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Zero-Tillage On Climatic Change Situation Of Bundelkhand Agro-Climatic Zone In Wheat Under Black Gram-Wheat Cropping System

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Abstract
The lower bulk density recorded 1.42 in (ZT) was a result of good interaction between the soil and the decomposed black gram straw, the potential to enhance microbial growth with the resultant effect on the slow break down of organic materials to release soil organic carbon (SOC) within the soil. CT method showed higher bulk density that it was as a result of the destruction caused by the physical breakdown of soil structure by ploughing lead to increased soil macro-pore space and high porosity. The highest soil pH was recorded by CT with an average of 7.6 and lowest soil 6.3 pH was recorded by ZT that reducing pH leading to reduced water movement and encouraged the retention of nutrients and hydrogen ions from decomposed straw and the mineralization of inorganic fertilizer. The available of total organic carbon (TOC) 1.5% and available phosphorus (AP) 26.2 (kg/ha), available nitrogen (AN) 347(kg/ha) and available potash (AK) 137 (kg/ha) were recorded higher significantly under ZT compared to the CT at the 0–20 cm soil depth. The soil nutrients movements and loss of total nitrogen that there were high concentrations of soil inorganic nitrogen in the top soil at depths of 0–20 cm., as the soil depth increases, the concentration of these nutrients under the ZT tillage methods decreases relative to CT, which showed continuous and persistent increase as the soil depth increases. At the highest soil depth (80–100 cm), CT recorded high levels of TN, $NH4^+$-N and $NO3^-$-N with 1.85 g kg^{-1}, 71.0 g kg^{-1} and 18.2 g kg^{-1}, respectively. The percentage increases in TN, $NH4^+$-N and $NO3^-$-N by CT over the ZT tillage methods were 17.3, 21.8 and 110%, respectively. The distribution of soil nutrients was generally high in the top soil, with high and significant values recorded under the ZT methods, the black gram straw played a significant role in the hydrological dynamics of the ZT as a result of the creation of a gradual stable aggregate structure that contributed to the high nutrient levels under the conservation tillage plots relative to CT. On the other hand, using farm machinery under CT to break and thoroughly mix black gram straw and other crop stubbles with the soil at the depth of 0–20 cm makes the soil vulnerable to agents of erosion, as well as speeding up the mineralization of black gram straw when temperature and other environmental factors become favorable. Higher values, significantly different from all the conservation tillage methods, were recorded under CT. This clearly shows the potential of CT to contribute to AgNPS pollution. At the end of the study, CT recorded the highest runoff (256 mm), high concentration of TN in runoff water (1.54 mg·L^{-1}) and TN runoff loss (3.1 Kg·N·ha^{-1}), which were significantly different from the ZT recorded the lowest values. The highest value recorded by CT was likely a result of the breakdown of the soil particles by the tillage implement making the soil loose and susceptible to running water. This makes nutrients from the decomposed black gram straw very mobile and easily moved by running water. 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, volatizing 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 promoting the conservation of the precious resources, reducing the critical inputs and improving the soil physical, biologically and chemically properties. 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.

Keywords: *Zero-tillage, Cropping System, Natural Resources Management*

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I. Introduction

The plough has been developed in early days of agriculture and was first pulled by man and later by animals. The use of the plough is often mentioned in the Bible and one of the best-known citations is "they shall beat their swords into plough shares" (Isaiah 2.V.4.). But the plough of biblical times had nothing to do with modern ploughs of the 19th century. In those days a plough was nothing else than a branch from a tree that scratched or scarified the soil surface without mixing the soil layers. Ploughs that inverted the soil layers and thus gave a better weed control were not developed until the 17th century. Only in the 18th and 19th century did ploughs become more and more sophisticated. But it was not until the end of the 18th century that German, Dutch and British developments of this tool led to an almost perfect shape of the mould board, which turned the soil by 135° and was very efficient in weed control. It is this plough that avoided famine and death at the end of the 18th century, since it was the only tool that could effectively control quack grass (*Agropyron repens*), a weed that had spread all over Europe and could not be controlled with "conventional" tools. Because the modern plough saved Europe from famine and poverty it became a symbol of "modern" agriculture and is used as such by many agricultural research institutes, universities, agronomy schools, etc. One of these early ploughs of 1884 is displayed at the agricultural museum of the University of Hohenheim, in Stuttgart, Germany, and in a festival is taken around the city of Hohenheim each year, to commemorate the invention of this implement. By knowing the history of this tool, it becomes understandable why Europeans and especially Germans are often such fervent advocates of the plough, which has turned to be the most often used symbol of agriculture world-wide. Against this background, the colonial powers took the plough to America, Asia and Africa, where it became an important tool for the development of newly cultivated land. But it took many decades to discover that the same tool that brought food and wealth to Europe would bring soil erosion and degradation to the warmer environments. Often the experts mainly from Europe have spread the concept that tillage makes the soil fertile and therefore cannot be replaced. They have not understood the significance of soil erosion, as well as intensive weathering under hot, humid conditions. This has resulted in the widespread distribution of poor, badly eroded, infertile soils all over the tropics and subtropics. Economic interests and the lack of experience of some of the expatriate experts have led, first the colonial countries and later the aid donor countries, to spread the culture of the plough in developing countries, while the so called "primitive technologies" have been classified as backward and unproductive.

