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Review of various studies of tillage practices on some soil physical and biological properties

***[1]Nabayi, A., [1]Girei, A.H., [1]Mahmud, A.T., [1]Onokebhagbe, V. O., [1]Yusif, S.A., [1]Santuraki, H. A. and Nzamouhe M.[2]**

[1]Department of Soil Science, Faculty of Agriculture, Federal University Dutse, Jigawa state. Nigeria. PMB 7156

[2]Department of Soil Science and Land Resources Management, Federal University Wukari, Taraba State. Nigeria. PMB 1020

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Corresponding Author's E-mail Address:

abba.nabayi@fud.edu.ng +2347031068906

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ABSTRACT

The objective of this paper was to review the various studies of tillage practices effects on some selected soil physical and biological properties from 2000 to 2021 and summarise the findings. The findings of the review indicated that generally, No-tillage (NT) systems has greater benefits than the conventional tillage systems under various soil, environmental, and management conditions. These benefits include using fewer machines, reducing fuel cost, reduced soil loss due to improved aggregate stability, improved soil temperature, and minimal soil erosion due to the protective effect of crop residues left on the soil surface. Furthermore, NT soils possess lower soil bulk density (BD), higher porosity, greater infiltration rate and water retention. Even though some studies reported NT to have higher soil BD and cone index and lower moisture content compared to conventional tillage, however, the studies show no significant crop yield difference after long years of practise. In addition, the presence of the crop residues on the surface leads to higher microbial biomass, which improves the soil through burrowing and creates more soil pores, thereby improving the soil hydraulic conductivity as compared to conventional tillage practices irrespective of the soil type. Conclusively, the NT system improves soil properties in both short- and long-term duration under various soil types as compared to conventional tillage. NT is therefore recommended for soil and water conservation purposes which would lead to higher crop yield.

1.0. Introduction

Tillage has been an integral part of agricultural and food production since the earliest great civilizations. Tillage has long been regarded as a critical agronomic practise because it can alter soil properties and create a complex soil ecosystem (Strudley *et al*., 2008; Jabro *et al*., 2015). It controls weeds, incorporates amendments and plant residues, and creates an environment conducive to seed germination, plant emergence, growth, and development (Castellini *et al*., 2019; Nabayi *et al.,* 2017). Tillage practises change the soil's physical properties, such as bulk density, aggregate stability, water movement, and storage (Lal & Shukla, 2004; Jabro *et al.,* 2009, 2011, 2015). Studies have reported that deep tillage practice enhances water movement and aeration in the soil, increases rooting depth and growth, and allows for deeper chemical movement than is possible in no-till soil (Diaz-Zorita, 2004; Strudley *et al.,* 2008). However, despite the importance of tillage practices to soil and crop improvements, studies have shown that tillage practices have negative impact to the soil which affect the crop productivity. For instance, several reported that conventional tillage disrupts the soil structure, which can lead to runoff and erosion (Jabro *et al.,* 2014, 2015; Nabayi *et al*., 2019a; Nawaz *et al.,* 2013; Zhao *et al.,* 2017). Similarly, reduced tillage systems (RT) result in soil compaction, acidification, and nutrient and organic matter concentrations in the surface horizon (Lal, 2004).

On the other hand, NT also known as zero-tillage or direct seeding is define as planting in previous crop's stubble followed by no tillage (Fasinmirin & Reichert, 2011; Soane *et al*., 2012). Studies reported that NT to have beneficial effect on soil physical properties as compared to the conventional tillage system (Mathew *et al*., 2012; Mchunu *et al*., 2011). NT is increasingly being considered a component of sustainable agriculture due to its ability to increase soil water infiltration and reduce soil water erosion and associated losses of fertile soil material (Huggins & Reganold, 2008). NT systems also improve soil physical properties by increasing soil water availability (Abu-Hamdeh, 2004) and the number of bio pores (Ashworth *et al*., 2017), both of which could lead to higher crop yield. No-tillage can increase crop yields (Zhao *et al.,* 2017), minimise soil erosion, improve soil structure, and increase soil organic matter concentration (Laudicina *et al.,* 2015), and play a beneficial role in yield stability and water use promotion as a major agricultural measure for maintaining farmland productivity (Navarro-Noya *et al*., 2013). Overall, NT and sod-seeding is used nowadays, especially for cereal cultivation (Castellini *et al*., 2019).

