International Journal of Agriculture Innovations and Research
Volume 5, Issue 6, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received: 15/05/2017 | Accepted on : 25/05/2017 | Published : 08/06/2017

A Comparison of Zero-tillage Technology and Traditional Techniques for Sowing of Wheat: Evidence from Farmers Field by Front line Demonstration

P. D. Verma[1], Parmanand[2*] and S. K. Tamrakar[3]
[1] Subject Matter Specialist – Farm Machinery and Power Engineering, KrishiVigyan Kendra, Bhatapara, Chhattisgarh.
[2]Ph.D.Scholar in Deptt. of Farm Machinery and Power Engineering, FAE, SVCAET, IGKV, Raipur, Chhattisgarh.
[3] Assistant Professor (Horticulture), DKSCARS Bhatapata, IGKV Raipur, Chhattisgarh.
*Corresponding author email id: erparmanandsahu@gmail.com

Abstract — **The study was conducted in the district Balodabazar-Bhatapara of Chhattisgarh state under Project National initiative on climate resilience agriculture (NICRA) by KrishiVigyan Kendra, Bhatapara through coordinating institution ICAR-CRIDA Hyderabad. The trial of four year was carried out during Rabi 2012-13, 2013-14, 2014-15, and 2015-16 on forty farmer's field of NICRA Project adopted village Bakulahi of Bhatapara block of the district with size of trial is one acre. To evaluate the potential of conservation agriculture to improve soil water balance and agricultural productivity, the In-situ moisture conservation technique of Natural Resource Conservation module under NICRA project was demonstrated and calibrated using the data of a field experiment in NICRA Adopted village Bakulahi, Climatic vulnerability of the village is Draught. The average annual precipitation at the site is 863 mm, 73% of which falls during the growing season. The data collected from the field were analyzed and the result of the study in respect of percentage increase in yield in recommended practice increased 10.62% over farmers practice. The average yield in zero-tillage method was recorded 24.42 q ha^{-1} over conventional sowing it is 22.08q ha^{-1}. The B:C ratio was observed higher side in zero-tillage method is 2.56 as compared to conventional method sowing of wheat is 2.03. The additional wheat production from zero-tillage technology gives about Rs. 6732/- per ha additional income. The finding have clearly established that wheat sowing can be advanced at least 10-15 days over conventional tillage system, enabling to harvest an advantage that cannot be obtained by using recommended varieties for late sown condition.**

Keywords — **Zero Tillage, Resource Conservation Technology, NICRA, Climate Resilience Technology**

I. Introduction

The district Balodabazar-Bhatapara is located at central part of Chhattisgarh under Chhattisgarh plain agro-climatic zone. The annual rainfall of the district is 1100 mm but the study area Bhatapara block of the district in NICRA project Adopted village Bakulahi, Climatic vulnerability of the village is Draught. The average annual precipitation at the site is 863 mm, 73% of which falls during the growing season. The cropping intensity of the district is 130.91% with paddy grown in kharif season and wheat, gram, lathyrus in the Rabi season. However Mono cropping of paddy is the dominating system. Among the double cropping systems-lathyrus is important in the plains under rain fed conditions. The cultivable area of the district under upland is near about 24.22%, 50.83% is on midland and 24.94% under lowland. Swarna and Mahamaya are two very popular varieties of paddy in the district. Both varieties have 135-145 days duration. In the rainfed system, double cropping is limited because of a lack of residual moisture for the establishment of a second crop after medium to late variety of paddy [18].

On-station and on-farm trials with ZT wheat in the rice-wheat systems of the IGP have shown primarily positive impacts on wheat crop management, particularly through reduced input needs combined with potential yield increases [3]; [6]; [8]; [11]. Effects on land preparation and crop establishment that CT practices for wheat are very intensive in India's rice-wheat systems. Due to the adoption of ZT technology, the number of field operations for wheat crop establishment (including tillage) decrease from an average of seven to only one [8]; [9]. Effects on soils, weeds, pests and diseases in ZT typically improves soil quality in various dimensions, including soil structure, soil fertility and soil biological properties. Rice-wheat systems typically have low soil organic carbon [1]. ZT soils reportedly have higher organic carbon contents than CT soils, but also a lower pH (due to nitrification; [8] [9]). ZT typically reduces the incidence of weeds in the wheat crop [7]; [8]; [9]; [10]. In fact, ZT reduced the nematodes population and enhanced both the earthworm population and predator diversity and density in wheat [8]; [9].