The Green Revolution transformed the Indo-Gangetic Plains, which spread from Pakistan through Northern India and the Terai (plains) region of Nepal to Bangladesh, into the cereal basket of South Asia. The technological packaging of improved wheat and rice seed, chemical fertilizer, and irrigation in an overall supportive environment for agricultural transformation led to rapid productivity growth and the advent of rice-wheat systems, which now cover an estimated 14-million hectares in the region (Gupta *et al*. 2003, Gupta and Seth 2007, Timsina and Connor, 2001). Over the past decade, however, factor productivity growth has stagnated (Kumar *et al*. 2002, Ladha *et al.* 2003, Prasad 2005, Duxbury 2001, Kataki, *et.al*. 2001) leading to concerns over national food security and lagging rural economic growth. This has led to a quest for technologies that conserve resources, reduce production costs, and improve production while sustaining environmental quality (Erenstein *et al*.2008a, Gupta and Sayre,2007, Gupta and Seth 2007, Hobbs and Gupta, 2003a). One such promising technology is zero tillage: the seeding of a crop into unplowed fields, also known as no-till, direct seeding/drilling, or conservation tillage (Erenstein, 2002, Erenstein *et al*. 2008b). Zero tillage typically saves energy, helps reverse soil and land degradation (such as decline of soil organic matter, soil structural breakdown, and soil erosion), and leads to more efficient use of water and other inputs (Erenstein and Laxmi 2008). No-till approach started from 1960s by farmers in India. The zero-tillage system was being followed in the Indo-Gangetic plains where rice-wheat cropping was present. Wheat was to be planted after rice harvest without any operation. Hundreds of farmers were following the same system and getting more yields and profits by reducing the cost of cultivation. In South, the Southern-districts like Guntur and some parts of West Godavari of Andhra Pradesh state follow the Zero-tillage (ZT) system in rice-maize cropping system.

Northern India’s rice-wheat cropping rotations cover more than 4-million hectares and farmers typically burn some 23-million tons of rice straw annually, producing a toxic haze that chokes local inhabitants and populous cities, while contributing to global climate change. CGIAR research led by the International Maize and Wheat Improvement Center (CIMMYT) in South Asia has made a significant difference toward efforts to stop the harmful practice, by providing a more ecologically friendly alternative. Zero tillage–an innovative approach researched and promoted by CGIAR researchers at CIMMYT and their partners–provides farmers with a mechanized alternative to burning and tilling land between the rice harvest and wheat planting season. Until recently, rice straw was burned in the fields by farmers after harvest as the fastest and cheapest way to prepare the land for wheat planting. The zero-tillage approach instead offers a way to sown wheat directly into unplowed paddies and rice straw, using innovative machinery and attachments that can chop the left-over rice stalks, spread the residue evenly as mulch, and plant seeds into the soil–all without the need for clearing. Zero tillage been shown to cut farm-related greenhouse gas emissions by more than 75% and has brought farmers profits of $130 million. Recognizing that the cost of machinery is prohibitive for some smallholder farmers, CGIAR research has further supported the development of policies that promote mechanization, and ease business for local entrepreneurs who rent out the needed equipment, making it possible for farmers to implement the approach in the field. Subsidies under a 2018 policy to promote mechanization for managing crop residues in the states of Punjab, Haryana, Uttar Pradesh and the National Capital Territory of Delhi sparked the adoption of zero-tillage on 0.8 million hectares, significantly reducing harmful burning and bringing farmer's profits of $130 million. The practice has also been shown to cut farm-related greenhouse gas emissions by more than 75%, and is 10-20% more profitable for farmers on average than the previously used methods of burning and tilling.

Zero-tillage has been one of the most used Resource Conserving Technologies (Gupta, 2007) employed for saving precious resources, which given 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 back drop 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 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 (Laxmi and Mishra,2007). 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. 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 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. This was 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

Madhya Pradesh (M.P.) 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 q/ha to 25.8 q/ha 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 the same year. The average yield of wheat in the State, in that year was about 26 q/ha. It was well known fact that agricultural 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. (Baghel, 2019).