The negative effect of the conventional tillage practices needs an urgent intervention for soil and water conservation purposes which have a greater impact on crop yield. Numerous studies have reported on the use of soil properties such as BD, porosity, hydraulic conductivity, and soil penetration resistance as criteria for evaluating the effects of soil tillage (Nabayi *et al.,* 2017; 2018a). In this study, literatures have been reviewed from 2000 to 2021 generally, however, in the study summary, emphasis was given to studies from the last two years (2019 to 2021) to capture the current trend of the research topic. Therefore, the objective of this paper was to review the various studies of tillage systems on some soil physical and biological properties from 2000 to 2021 so that a recommendation will be made on how the negative impact of conventional tillage practices would be overcome.

Effect of tillage practices on soil physical properties

Effect of tillage practices on soil hydraulic properties

A better understanding of how tillage systems affect soil hydraulic properties is necessary for soil water conservation and management across various soil types, management scenarios, and climates. Soil structure is an important soil characteristic that can be altered by tillage practises because of its effects on porosity and soil hydraulic conductivity, both of which contribute to creating optimal conditions for plant growth and crop establishment (Nabayi *et al*., 2018b). In some cases, ongoing soil inversion can degrade soil structure, reduce available soil water, deplete soil organic carbon, and increase greenhouse gas emissions into the atmosphere. Water infiltration, hydraulic conductivity, and water retention help the soil capture and store precipitation or irrigation water. Soils that drain quickly when wet and retain moisture during droughts are critical for agricultural production as climate variability increases, which is expected to include more intense and frequent rainstorms or droughts in the future (Nabayi *et al*., 2019b; Pryor *et al*., 2014). Increased compaction of the topsoil under NT systems may result in decreased water infiltration, and the soil may become waterlogged during periods of heavy rainfall. As a result, no-tillage is less suitable during wet years or in areas with high rainfall (Lampurlanes *et al*., 2001).

Water infiltration was greater in tilled soils than in untilled soils in other studies (Ferreras *et al*., 2000; Nabayi *et al*., 2019b). Different tillage practises may affect the soil's ability to absorb and retain water depending on the degree of soil disturbance. On the other hand, Blanco-canqui *et al*. (2017) determined that soil hydraulic conductivity was greater in chisel-plowed plots than other tilled soils, owing to the increased soil aggregation caused by the chiselling practise, while Nabayi *et al*. (2019a, b) reported higher saturated hydraulic conductivity (K*sat*) under NT as compared to other tillage systems. Nabayi *et al.* (2018a) observed that NT soils had higher hydraulic conductivities than tilled soils and attributed this to decreased soil BD and increased porosity compared to tilled soils. According to Miriti *et al*. (2013) and Karuma *et al*. (2014), various tillage practises had no significant effect on soil K*sat* in rotational cropping systems. Previous research has established the importance of conservation and NT practises in reducing evaporation and increasing soil water storage. Martinez *et al*. (2011) stated that conservation tillage increased soil water content more than conventional tillage in compacted sandy loam soil. Conversely, Kovac *et al*. (2005) concluded that conventional tillage resulted in significantly higher soil moisture content than reduced and NT systems in loamy soil.