The generally positive yield effects of ZT on wheat are mostly due to: (i) timely sowing; and (ii) increased input-use efficiency and weed control [12]. Terminal heat implies that wheat yield potential reduces by 1-1.5% per day if planting occurs after 20 November [3]; [13]; [15]. Approximately 30% of wheat cultivation is under late sowing in the Indian IGP, and ZT allows for timelier establishment. In direct sowing no planking is done and therefore most of the because of seeds remains exposed in the furrows and because of this energy required for metabolic activities of monocot seeds is less. This leads to early formation of seminal roots in 12-15 DAS. The formation of seminal roots in 12-15 conventional conditions is usually 15 DAS and become dysfunctional 30 DAS and crown root initiation stage is at 21-25 DAS. Therefore seminal roots which enhance crop growth formed 10-12 days before and are functional along with crown roots for another 5-10 days [17]. Early growth promotes higher yield in late sown condition also. Two factors contribute to the overall profitability of ZT that the value of the yield increase and the production cost savings, particularly savings in land preparation and crop establishment. Savings in irrigation pumping and inputs may add to this.

Socio-economic and system impacts both large and small landholders adopt ZT [5]; [10]. For now though, the technology has spread far more significantly and thereby primarily benefited the better endowed areas. In much the same way, the early adopters of ZT tend to be better endowed (e.g. larger landholdings, better educated; [14]). Using a conversion factor of 2.6 kg CO_2 emission per liter of diesel [12] and a relatively conservative estimate of 35 liters of diesel saved per hectare, we estimate ZT annually saving 91 kg of CO_2 emission per hectare. [2] have highlighted that ZT with residue retention and 50% of the recommended application of nitrogen / phosphorus / potassium fertilizer could effectively half the total carbon-equivalent emissions to 14 t CO_2 ha^{-1} per year compared with a high-input CT cropping system with residue burning and organic amendments, due to improved nutrient use and environmental efficiency.

II. Material and Methods

The trial was carried out during Rabi 2012-13, 2013-14, 2014-15, and 2015-16 on forty farmer's field of NICRA Project adopted village Bakulahi of Bhatapara block of the district with size of trial is one acre. The machine Zero till seed cum fertilizer drill was provided by Faculty of Agricultural Engineering, IGKV, Raipur (In rabi 2012-13) and CIAE Bhopal (In Rabi 2013-14 to 2015-16), under central sector scheme of farm mechanization. The farmers were selected on the basis of their past experience. Before trial training were conducted to farmers about use of Zero till seed cum fertilizer drill machine by the KVK scientists. Yield effects, cost savings and profitability, socio-economic and system impacts, climate resilience environmental impacts and energy use pattern i.e. Energy use efficiency (energy ratio), energy productivity, specific energy [17], and net energy were calculated, as they are shown in Equations 1–4 [16] were study on above trial.

$$\text{Energy efficiency} = \frac{\text{Total energy output (MJ/ha)}}{\text{Total energy intput (MJ/ha)}} \quad \ldots(1)$$

$$\text{Energy productivity} = \frac{\text{Grain yield (kg/ha)}}{\text{Total energy intput (MJ/ha)}} \quad \ldots(2)$$

$$\text{Specific energy} = \frac{\text{Total energy intput (MJ/ha)}}{\text{Grain yield (kg/ha)}} \quad \ldots(3)$$

$$\text{Net energy} = \text{Energy output (MJ/ha)} - \text{Energy input(MJ/ha)} \quad \ldots(4)$$

Keeping in the view need, under rainfed farming to increase area under double cropping in the district therefore Krishi Vigyan Kendra Bhatapara has taken following technologies i.e. Promotion of short duration varieties of Paddy, Direct seeded line sowing of paddy and Use of Zero Till Seed cum Fertilizer Drill (ZTSD) for Sowing of Wheat, intervention by front line demonstration.

III. Result and Discussion

The zero-tillage technology is not remunerative but also eco-friendly. It envisages 100 per cent saving in land preparation as wheat sowing is done just after harvesting of preceding rice crop without any ploughing. Thus in zero tillage the soil is left undisturbed from harvest of rice to sowing of wheat. The data collected from the field were analyzed and the results of the study in respect of (i) Percentage increase in yield and (ii) Benefit Cost ratio are summarized below:

(i) Percentage increase in yield: the yield in recommended practice increased 10.62% over farmers practice. The average yield in Zero till seed cum fertilizer drill method was recorded 24.42 q ha^{-1} over conventional sowing it is 22.08 q ha^{-1}. The difference of yield in ZTSD and conventional sowing is justified in table 1.

