

Assessment of Zero-tillage for Wheat Planting in Black gram-Wheat Cropping Pattern on Climatic Change Situation of Bundelkhand Agro-climatic Zone

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Abstract

There is an urgent need to match food production with increasing world population through identification of sustainable land management strategies. However, the struggle to achieve food security should be carried out keeping in mind the soil where the crops are grown and the environment in which the living things survive. Conservation agriculture (CA), practicing agriculture in such a way so as to cause minimum damage to the environment is being advocated at a large scale world-wide. Conservation tillage, the most important aspect of CA, is thought to take care of the soil health, plant growth and the environment. This work done on zero-tillage to understand its impact from the perspectives of the soil, the crop and the Bundelkhand Agro-climatic Zone conditions. Processes of climate change mitigation and adaptation found zero tillage (ZT) to be the most environmental friendly among different tillage techniques. Therefore, conservation tillage involving ZT and minimum tillage which has potential to break the surface compact zone in soil with reduced soil disturbance offers to lead to a better soil environment and crop yield with minimal impact on the environment. A comparison between zero tilled and conventionally tilled in wheat indicated that cost of cultivation was Rs. 9335/ha in zero tillage less than check plot. While in check it was higher Rs. 19934/ha. The zero tillage saved entire Rs. 10599/ha as cost thus reducing the cost. Besides this, the average irrigation requirement in zero tillage was less 4.53 (unit) as against 5.11 (unit). It may be concluded that adoption of zero tillage saved the water in the Bundelkhand might be in practices. Adopter reported a saving of 30.2% human labour and 35.11% mechanical labour in zero tillage. Reducing the seed rate from 10-20 kg/ha in zero tillage was observed. More and thick strong tilling in zero tillage and less use of fertilizers which avoiding losses due to leaching, volatilizing and run off of fertilizers in conventional method. The grain yield in demonstration of zero-tillage was recorded an average of 2.94 tones/ha while in check plots the grain yield was higher and it was an average in 4.2 tones/ha. The straw yield was average 4.7 tones in zero-tillage and 6.8 tones/ha in conversational farmer practices. Total grass return was found in zero-tillage Rs.63945/ha and in conventional it was Rs.93090/ha. The higher net returns Rs.74656/ha in conventional tillage and less net return was obtain in zero-tillage Rs. 54610/ha. The results showed that grain yield and net return were higher in conventional method while the cost of cultivation was too higher in conventional tillage. But the average benefit cost ratio 5.8 was greater in zero-tillage than 4.0 conventional tillage practices of the local farmers. Hence, zero tillage in wheat cultivation was also showing the considerable amount of profit, besides promoting the conservation of the precious resources. Zero tillage wheat requires lesser amount of critical inputs, which constitutes more than 40% of the total cost. Zero tillage may lead to soil compaction and thereby cause damage to soil fertility in the long run. Government should undertake proactive initiatives to provide the implement on hiring basis or form self-help groups which could be manage these at village or Panchayat level, so that the small and marginal farmers could also get benefit of improved cultivation practices. Zero tillage reduces water requirement of crop and the loss of organic carbon by oxidation. Zero tillage reduces Phalaris minor problem in wheat. The carbon status of soil was significantly enhanced in surface soil.

Key words: Zero-tillage, cropping pattern, Natural resources Management

Introduction

Bundelkhand region is largely characterized by shallow red soils, undulating topography, extreme weather conditions, and recurrent droughts, making the agriculture in the region more difficult leading to low crop productivity, crop intensity, and higher soil loss through erosion and runoff. Low moisture holding capacity of soils in the region makes it difficult to cultivate crops on residual moisture during post rainy season. This region consists of six districts of Madhya Pradesh (Datia, Tikamgarh, Chhatarpur, Damoh, Sagar, and Panna) and seven districts of Uttar Pradesh (Jhansi, Jalaun, Lalitpur, Hamirpur, Mahoba, Banda, and Chitrakoot) of Central India which are jointly known as Bundelkhand region. The studies conducted at Tikamgarh district by KVK, Tikamgarh with convergence of CIMMYT pilot project during 2021-22. Thus, conservation agriculture practices aims at minimal soil disturbance, permanent soil cover, and crop diversification and helps in decreasing or reverting the negative effects of conventional farming. The conservation practices reduce the production cost, green house gas emission, soil erosion, and runoff losses and improve the soil health and crop productivity. The cropping system following in this region for major crops were soybean/black gram/sesame-wheat cropping pattern. The most of the *Kharif* crop area sown through broad casting method of sowing and some area of *Rabi* too seed broad casted as sowing method. Any zero-tillage practices have not been done in soybean/black gram/sesame-wheat at this district.