Bundelkhand Agro-climatic 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 6-districts of Madhya Pradesh (Datia, Tikamgarh, Chhatarpur, Damoh, Sagar, and Panna) and 7-districts of Uttar Pradesh (Jhansi, Jalaun, Lalitpur, Hamirpur, Mahoba, Banda, and Chitrakoot) of Central India which is jointly known as Bundelkhand region. Tikamgarh district belong to the same Agro-climatic zone one of Madhya Pradesh state. Tikamgarh district was produced 32.5% of wheat from 20.9% area during 2019-20 of the total cultivated area (GOI 2019-20). At present, wheat 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 first time was an attempt to look into the economics of zero-tillage in this the region

II. Material And Methods

The studies were conducted at Tikamgarh district by Krishi Vigyan Kendra (KVK), Tikamgarh (M.P.) with convergence of CIMMYT pilot project during 2020-21. Thus, conservation agriculture practices aim 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/groundnut and sesame-wheat, mustard, chickpea and pea cropping pattern. The most of the *Kharif* crops area were sown by the farmers traditionally through broad-casting method of sowing (flat bed) and some area of *Rabi* too seed broad casted as sowing method. Any zero-tillage practices have not yet been carried out in *Kharif-Rabi* major crops except few little patches adjacent near the Uttar Pradesh (U.P.) border area of few villages of this district (Dinesh *et.al.,* 2021).

The field demonstrations under these studies carried out 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/groundnut and sesame-wheat, mustard, chickpea and pea cropping system patter in light to medium 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 (Table-1).

Table-1 The details of the zero-tillage demonstration conducted during *Rabi* season of 2020-21 at Tikamgarh district

Demonstrations/Treatments	Name of Farmers	Villages	District	State	Date sowing	Variety	Area (ha)
T1	Suneel Kushwaha	Hasgora	Tikamgarh	M.P.	25-11-2021	Super 303	0.4
T2	Bhanu Pratap Singh	Batwaha	Tikamgarh	M.P.	25-11-2021	Super 303	0.4
T3	Jai hind Singh	Batwaha	Tikamgarh	M.P.	25-11-2021	Super 303	0.4
T4	Gulab Sour	Kodiya	Tikamgarh	M.P.	26-11-2021	Super-1-SR-14	0.4
T5	Ratiram Sour	Kodiya	Tikamgarh	M.P.	26-11-2021	Super-1-SR-14	0.4

The project for zero-tillage was with 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, wheat-black gram-cropping systems addressed with NRM and cropping activities besides involvement of FPOs by engagement of the private sector participation KVK, Tikamgarh and Datia from (M.P.), and Jhansi and Lalitpur from (U.P.) as representative were identified as partners for this project with entitled as "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 at Hasgora village and village-Batwaha farmers and Super-1SR-14 for Kodiya 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.2020 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.

Experimental Conditions

Five demonstrations/treatments made up of conventional tillage (CT) or farmers' practices tillage methods and with each one zero-tillage (ZT) methods were used for the study. The experimental plots had been under cultivation for the previous one year. The treatment descriptions are: zero tillage direct seeding (ZT) and conventional tillage (CT). The demonstrations/treatments were arranged in RBD in triplicate. The demonstrations/treatment sites were divided into two main blocks using bunds (about 100 cm) to represent one control plot and one zero-tillage plot with each farmer in their village as replications. Each block was as main plots and control plots. The dimensions of each plot were 10 × 40 m (length × width) = 400 m^2. ZT plots were sprayed with non-selective weedicide to kill the existing weeds glyphosate was applied @ 75-80 ml/L of water at 10-days before sowing the seed. Treated seed with fungicides Vitavax @ 2.5 g/Kg seed of wheat with a density of 100 Kg/ha were sown by tractor mounted zero-tillage seed-cum-ferti-drill at maintaining row to row spacing 20 cm after black gram harvesting field with no land preparation. While in the conventional method, the crop was sown during the same dates as ZT in November, 2021 by broadcasting method maintaining no row to row spacing or depth of seed after 3 ploughing (one deep ploughing followed by two harrowing) followed by planking. The recommended seed rate of 125Kg/ ha was maintained in CT. The seed depth was maintained at the depth of 5-7 cm using in seed drill using for zero-tillage (ZT) while in CT there was broadcasting method of sowing, therefore, the seed depth was not proper maintained and weedicides spraying in CT was used selective after germination. For conventional tillage and zero-tillage the N: P: K was applied @ 150:60:40 kg ha·' at the time of sowing. The remaining half of the nitrogen was applied in the form of urea in two equal splits as top dressing. Half of the nitrogen and full dose of phosphorus and potassium was applied at the time of sowing with seed drill in ZT while in CT it was broad casted at the field during seed broad casted. First top dressing was done with first irrigation at 21 DAS and second top dressing was done with second irrigation at 45-DAS. Three irrigations were given in the field where wheat grown through conventional tillage and ZT. First, second and third irrigation was given at CRI, flowering and milk stage respectively, where as in case of zero tillage, 2 irrigations were given first at CRI stage and second at flowering stage. The proper weed control practices were adopted to control the weeds. Harvesting was done manually on its physiological maturity. The yield attributes namely spike length, number of spike m^{-2}, number of grains $spike^{-1}$ and l000 grain weight (g) were recorded at the time of harvesting from five randomly selected plants leaving border areas of experimental plot. The mean value of the randomly collected data. Grain yield was recorded from each plot and converted to t ha^{-1} and economics was based on prevailing market price. After planting, the plots were managed using typical flooding irrigation water throughout the entire wheat growing season irrigations stages of wheat crops. Crop protection (weed and disease control) was carried out, when necessary, with the use of selective weedicidesas well as selective fungicides.