(ii) Benefit Cost ratio: B:C ratio were also worked out for both farmers practice and demonstration plots from sowing to harvesting as given in table. The B:C ratio as observed from table has been more in ZTSD field as compare to conventional method of sowing of wheat. It is because of reduction in primary tillage operation in ZTSD method as well as due to higher production.

Table 1: Analysis of Zero tillage and conventional method (average data of four years)

Treatment	Yield	% change in Yield	Parameter*	% change in Parameter	Cost of cultivation	Gross Cost	Net return	B:C Ratio
	(q /ha)		(No. of Panicle/m²)		(Rs./ha)	(Rs./ha)	(Rs./ha)	
T_1	22.08	10.62	243	8.65	15222	30685	15463	2.03
T_2	24.42		264		13298	33918	22195	2.56

T_1: Farmers practice (Conventional system-After harvesting of paddy tillage operation and sowing)

T_2: Recommended practice (Zero tillage system-After harvesting of paddy direct sowing of wheat by ZTSD)

Table 2: Analysis of sowing parameters, time and energy use pattern in wheat production for Zero tillage and conventional method

Parameters	Zero tillage system	Conventional tillage system
Sowing parameters		
a. Bulk density (g/cm^3)	1.63	1.52
b. Moisture content (%)	16.80	15.20
Time required		
a. Preparatory tillage (h/ha)	Nil	7.25
b. Sowing (h/ha)	2.15	2.05
Diesel consumption(l/ha), Tillage+Sowing	6.50	28.20
Energy use pattern		
a. Total direct energy used (MJ/ha)	366.02	1587.94
a. Total energy input (MJ/ ha)	10131.21	11734.31
b. Total energy output (MJ/ha)	133869.15	137077.45
c. Net energy (MJ/ha)	123737.94	125343.14
d. Energy ratio	13.21	11.68
e. Specific energy (MJ/ha)	4.19	5.31
g. Energy productivity (kg/MJ)	0.24	0.19

Data regarding time requirement under different tillage and seeding systems as well as direct seeding of wheat by zero-till fertilizer seed-drill are given in Table 2. The time requirement (h ha^{-1}) for seed bed preparation and seeding of wheat crop 9.30 and 2.15 under conventional and zero tillage systems, respectively. This clearly indicates that time saving under zero tillage was 76.88 percent over conventional system (Table 2). The fuel consumption for seedbed preparation and seeding of wheat crop under conventional system was 28.20 whereas it was 6.50 l ha^{-1} for zero till fertilizer seed drill system the percentage saving of fuel under zero till fertilizer seed drill system was 76.95 percent compared to conventional system. This showed that zero tillage system of wheat sowing may be considered as fuel efficient compared to conventional system.

Fig.1:FLD visit by AICRP Wheat, Scientist

Fig.2:FLD (Zero-tillage Wheat) at NICRA village Bakulahi

The total direct energy used for tillage + seeding in both the zero tillage and conventional system were 366.02 and 1587.94 MJ h-1, respectively. The conventional system of seeding (tillage + seeding) required 4.34 times more energy compared to zero till fertilizer seed drill system for sowing of wheat. However on the basis of total energy input for wheat cultivation under conventional method was 1.16 times more compared to improved method of seeding (zero till fertilizer seed drill). Economic analysis shows that zero tillage system resulted higher net benefit compared to conventional system and it is very well reflected through higher benefit cost ratio (2.56) as compared to conventional system. Comparing the energy parameters it was in zero tillage received higher energy ratio (13.21) and lower specific energy (4.19) compared to conventional system. Combining the factors like higher energy ratio, lower specific energy and higher benefit cost ratio, it may be said that the cultivation of wheat under zero till fertilizer seed drill was found better compared to conventional sowing and results proven that, zero tillage is the Climate Resilience Based Natural Resource Conservation Technology for Wheat in the Rice-Wheat Cropping Pattern.