Zero-tillage has been one of the most used Resource Conserving Technologies employed for saving precious resources,

which given more economic production^[1]. Adoption of zero tillage resulted in high crop yield^[4], lower production cost and saving in water and energy^[5]. It not only promotes input-use efficiency but also strengthens natural resource base^[2] 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^[3]. Due to these reasons various organizations including international institutions were engaged in promoting this agricultural technology. The zero-tillage was 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^[2]. Timely sowing could 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.) and in wheat (*Triticum aestivum* L.) growing region of Haryana (Mehla *et al.*,2000). Besides, the pre-sowing irrigation was totally saved in zero-tillage^[4]. Most of the farmers reported that the duration of irrigation pump operation was less in zero-tillage as compared to the conventional tillage, which might be due to high percolation rate in the latter case on account of good tilth. Although, this parameter has not been covered in the studies, nevertheless, from the existing evidences, it may be concluded that adoption of zero tillage saved the water in the TGP of India^[3,1]. 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

Madhya Pradesh is one of the important states in India producing near about 10% of total wheat production in the country. It was adaptable to different soils, climates and elevation. After the green revolution the yield per hectare of wheat in India increased from 14.1 quintal per hectare to 25.8 quintal per hectare on the farm of major wheat growing states as well as on the progressive farm of Madhya Pradesh also. Madhya Pradesh is an equally important wheat growing states of India. Madhya Pradesh occupied about 5002 thousand hectares under wheat in 2018-19. The total production of wheat was 13132 thousand tones in same year. The average yield of wheat in the State, in that year was about 26 quintal per hectare. It was well known fact that agricultural

Material and Methods

The study was conducted during Rabi season of 2020-21 among five farmers- viz., Sunil Kushwaha belong to village-Hasgora, Bhanu Pratap Singh and Jai Hind Singh of village- Batwaha while Gulab Sour, and Ratiram Sour of village-Kodiya were selected for zero-tillage sowing method in wheat under soybean/black gram/sesame- wheat cropping system patter in medium to light soil. All five farmers were convinced for no ploughing their fields after *Kharif* crops harvested to conducted zero-tillage in *Rabi* so that un-ploughed field to be available. The project for zero-tillage was with

growth, among others factors, depends upon the manner of utilization of resources by the farming community and it was true also in wheat cultivation. In this respect, the agricultural economists want to know that if the farmers were already allocating their resources optimally, no additional income can result from reallocation of farm resources and we would have to look to other sources for agricultural growth. If, on the other hand, the farmers were not allocating their resources optimally, there exists an inexpensive source of agricultural growth through reallocation of resources. Thus, a study on the resource use efficiency of wheat growers acquires special importance. (Baghel, 2019). Tikamgarh district contributed 20.90% area and produced 32.5% wheat in 2019-20 of the total cultivated area (GOI 2019-20). 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 was an attempt to look into the economics of zero-tillage in the region

convergence with RLBCAU-CIMMYT-KVKs participatory extension research project of Bundelkhand in black gram-wheat cropping systems. In this context, the CIMMYT was for one year as pilot project in Jhansi, Niwari, Datia, Tikamgarh and Lalitpur districts involved KVKs and other private partners kept RLBCAU as the main centre and KVKs there were as sub-centers. In this pilot project, black gram-wheat cropping systems addressed with NRM and cropping activities besides involvement of FPOs by engagement of the private sector participation KVK

Tikamgarh and Datia (M.P.) and Jhansi and Lalitpur (U.P.) were identified as partners for this project in Bundelkhand-CIMMYT “Sustainable and Diversified Agri-Food Systems for Improving Resource Use Efficiency and Farm Incomes in Bundelkhand, India - Pilot Project”.. Each demonstration plot size was 0.4 ha with control plot ones. The wheat varieties were used to sown in demonstrations were Super-303 for Hasgora and Batwaha farmers and Super-1SR-14 for Kодиya village farmers. The zero-tillage machine was managed from

NGO of Lalitpur district for conducting the first time zero-tillage at the Tikamgarh district. The date of sowing was 25-26th Nov.2021 for all the trails. The other recommended practices were the same as wheat cultivation practices adopted by the local farmers. The local check wheat varieties- GW-322 and LOK-1 were taken with local farmers practices as seed broad casting sowing method with conventional practices. The seed rate of farmers was 50-60 Kg/acre used in conventional practices and as in demonstration the seed rate was used as 40 Kg/acre (Table-1).