Soil Sampling and Analysis

A total of 10-sampling points were selected from the five treatment sites, with each plot sampled five times at incremental soil depths of 0–20, 20–40, 40–60, 60–80, 80–100 cm with the help of soil auger. Soil samples were collected after demonstrations/treatment sowing (Nov., 2020 to crop harvested at each one month of crop successive growth of wheat in demonstrations as well as control plots of each farmer during the wheat active growth stage (from Nov.,2020) and at harvest (March-April, 2021) for the 2020-21 growing seasons, respectively. Augured soil samples were air dried for 4–5 days, and sieved into various sizes of 2 mm, 1 mm and 0.15 mm for laboratory analysis. The basic physical and chemical properties were determined using standard methods. Undisturbed soil samples were used to determine soil bulk density using the core method (Rahman *et. al.*,2008). Soil pH was measured using a glass electrode (pH meter) in a soil to water ratio of 1: 2.5 (Xu *et.al.*,2016). Soil alkaline-nitrogen (AN) was determined using the alkaline hydrolysis diffusion method (Wang *et.al.*,2018). Total nitrogen (TN) was determined by the macro-Kjeldahl wet oxidation method (Calvo-Fernández *et.al*.,2016). Soil total organic carbon (TOC) was estimated using the potassium dichromate volumetric method (He *et.al*.,2017). Exchangeable K was determined using flame photometry (Ji *et.al*.,2014). Available phosphorous (AP) was determined by the Olsen method (Egan *et.al.* 2016). Nitrate (NO3-N) and Ammonium (NH4+-N) were extracted using KCl (Zhang *et.al.,* 2016), and determined by detection using a Skalar flow injection analyzer (SA5000). Initial soil physical and chemical properties of the experimental site were recorded before land preparation and 30-days after sowing of wheat as initiation before the experiment in 2021-Bulk Density 1.56 ($g \cdot cm^{-3}$), pH 6.99, TOC 45.35 ($g \cdot kg^{-1}$), TN 1.73 ($g \cdot kg^{-1}$), TP 1.19 ($g \cdot kg^{-1}$), AN 10.83 ($mg \cdot kg^{-1}$), Exchangeable K 65.47 ($mg \cdot kg^{-1}$), NO_3^-, N 25.56 ($mg \cdot kg^{-1}$) and NH_4^+-N 60.10 ($mg \cdot kg^{-1}$)

Growth and Yield Parameters of wheat

Growth and yield parameters such as plant height, stored straw yield, and grain yield of wheat were measured at maturity by demarcating an area of 2 x 2 m square on each treatment plot and yield per hectare estimated.

Data Analysis

In the present study, all experiments were conducted in triplicate. The data presented in figures and tables are the arithmetic mean values of the triplicate measurements. Data on soil physical and chemical properties, as well as N loss, were analyzed using SPSS version 23, Correlation analysis was done by using lNDOSTAT Version 7.