IV. Conclusion

The zero till fertilizer seed drill was found energy efficient and cost efficient compared to conventional sowing of wheat on the basis of energy ratio, specific energy and benefit cost ratio. As timely sowing of wheat is a major problem in Rice-Wheat cropping pattern. The use of zero tillage technology besides being economical, time saving, energy efficient, manages weeds, soil along with its moisture and advances sowing time. Adoption of zero tillage technology enabled farmers to plant wheat about 10-15 days earlier conventional practice. Early planting resulted in 11% additional grain yield over conventional practice. The average yield in zero-tillage method was recorded 24.42 q ha^{-1} over conventional sowing it is 22.08q ha^{-1}. The B:C ratio was observed higher side in zero-tillage method is 2.56 as compared to conventional method sowing of wheat is 2.03. The additional wheat production from Zero tillage technology gives about Rs. 6732/- per hectare additional income. Short duration varieties of paddy with line sowing and use of zero seed cum fertilizer seed drill in seeding of Rabi crops; increase the prospect of double cropping under rainfed condition. The farmers were convinced of the above interventions.

Acknowledgment

Authors are thankful to Dr. A.K. Dave and Dr. Ajay Verma, Professor, Department of Farm Machinery and Power, Faculty of Agricultural Engineering, SVCAET&RS, Indira Gandhi Agricultural University, Raipur, Chhattisgarh for their encouragement.

References

[1] Duxbury, J.M., Abrol, I.P., Gupta, R.K. and Bronson, K.F. 2000. Analysis of long-term fertility experiments with rice-wheat rotations in South Asia. In:Abrol, I.P. et al. (eds) Long-term Soil Fertility Experiments in Rice-Wheat Cropping Systems. *RWC Paper Series 6.* Rice-Wheat Consortium of the Indo-Gangetic Plains, New Dehli, 7-22.

[2] Grace, P.R., Jain, M.C., Harrington, L. and Robertson, G.P. (2003). The long-term sustain-ability of the tropical and subtropical rice-wheat system: an environmental perspective. In: Ladha, J.K. et al. (eds) Improving the Productivity and Sustainability of Rice-Wheat Systems: Issues and Impacts. ASA Special Publication No. 65. *American Society of Agronomy-Crop Science Society of America-Soil Science Society of America, Madison, Wisconsin, 27-45.*

[3] Hobbs, P.R., and R.K. Gupta.. 2003a. Resource-conserving technologies for wheat in the rice- wheat system. In: J.K. Ladha, J.E. Hill, J.M. Duxbury, R.K. Gupta, and R.J. Buresh (eds.), Improving the Productivity and Sustainability of Rice-Wheat Systems: *Issues and Impacts. ASA Special Publication Number 65. Madison, Wisconsin: ASA-CSSA-SSSA. 149-172.*

[4] Khan M.A. and Singh G., 1996. Energy inputs and crop production in Western Pakistan. Energy, 21: 45–53.

[5] Laxmi, V., Gupta, R.K., Swarnalatha and Perwaz, S. (2003) Environmental impact of improved technology- farm level survey and farmers' perception on zero tillage (case study). Paper presented at Roles of Agriculture Workshop, Rome, 20-22 October. *Indira Gandhi Institute of Development Research, Mumbai, India. Also available at http://www.fao.org/es/ESA/Roa/ROA-e/case_studies-e.htm#India (accessed ?).*

[6] Laxmi, V., O. Erenstein and R.K. Gupta. 2007. Impact of zero-tillage in India's rice-wheat systems. *New Delhi: CIMMYT and the Rice-Wheat Consortium for the Indo- Gangetic Plains*

[7] Malik, R.K., Gill, G. and Hobbs, P.R. (eds) (1998) Herbicide Resistance-A Major Issue for Sustaining Wheat Productivity in Rice-Wheat Cropping Systems in the Indo-Gangetic Plains. *RWC Paper Series 3. Rice—Wheat Consortium of the Indo-Gangetic Plains, New Delhi.*

[8] Malik, R.K., R.S. Balyan, A. Yadav, and S.K. Pahwa (eds.). 2002a. Herbicide Resistance Management and Zero-Tillage in Rice-Wheat Cropping System. *Proceedings of International workshop, Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), 4-6 March, 2002. Hisar, India: CCSHAU.*

[9] Malik, R.K., Mehla, R.S. and Singh, B.K. (2002b) Conservation tillage technologies and farmersparticipatory research, extension approaches in Haryana- a case study. In: *RWC (ed.) Proceedings of the International Workshop on Developing an Action Program for Farm-level Impact in Rice-Wheat System of the Indo-Gangetic Plains, New Delhi, 25-27 September, 2000. RWC Paper Series 14. Rice-Wheat Consortium of the Indo-Gangetic Plains, New Delhi, 31-45.*