Table1 The detail of the zero-tillage demonstration conducted during Rabi season of 2020-21 at Tikamgarh district

Name Farmer	Village	District	State	Date sowing	Variety	Area (ha)
Suneel Kushwaha	Hasgora	Tikamgarh	M.P.	25-11-2021	Super 303	0.4
Bhanu Pratap Singh	Batwaha	Tikamgarh	M.P.	25-11-2021	Super 303	0.4
Jai hind Singh	Batwaha	Tikamgarh	M.P.	25-11-2021	Super 303	0.4
Gulab Sour	Kodiya	Tikamgarh	M.P.	26-11-2021	Super-1-SR-14	0.4
Ratiram Sour	Kodiya	Tikamgarh	M.P.	26-11-2021	Super-1-SR-14	0.4

Results and Discussion

A comparison between zero tilled and conventionally tilled wheat (Table 2 and 3) indicated that most of the input requirements for the demonstration trials were pests and diseases management cost Rs. 0.0/ha, average irrigation cost Rs.1040/ha which was varies from Rs. 925-1200/ha, harvesting and threshing cost Rs. 3750/ha, tillage cost Rs.1500/ha, average fertilizer costs Rs. 2170/ha which was varies farmer to farmer Rs. 2025-2500/ha and weed management cost Rs. 875/ha while it was Rs. 9335/ha in zero tillage less than check plot. While in check it was higher Rs. 19934/ha as in pests and

diseases management cost Rs. 0.0/ha, average irrigation cost Rs. 3044/ha which was varies from Rs. 2670-3550/ha, harvesting and threshing cost Rs. 3750/ha, ploughing and sowing cost Rs.6000/ha, average fertilizer costs Rs. 4140/ha which was varies farmer to farmer Rs. 3900-4800/ha and weed management cost Rs. 1500/ha. The zero tillage saved entire Rs. 10599/ha as cost which was higher in farmers’ local wheat cultivation practices thus the cost of cultivation minimizing to the great extent which would be helped in doubling the farmers income and reducing the cost. Besides this, the average

irrigation requirement in zero tillage was 4.53 (unit) as against 5.11 (unit) irrigations in the conventional tillage^[3]. Besides, the pre-sowing irrigation was totally saved in zero tillage^[4]. 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 been covered in the study, nevertheless, from the existing evidences, it may be concluded that adoption of zero tillage saved the water in the Bundelkhand might be in practices^[3]. Labour was grouped into human and mechanical labour. Adopter reported a saving of 30.2% human labour and 35.11% mechanical labour in zero tillage.

Table 2 The detail of the cost of cultivation involved like weed management, insect-pests and diseases management, and irrigation, harvesting and threshing (Rs./ha) in zero-tillage and in check demonstrations of the farmers’ practices during Rabi season of 2020-21 at Tikamgarh district

Check Weed Management costs (Rs/ha)	Demo. Pst & Fung mgnt cost (Rs/ha)	Check Pest & Fungicide Management costs (Rs/ha)	Demo. Irrigation cost/ha	Check Irrigation costs (Rs/ha)	Demo. Harv & thresh costs Rs/ ha	Check Harvesting & Threshing costs (Rs/ha)
1500	0	0	1075	3100	3750	3750
1500	0	0	1200	3550	3750	3750
1500	0	0	1200	3550	3750	3750
1500	0	0	800	2350	3750	3750
1500	0	0	925	2670	3750	3750

Seed requirement in both the situation of crop cultivation was almost differences of 10-20 kg/ha more seed in farmer practices while 40kg/ha was in zero-tillage which could saved 10-20 kg/ha seed and its extra cost in zero-tillage than farmers’ practices. Farmers perceived that more and thick strong tilling in zero tillage on the less 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 wheat forced the farmers to apply little higher seed rate. Adopters of zero tillage applied 209 kg/ha plant nutrients (NPK) as against the non-adopter’s 283 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 P₂O₅, which helped in healthy crop growth. Farmyard manure application was entirely governed by the conventional practices in the region.

Table 3 The detail of the cost of cultivation involved like tillage cost, ploughing and sowing, fertilizer and weed management Rs./ha in zero-tillage and in check demonstrations of the farmers' practices during Rabi season of 2020-21 at Tikamgarh district

Demo. Tillage cost (RS/ha)	Check Ploughing and Sowing costs (Rs/ha)	Demo. Fertilizer costs (Rs/ha)	Check Fertilizer costs (Rs/ha)	Demo. Weed mgmt costs (Rs/ha)
1500	6000	2500	4800	875
1500	6000	2025	3900	875
1500	6000	2025	3900	875
1500	6000	2200	4100	875
1500	6000	2100	4000	875

The grain yield in demonstration of zero-tillage was recorded an average of 2.94 tones/ha which was varies from 2.7-3.5 tones/ha from farmers to farmers and varieties to varieties. While in check plots the grain yield was higher and it was an average in 4.2 which was varies from 4.1 to 4.5 tones/ha. The straw yield was average 4.7 tones in zero-tillage and 6.8 tones/ha in conversational farmer practices with variation in farmers and varieties. The

adopter's wheat yield was higher by 292 kg/ha. Yadav *et al.*, (2002) many workers estimated around 200 kg/ha higher yield with zero tillage than that of conventional tillage^[6]. 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 (Table 4 and Table 5).