III. Results And Discussion

Effect of Tillage Methods on Soil Properties

(i) Bulk Density ($g \cdot cm^{-3}$)-The distribution of bulk density (0–20 cm) at the end of the study shown in Table-2. Bulk density generally decreased under the conservation tillage techniques. The soil bulk density of the resilient practice-Zero-tillage (ZT) and conservation tillage (CT) or farmer tillage practices (FP) treatments did not differ significantly when soil monitoring was performed in Nov.-Dec.,2020 during wheat sowing time of the year in an average. Significantly, lower bulk density of 1.60 was recorded by CT at the beginning of the experiment in Nov., 2020. ZT recorded a bulk density of 1.62 $g.cm^{-3}$ at the end of the study in March-April, 2021 in the year 2020-21, the average highest soil bulk density was recorded by CT (1.65 $g.cm^{-3}$). The results reveal that soil bulk density of ZT technique was significantly higher than CT at the beginning of the experiment. However, at the end of the experiment in March-April 2021, CT recorded the highest soil bulk density, which was significantly different from the rest of the treatments. The lower bulk density recorded by ZT 1.42, especially ZT, at the end of the study in March-April 2021 (Table-2) was a result of good interaction between the soil and the decomposed black gram straw which was taken earlier crop in *Kharif* season 2020. This has the potential to enhance microbial growth with the resultant effect on the slow break down of organic materials to release soil organic carbon (SOC) within the soil. Similar results have been produced by other researchers. For example, it was widely acknowledged that the physical properties of the soil required for adequate crop improvement were enhanced by the accumulation of OM in the soil (Bolvin *et.al*.,2009 and Ruehlmann *et.al*., 2009). Boosting soil organic carbon (SOC) availability in the soil will reduce bulk density, improve water holding capacity and enhance soil aggregate stability (AS) (Celik *et.al*., 2004). Results of the study in selected areas in Tikamgarh district showed an enhanced biomass accumulation, increased productivity of soils with adequate N and P nutrients and moisture retention in CA fields compared to non-CA fields (Kugbe *et.al*.,2015). Moreover, conservation measures lasting several years could reduce bulk density and aggregate stability of the soil through increase in SOM and adoption of cover crops (Higashi *et.al*., 2014). According to (He *et.al*., 2011), soil bulk density in the top soil experiences a decline resulting from the practice of zero tillage cropping. Soil properties were positively enhanced due to the yearly retention of crop residues (Zhang *et.al*., 2004). Additionally, suitable bulk density (1.2–1.3 $g \cdot cm^{-3}$) is appropriate for the absorption of water and nutrients for plant growth (Zhang *et.al*., 2016) with bulk density having the propensity to high light soil compaction. The low bulk density initially recorded by CT was as a result of the destruction caused by the physical breakdown of soil structure by the power tiller. This leads to an increase in soil macropore spaces resulting in lower bulk density and high porosity. However, with time, densification of soil associated with environment factors such as wetting and drying could lead to a high bulk density under CT.

Table -2 Data on Soil physical parameters before experiment in (CT) and (ZT) of demonstration conducted during *Rabi* season of 2020-21 at Tikamgarh district

Demonstrations /Treatments	Bulk Density ($g \cdot cm^{-3}$)		Soil pH		(TOC)%,		(AP)Kg/ha		(AN)Kg/ha		(AK)Kg/ha	
	CT	ZT	CT	ZT	CT	ZT	CT	ZT	CT	ZT	CT	ZT
(T1)	1.58	1.61	6.9	6.6	0.43	0.45	15.5	16.3	277	278	110	108
(T2)	1.64	1.6	7.3	6.8	0.45	0.46	15.3	15.8	282	285	109	112
(T3)	1.59	1.64	7.5	7.0	0.46	0.43	15.8	16.1	283	282	108	107
(T4)	1.59	1.63	7.3	7.1	0.42	0.47	16.6	15.8	276	277	107	111
(T5)	1.60	1.62	7.1	6.8	0.45	0.46	15.9	15.9	279	279	109	110
Average	1.65	1.62	7.2	6.8	0.44	0.45	15.8	15.9	279	280	108	109

Abbreviations: Total organic carbon (TOC %), Available phosphorus (AP/Kg/ha), Available potash (AK/kg/ha)

(ii) Soil pH- The highest soil pH at the end of the study period 2020-21 was recorded by CT with an average of 7.6 (slightly alkaline) but it was 7.2 near neutral pH at the beginning of the study. While in ZT at the beginning of the study 6.8 pH (slightly acidic but closed to neutral) was recorded but which reduced and recorded at the end of experiment 6.3 pH (soil with a pH of 6.1 to 6.5 considered slightly acidic, and generally suitable for most plants). This was significantly lower in different compared to higher in the CT (7.6) but at the beginning of experiment there was significantly not different in both the sowing practices. However, the lowest soil pH at the end of the study in the month of March 2021 was recorded by ZT, with 6.3 pH, indicating slight acidity. Results from the experiment showed that ZT method recorded a reduction in soil pH. The reduction in pH was a result (Table-3) of the reduced water movement, which encouraged the retention of nutrients and hydrogen ions from decomposed black gram straw and the mineralization of inorganic fertilizer. The high presence of hydrogen ions causes the soil to become acidic. This can be explained by other studies that have also recorded acidification in the soil profile of conservation tillage (Pierson-Wickmann *et. al.,* 2009), asserted that many years of using N-containing fertilizers such as ammonium or related organic forms of N leads to nitrification, releasing H+ that causes a deficit in basic cations. Additionally, due to the eluviation of rainfall and irrigation, some hydrogen

(H+) substances were leached from the A layer into the subsoil, which subsequently caused the decrease in the pH of soils under conservation tillage. Furthermore, production enhances humus formation with a resultant increase in H+ ions (Malo *et.al.,* 2005).

