similarly, net return accounted to Rs. 41,695 in zero tillage and Rs. 33,431 per hectare in conventional tillage. The net income was higher in zero tillage due to lower expenses incurred on operational cost. The average total operational cost per hectare amounted to Rs. 26,809 in zero tillage method and Rs. 31,605 in conventional tillage method of cultivation. The lower operational cost was due to lower expenses incurred on human labour, machine and irrigation in zero tillage than conventional tillage method. The higher input-output ratio of 2.56 was observed in zero tillage and it was 2.06 in conventional tillage.

***Input use in wheat production***

Evidence from the field investigation suggests that zero tillage is economically attractive due to higher wheat yield and lower expenses on human labour, machine labour and irrigation. As shown in Table 5, on an average, farmers saved 13.93%, 45.88%, 6.13%, and 15.98% cost on human labour, machine labour, fertilizer, and irrigation, respectively in zero tillage than conventional tillage of wheat cultivation.

***Comparative economics of wheat production***

Wheat yield in zero tillage was higher than conventional tillage by 5.54% (Table 6). Findings showed that among the integrated resource management technologies, zero tillage for wheat production was most successful in terms of good crop establishment and increased yield (Ladha *et al.,* 2009). The gross and net returns in zero tillage were higher by 5.33% and 24.72%, respectively. The higher net return was obtained in zero tillage mainly due to reduction in the operational cost by 15.17%. Similar results were also reported by Erenstein (2007) in his study on zero tillage.

***Farmer's perception about zero tillage***

Farmers who have adopted zero tillage in wheat are very much interested to continue this method of cultivation in future. According to farmer's opinion regarding zero tillage technology, germination is good and

**Table 4.** Cost and return estimation of wheat production

| Particulars | Conventional tillage(Rs/ha) | Zero tillage(Rs/ha) | % change |
|---|---|---|---|
| Human labour | 12181 | 10589 | -15.03 |
| Machine labour | 6299 | 3409 | -84.78 |
| Seeds | 2149 | 2384 | 9.86 |
| Fertilizer | 3389 | 3417 | 0.82 |
| Plant protection chemicals | 3520 | 3705 | 4.99 |
| Irrigation | 1388 | 1307 | -6.20 |
| Overhead Cost | 2680 | 2000 | -34.00 |
| Total Operation Cost | 31605 | 26809 | -17.89 |
| Gross Income | 65036 | 68504 | 5.06 |
| Net Income | 33431 | 41695 | 19.82 |
| Input-Output Ratio | 2.06 | 2.56 | - |

**Table 5.** Input use in wheat production

| Particulars | Conventional tillage | Zero tillage | % change |
|---|---|---|---|
| Human labour (man days/ha) | 59.40 | 51.13 | -13.93 |
| Machine labour (hrs/ha) | 10.50 | 05.68 | -45.88 |
| Seeds (kg/ha) | 107.45 | 119.18 | 10.92 |
| Fertilizer (kg/ha) | 382.85 | 359.39 | -06.13 |
| Plant protection chemicals (gm/ha) | 2198.30 | 2383.55 | 08.43 |
| Irrigation (hrs/ha) | 30.13 | 25.32 | -15.98 |

**Table 6.** Comparative economics of conventional and zero tillage methods of wheat production

| Particulars | Conventional tillage(Rs./ha) | Zero tillage(Rs./ha) | % change |
|---|---|---|---|
| Yield (qt./ha) | 53.48 | 56.44 | 05.54 |
| Operation Cost | 31605 | 26809 | -15.17 |
| Gross Income | 65036 | 68504 | 05.33 |
| Net Income | 33431 | 41695 | 24.72 |

yield is higher than conventional tillage in wheat. Sowing of crop could be done 10-15 days earlier than conventional tillage. It saves time and diesel cost during field preparation. They also opined that due to high demand and comparatively less availability of zero-till-drill in the village, many farmers remain deprived of wheat sowing by this technique.

Farmers adopted zero tillage in rice due to high labour requirement for cultivation through conventional tillage method. During transplanting and weeding farmers faced the dearth of labour availability. The conventional tillage method was a labour intensive method of rice cultivation. Although they get slightly lower yield compared to zero tillage, farmers in the study area are interested in shifting from conventional method of transplanting rice to direct seeded rice due to rising fuel prices and shortage of labour and availability of irrigation water. About 90 percent farmers expressed the view that high weed infestation with zero tillage in rice is a major limitation to adopt this technology as risk of yield loss is high. The other constraints expressed by the farmers were lesser availability and high cost of seed drill.

## Conclusions

Conventional tillage method of crop establishment in rice and wheat requires a large amount of inputs. In the present scenario of rising inputs cost and labour shortage in agriculture, farmers need input saving alternative technologies to sustain crop production. The results of the present study have shown that zero tillage technology has potential to increase farmer's income and save inputs cost in both rice and wheat crops. The study revealed that the net return was higher in zero tillage mainly due to reduction in operational cost by 14.01% than conventional method of rice cultivation. In case of wheat, both yield and net returns were significantly higher in zero tillage by 5.54% and 24.72%, respectively. The saving of human labour, machine labour and irrigation

were 12.95%, 41.75% and 17.60%, respectively in rice production by zero tillage method. Similarly, use of human labour, machine labour and irrigation were saved by 13.93%, 45.88% and 15.98%, respectively in zero tillage than conventional method of wheat production. Hence, zero tillage technology in rice and wheat production system promises to be an important alternative for higher farm income and saving of scarce resources in resource starved regions.

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Received: December 2011; Accepted: November 2012