Table 4 The detail of the grain yield tones/ha, straw yield t/ha, grain price Rs./tones, and straw price Rs./tones involved in zero-tillage and in check demonstrations of the farmers' practices during Rabi season of 2020-21 at Tikamgarh district

Demo. Grain Yield (t/ha)	Check Grain Yield (t/ha)	Demo. Straw Yield (t/ha)	Check Straw Yield (t/ha)	Grain price (Rs/t)	Demo. Total Grain price (Rs)	Check total Grain price (Rs)	straw price (Rs/t)	Demo. Total Straw price (Rs)	Check total Straw price (Rs)
3.5	4.5	5.6	7.2	20150	70525	90675	1000	5600	7200
3.0	4.3	4.8	6.9	20150	60450	86645	1000	4800	6880
3.0	4.3	4.8	6.9	20150	60450	86645	1000	4800	6880
2.5	4.1	4.0	6.6	20150	50375	82615	1000	4000	6560
2.7	4.2	4.3	6.7	20150	54405	84630	1000	4320	6720

It was evident that total grass return was found in zero-tillage Rs. 63945/ha and in conventional it was Rs.93090/ha. The higher net returns Rs.74656/ha in conventional tillage and less net return was obtain in zero-tillage Rs. 54610/ha. The results showed that grain yield and net

return were higher in conventional method while the cost of cultivation was too higher in conventional tillage. But the average benefit cost ratio 5.8 was greater in zero-tillage than 4.0 conventional tillage practices of the local farmers. The cost increased or reduced were 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.

Table 5 The detail of the grain yield t/ha, straw yield t/ha, grain price Rs./tones, and straw price Rs./tones involved in zero-tillage and in check demonstrations of the farmers' practices during Rabi season of 2020-21 at Tikamgarh district

Demo. Partial cost (Rs/ha)	Check Partial cost (Rs/ha)	Demo. Total revenue (Rs/ha)	Check Total revenue (Rs/ha)	Demo. Net income (Rs/ha)	Check Net income (Rs/ha)	Demo. BC ratio	Check BC ratio
9700	19150	76125	97875	66425	78725	6.8	4.1
9350	18700	65250	93525	55900	74825	6.0	4.0
9350	18700	65250	93525	55900	74825	6.0	4.0
9125	17700	54375	89175	45250	71475	5.0	4.0
9150	17920	58725	91350	49575	73430	5.4	4.1

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 could be alone driving 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 were shrinking day by day. Although, there were 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 was warranted that the Government should undertake proactive initiatives to provide the implement on hiring basis or form self-help groups which

Conclusion

There is an urgent need to match food production with increasing world population through identification of sustainable land management strategies.

could be manage these at village or Panchayat level, so that the small and marginal farmers could also get benefit of improved cultivation practices 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 was needed. Zero tillage reduces cost of cultivation by nearly Rs 2,500-3,000/ha through reduction in cost of land preparation, and reduces diesel consumption by 50-60 litres per hectare. Zero tillage reduces water requirement of crop and the loss of organic carbon by oxidation. Zero tillage reduces *Phalaris* minor problem in wheat. The carbon status of soil was significantly enhanced in surface soil (0-5 cm), particularly under crop residue retention with zero tillage (Policy paper 31-Doubling Strategy for Doubling Income of Farmers in India).

However, the struggle to achieve food security should be carried out keeping in mind the soil where the crops are grown and the environment in which the living

things survive. Conservation agriculture (CA), practicing agriculture in such a way so as to cause minimum damage to the environment is being advocated at a large scale world-wide. Conservation tillage, the most important aspect of CA, is thought to take care of the soil health, plant growth and the environment. This work done on zero-tillage to understand its impact from the perspectives of the soil, the crop and the Bundelkand Agro-climatic Zone conditions. Processes of climate change mitigation and adaptation found zero tillage (ZT) to be the most environmental friendly among different tillage techniques. Therefore, conservation tillage involving ZT and minimum tillage which has potential to break the surface compact zone in soil with reduced soil disturbance offers to lead to a better soil environment and crop yield with minimal impact on the environment. A comparison between zero tilled and conventionally tilled in wheat indicated that cost of cultivation was Rs. 9335/ha in zero tillage less than check plot. While in check it was higher Rs. 19934/ha. The zero tillage saved entire Rs. 10599/ha as cost thus reducing the cost. Besides this, the average irrigation requirement in zero tillage was less 4.53 (unit) as against 5.11 (unit). It may be concluded that adoption of zero tillage saved the water in the Bundelkhand might be in practices. Adopter reported a saving of 30.2% human labour and 35.11% mechanical labour in zero tillage. Reducing the seed rate from 10-20 kg/ha in zero tillage was observed. More and thick strong tilling in zero tillage and less use of fertilizers which avoiding losses due to leaching, volatilizing and run off of fertilizers in conventional method.

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