Table-3 Data on Soil physical parameters at the end of experiment in (CT) and (ZT) of demonstration conducted during *Rabi* season of 2020-21 at Tikamgarh district

Demonstrations/ Treatments	Bulk Density (g·cm−3)		Soil pH		(TOC)%		(AP)Kg/ha		(AN)Kg/ha		(AK)Kg/ha	
	CT	ZT	CT	ZT	CT	ZT	CT	ZT	CT	ZT	CT	ZT
(T1)	1.66	1.41	7.4	6.3	0.68	1.51	18.5	26.3	297	348	123	138
(T2)	1.67	1.42	7.5	6.3	0.71	1.52	19.3	25.6	297	345	122	137
(T3)	1.68	1.46	7.7	6.4	0.69	1.50	19.8	26.1	298	349	125	136
(T4)	1.62	1.45	7.8	6.3	0.71	1.52	18.6	27.7	296	347	126	137
(T5)	1.64	1.47	7.7	6.4	0.72	1.51	19.9	25.5	299	349	127	139
Average	1.65	1.44	7.6	6.3	0.70	1.51	19.2	26.2	297	347	124	137

(iii) Available Organic Carbon (%) and major nutrients (NPK Kg/ha)-Results from the study (table-2) also showed that the available total organic carbon (TOC) 1.5% and major nutrients as available phosphorus (AP) 26.2 (kg/ha), available nitrogen (AN) 347(kg/ha) and available potash (AK) 137 (kg/ha) were recorded after harvesting of the crop in soil which found in increasing manner significantly under ZT compared to the CT of the treatment as TOC, AP, AN and AK were 0.70%, 19.2, 279, 124, respectively. However, significant differences among the treatments were recorded. The data recorded before experiment for the organic carbon 0.44 %, available phosphorus 15.0 (Kg/ha), available nitrogen 279 (kg/ha) and available potash 108 (kg/ha) in CT while in ZT the 0.45, 15.9, 280 and 109 for organic carbon (%), available phosphorus (Kg/ha), available nitrogen (kg/ha) and available potash (kg/ha, respectively recorded for the ZT. Generally, all the physically parameters were found increasing in ZT after harvesting the crop in March ,2021. The ZT performed better in terms of increasing soil nutrients at the 0–20 cm soil depth compared to CT. All soil TOC, AN, AP and AK at the depth of 0–20 cm for all the treatments increased. Higher levels of nutrients were recorded under ZT, which promoted wheat growth and led to higher straw yields and implementation of ZT-tillage. Enhanced SOC accumulation after production has been reported in different areas in China (Zhong, 2009). In the past 20-years, many cultivable soils have revealed an increase in SOC and total nitrogen (Zhang *et.al.,*2004). Residue retention coupled with their breakdown had a positive effect on SOC content in the soil layer (Choudhury *et.al.,* 2014). Moreover, combining retained residue with different tillage methods increased SOC levels, water stable aggregates and microbial biomass, and subsequently enhanced soil fertility and quality (Abdullah *et.al.,* 2014). Similarly, our results showed a gradual but consistent increase in TOC accumulation under the conservation tillage methods during the two years of this study. The high nutrients levels among the conservation tillage methods at the soil depth of 0–20 cm could be as a result of the additional nutrients realized from the mineralization of rice straw coupled with the application of inorganic fertilizer. The presence of adequate organic manure also helped retain the inorganic fertilizer for efficient utilization by the crop. The improved amounts of TN, as well as N, P, and K in their available forms could be related to the availability of soil surface residues, creating the right environmental conditions for soil microbial activity and the mineralization of SOM. The changes in the soil properties were mainly attributable to the management of activities such as black gram straw incorporation and fertilizer application, a conclusion which was further evidenced from the wheat yield.