[10] Malik, R.K., Gupta, R.K., Singh, C.M., Brar, S.S., Singh, S.S., Sinha, R.K., Singh, A.K., Singh, R., Naresh, R.K., Singh, K.P. and Thakur, T.C. (2004) Accelerating the Adoption Resource Conservation Technologies for Farm Level Impact on Sustainability of Rice-Wheat System of the Indo-Gangetic Plains. *NATP Progress Report. Chaudhary Charan Singh Haryana Agricultural University, Hisar, India.*

[11] Malik, R.K., R.K. Gupta, C.M. Singh, A. Yadav, S.S. Brar, T.C. Thakur, S.S. Singh, A.K. Singh, R. Singh, and R.K. Sinha. 2005a. Accelerating the Adoption of Resource Conservation Technologies in Rice Wheat System of the Indo-Gangetic Plains. *Proceedings of Project Workshop, Directorate of Extension Education, Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), June 1-2, 2005. Hisar, India: CCSHAU.*

[12] Mehla, R.S., Verma, J.K., Gupta, R.K. and Hobbs, P.R. (2000) Stagnation in Productivity of Wheat in the Indo-Gangetic Plains: Zero-till-seed-cum-fertilizer Drill as an Integrated Solution. *RWC Paper Series 8. Rice-Wheat Consortium of the Indo-Gangetic Plains, New Delhi.*

[13] Ortiz-Monasterio, J.I., Dhillon, S.S. and Fischer, R.A. (1994) Date of sowing effects on grain yield and yield components of irrigated spring wheat cultivars and relationships with radiation and temperature in Ludhiana, India. *Field Crops Research 37, 169-184.*

[14] Pandey, L.M., Pal, S. and Mruthyunjaya (2003) Impact of zero-tillage technology in the rice (Oryza sativa)—wheat (Triticumaestivum) system of foothills of Uttaranchal State, India. *Indian Journal of Agricultural Sciences 73: 432-437.*

[15] Randhaw, A.S., Dhillon, S.S. and Singh, D. (1981) Productivity of wheat varieties, as influenced by the time of sowing. *Journal of Research. Punjab Agricultural University, Ludhiana.*

[16] Singh S., Verma S.R. and Mittal J.P., 1997. Energy requirements for production of major crops in India. *Agricultural Mechanization in Asia, Africa, and Latin America, 28: 13–27.*

[17] Singh, GPM, Dhan, Dharambir, and Rai, ENO., 2009, A case study on: performance evaluation of zero tillage seed drill in Allahabad district. *Journal of Soil and Water Conservation, 8 (2), 39-43(2009).*

[18] Urkurkar, J.S., and Sharma M.L., 2007, "line-sown short-duration ricefollowed by chickpea for rainfed environments of Chhattisgarh, India. *Technologies ForImproving Rural Livelihood In Rainfed System In South Asia, Published by IRRI, 59-64.*

Authors' Profile

P.D. Verma
Graduation in B. Tech. Agriculture Engineering from IGKV Raipur in 2006. M. Tech. from IGKV Raipur in Farm Machinery and Power Engineering in 2010. Presently working as a Subject Matter Specialist, Agriculture Engineering in Krishi Vigyan Kendra, Bhatapara, Dist-Balodabazar- Bhatapara, Chhattisgarh.

Parmanand
Graduation in B. Tech. Agriculture Engineering from IGKV Raipur in 2012. M. Tech. from IGKV Raipur in Farm Machinery and Power Engineering in 2014. Former he has worked as a Senior Research Fellow under NICRA project in Krishi Vigyan Kendra, Bhatapara, Dist-Balodabazar- Bhatapara, Chhattisgarh. Presently Ph.D. Scholar in Department of Farm Machinery and Power Engineering, FAE, SVCAET, IGKV, Raipur, Chhattisgarh.

S.K. Tamrakar
Graduation in B.Sc. Horticulture and M.Sc. in Horticulture from IGKV Raipur. Former he has worked as a Programme Coordinator and PI, NICRA project in Krishi Vigyan Kendra, Bhata--para, Dist-Balodabazar-Bhatapara, Chhattisgarh. Presently working as a Assistant Professor (Horticulture), DKSCARS Bhatapara, IGKV Raipur, Chhattisgarh.