Effect of Zero-Tillage Methods on Soil Nutrient Movement and TN Loss

The results showed from studies on soil nutrients movements and loss of total nitrogen that there were high concentrations of soil inorganic nitrogen (TN, NO_3^--N and NH_4^+-N) in the top soil at depths of 0–20 cm. Even though, no significant difference in TN was recorded among the treatments, ZT recorded values higher than the rest of the treatments increased in NO_3^- -N and NH_4^+-N, with ZT recording significant increase over CT. Interestingly, as the soil depth increases, the concentration of these nutrients under the ZT tillage methods decreases relative to CT, which showed continuous and persistent increase as the soil depth increases. At the highest soil depth (80–100 cm), CT recorded high levels of TN, NH_4^+-N and NO_3^--N with 1.85 g kg^{-1}, 71.0 g kg^{-1} and 18.2 g kg^{-1}, respectively. The percentage increases in TN, NH_4^+-N and NO_3^--N by CT over the ZT tillage methods were 17.3, 21.8 and 110%, respectively. The distribution of soil nutrients was generally high in the top soil, with high and significant values recorded under the ZT methods. This was probably a result of the protective role played by the black gram straw and other weed biomass decomposed to the top soil. This allows for the gradual decomposition of the black gram straw, allowing nutrients to incorporate well within the top soil, and also allowing nutrients from the inorganic fertilizer to be retained in the top soil. Also, the black gram straw played a significant role in the hydrological dynamics of the ZT as a result of the creation of a gradual stable aggregate structure that contributed to the high nutrient levels under the conservation tillage plots relative to CT. On the other hand, using farm machinery under CT to break and thoroughly mix black gram straw and other crop stubbles with the soil at the depth of 0–20 cm makes the soil vulnerable to agents of erosion, as well as speeding up the mineralization of black gram straw when temperature and other environmental factors become favorable. Similarly, other investigators have concluded that soil and nutrient losses could be adequately reduced by practicing cultivation methods that ensure adequate protection of the soil (Withers,2007). However, as the soil depth increases, the concentration of these nutrients decreased under the conservation tillage techniques but increased under the CT. Also, the inversion of soil under the CT not only exposed the black gram straw to microbial decomposers at the 20 cm soil depth, leading to a high rate of nitrogen mineralization, but also creates aggregate instability that encourages a high rate of infiltration, with a resultant increase in nitrogen leaching. At the relatively deeper soil depth (80–100 cm), highly significant levels of these nutrients were recorded under CT, signifying huge movement down the profile. These results indicate that conservation tillage has the tendency to reduce water movement and erosion. Similarly, previous studies have reported that conservation tillage methods considerably minimized the movement of water and soil erosion (Jordán *et al.*, 2010 and Won *et.al.*, 2021). The lowest measurements of runoff (mm), concentration of TN in runoff water and TN runoff loss (kg·N·ha−1) recorded under ZT (g·kg−1) were 156.3 mm, 0.72 (mg·L−1) and 1.51, respectively, with significantly different from the CT. Higher values, significantly different from all the conservation tillage methods, were recorded under CT. This clearly shows the potential of CT to contribute to AgNPS pollution. At the end of the study, CT recorded the highest runoff (256 mm), high concentration of TN in runoff water (1.54 mg·L−1) and TN runoff loss (3.1 Kg·N·ha−1), which were significantly different from the ZT recorded the lowest values. The highest value recorded by CT was likely a result of the breakdown of the soil particles by the tillage implement making the soil loose and susceptible to running water. This makes nutrients from the decomposed rice straw very mobile and easily moved by running water.

Effect of Tillage Methods on Wheat Productivity

A comparison between zero tilled and conventionally tilled wheat (Table 4 and 5) indicated that most of the input requirements for the demonstration trials were pests and diseases management cost Rs/ha, the average irrigation cost Rs.1040/ha which was varies from Rs. 925-1200/ha in zero-tillage, while harvesting and threshing cost Rs. 3750/ha, for both the tillage practices common. 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. This finding was 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 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. This was 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 30.2% human labour and 35.11% mechanical labour in zero tillage.

Table-4 The cost of cultivation (Rs. /ha) involved in zero-tillage and in check demonstrations during Rabi season of 2020-21 at Tikamgarh district

Treatments	Weed Management costs (Rs/ha)	Pest & Disease Management cost (Rs/ha)	Pest & Disease Management costs (Rs/ha)	Irrigation cost/ha	Irrigation costs (Rs/ha)	Harvesting & threshing costs Rs/ ha	Harvesting & Threshing costs (Rs/ha)
	CT	ZT	CT	ZT	CT	ZT	CT
T1	1500	0	0	1075	3100	3750	3750
T2	1500	0	0	1200	3550	3750	3750
T3	1500	0	0	1200	3550	3750	3750
T4	1500	0	0	800	2350	3750	3750
T5	1500	0	0	925	2670	3750	3750
Average	1500	0	0	1040	3044	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 P_2O_5, which helped in healthy crop growth. Farmyard manure application was entirely governed by the conventional practices in the region.

Table-5 The cost of cultivation (Rs./ha) involved in zero-tillage and in check demonstrations during Rabi season of 2020-21 at Tikamgarh district

Treatments	Tillage cost (Rs/ha)	Ploughing and Sowing costs (Rs/ha)	Fertilizer costs (Rs/ha)	Fertilizer costs (Rs/ha)	Weed mgmt costs (Rs/ha
	ZT	CT	ZT	CT	ZT
T1	1500	6000	2500	4800	875
T2	1500	6000	2025	3900	875
T3	1500	6000	2025	3900	875
T4	1500	6000	2200	4100	875
T5	1500	6000	2100	4000	875
Average	1500	6000	8350	4140	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) 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 (Table 4 and Table 5).

Table-6 The yield (t/ha) and economic parameters involved in zero-tillage and in check demonstrations during Rabi season of 2020-21 at Tikamgarh district

Demonstrations/ Treatments	**Grain Yield (t/ha)**		**Straw Yield (t/ha)**		**Total Grain price (Rs)**		**Total Straw Price (Rs)**	
T1	CT	ZT	CT	ZT	CT	ZT	CT	ZT
T2	4.5	3.5	7.2	5.6	90675	70525	7200	5600
T3	4.3	3.0	6.9	4.8	86645	60450	6880	4800
T4	4.3	3.0	6.9	4.8	86645	60450	6880	4800
T5	4.1	2.5	6.6	4.0	82615	50375	6560	4000
Average	4.2	2.7	6.7	4.3	84630	54405	6720	4320

Grain price (Rs/t) @ 20150, straw price (Rs/t)@ 1000

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-7 The economics of yields of zero-tillage and check demonstrations during Rabi season of 2020-21 at Tikamgarh district

Treatments	Partial Cost (Rs/ha)		Total Revenue (Rs/ha)		Net income (Rs/ha)		BC Ratio	
	CT	ZT	CT	ZT	CT	ZT	CT	ZT
T1	19150	9700	97875	76125	78725	66425	4.1	6.8
T2	18700	9350	93525	65250	74825	55900	4.0	6.0
T3	18700	9350	93525	65250	74825	55900	4.0	6.0
T4	17700	9125	89175	54375	71475	45250	4.0	5.0

T5	17920	9150	91350	58725	73430	49575	4.1	5.4
Average	18434	9335	93090	63945	74656	54610	4.0	5.8

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 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 liters 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).

IV. Conclusion

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 environmentally friendly among different tillage techniques. The lower bulk density recorded 1.42 in (ZT) was a result of good interaction between the soil and the decomposed black gram straw, the potential to enhance microbial growth with the resultant effect on the slow break down of organic materials to release soil organic carbon (SOC) within the soil. CT method showed higher bulk density that it was as a result of the destruction caused by the physical breakdown of soil structure by ploughing lead to increased soil macro-pore space and high porosity. The highest soil pH was recorded by CT with an average of 7.6 and lowest soil 6.3 pH was recorded by ZT that reducing pH leading to reduced water movement and encouraged the retention of nutrients and hydrogen ions from decomposed straw and the mineralization of inorganic fertilizer. The available of total organic carbon (TOC) 1.5% and available phosphorus (AP) 26.2 (kg/ha), available nitrogen (AN) 347(kg/ha) and available potash (AK) 137 (kg/ha) were recorded higher significantly under ZT compared to the CT at the 0–20 cm soil depth. The soil nutrients movements and loss of total nitrogen that there were high concentrations of soil inorganic nitrogen in the top soil at depths of 0–20 cm., as the soil depth increases, the concentration of these nutrients under the ZT tillage methods decreases relative to CT, which showed continuous and persistent increase as the soil depth increases. At the highest soil depth (80–100 cm), CT recorded high levels of TN, NH_4^+-N and NO_3^--N with 1.85 g kg^{-1}, 71.0 g kg^{-1} and 18.2 g kg^{-1}, respectively. The percentage increases in TN, NH_4^+-N and NO_3^--N by CT over the ZT tillage methods were 17.3, 21.8 and 110%, respectively. The distribution of soil nutrients was generally high in the top soil, with high and significant values recorded under the ZT methods, the black gram straw played a significant role in the hydrological dynamics of the ZT as a result of the creation of a gradual stable aggregate structure that contributed to the high nutrient levels under the conservation tillage plots relative to CT. On the other hand, using farm machinery under CT to break and thoroughly mix black gram straw and other crop stubbles with the soil at the depth of 0–20 cm makes the soil vulnerable to agents of erosion, as well as speeding up the mineralization of black gram straw when temperature and other environmental factors become favorable. Higher values, significantly different from all the conservation tillage methods, were recorded under CT. This clearly shows the potential of CT to contribute to AgNPS pollution. At the end of the study, CT recorded the highest runoff (256 mm), high concentration of TN in runoff water (1.54 $mg \cdot L^{-1}$) and TN runoff loss (3.1 $Kg \cdot N \cdot ha^{-1}$), which were significantly different from the ZT recorded the lowest values. The highest value recorded by CT was likely a result of the breakdown of the soil particles by the tillage implement making the soil loose and susceptible to running water. This makes nutrients from the decomposed black gram straw very mobile and easily moved by running water. 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, volatizing 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.

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