Although soil compaction affects many important soil physical properties, perhaps the most detrimental impact is the drastic reduction in hydraulic conductivity, which eventually results in soil erosion and reduced crop yields due to decreased infiltration, increased run-off, and poor drainage (Abu-Hamdeh, 2004). Previous researches that compare the soil hydraulic properties of various tillage systems discovered some discrepancies. Even more inconsistent are the effects of tillage practises on K*sat* (Blanco-Canqui *et al*., 2004). For example, when compared to other tillage systems, NT management may increase (Nabayi *et al*., 2018a, b) or do not affect soil water retention (McVay *et al*., 2006). Regardless of the conflicting findings regarding the performance of NT in soil and water conservation, the effectiveness of this practise in reducing runoff and soil losses is inextricably linked to the amount of crop residue mulch retained on the soil surface (Mchunu *et al*., 2011). Mchunu *et al*. (2011) attribute the 68 % reduction in soil losses caused by NT without mulch under sandy loam soils (62% sand) to the formation of erosion resistant soil crusts.

Effect of tillage practices on other soil physical properties

Castellini *et al*. (2019) reported greater infiltration rates in NT soils than in till soils, despite the no-till soil's higher BD and lower porosity. The absence of tillage resulted in a decrease in BD and an increase in porosity and aggregation. The structural improvement of the soil caused by incorporating organic residues may help to partially prevent soil degradation (Lal, 2004). Moreover, Hajabbasi and Hemmat (2000) stated that in an Isfahan clay loam soil, a NT system resulted in an increase in soil organic matter and thus larger aggregates. Conversely, Hemmat and Taki (2001) and Mirlohi *et al.* (2000) reported that no-tillage systems had a detrimental effect on crop yields in the arid regions of central Iran mainly due to the higher BD and low organic carbon content, as well as an initial weak soil structure.

Compaction of the soil refers to the packing effect of a mechanical force on it. This packing effect reduces the volume of pores in the soil mass and increases its density and strength (Nawaz *et al*., 2013). The indicators of soil compaction include BD and water infiltration (Nabayi *et* *al*., 2019b). Nawaz *et al*. (2013) reported that excessive compaction could result in negative consequences such as decreased water infiltration, root growth restriction, and increased runoff. These adverse effects have the potential to exacerbate erosion (Abu-Hamdeh, 2004).

Compacted soils limit water movement, cause nutrient and water stress, delay seedling emergence, reduce root growth, production, and penetration into the subsoil, and inhibit plant growth, all of which lead to lower crop yields (Hamza & Anderson, 2005; Lal & Shukla, 2004; Jabro *et al.,* 2014, 2015). According to literatures, depending on the depth and degree of compaction, soil compaction can reduce yield by up to 50 % in some areas (Lal & Shukla, 2004). Globally, farm machinery traffic alone affects 68.3 million hectares of compacted soils (Nawaz *et al.,* 2013). Adopting improved farming practises that minimise soil compaction is critical for crop productivity to remain stable while maintaining environmental quality and soil health (Jabro *et al.,* 2021).

Carbon in the soil is critical for crop production and soil quality preservation (Lal, 2004). Organic carbon in soil is critical for chemical composition and biological productivity, and the fertility and nutrient retention capacity of a field (Sadeghpour *et al*., 2016). Additionally, the organic carbon in the soil promotes soil aggregation and aggregate stability in micro-and macroaggregates, increasing the soil's physical stability (Mikha *et al*., 2015). Soil aggregation can increase soil organic carbon (SOC) storage by preventing carbon from mineralization and reducing soil erosion (Razafimbelo *et al*., 2008). Increased agricultural productivity is frequently associated with increased SOC and stable carbon cycling, whereas soil disturbance frequently results in a net loss of carbon to the atmosphere as carbon dioxide (CO_2). Tillage and crop residue management practises can affect soil aggregation, aggregate stability, and carbon sequestration in the soil (Mikha *et al*., 2015). Conservation tillage practises, particularly NT, cause the least disturbance to the soil and leave at least 30 % of the residue on the soil surface, thereby reducing soil erosion (Seitz *et al*., 2019). Increased residue and slowed residue decomposition, as well as improved aggregation and aggregate stability associated with NT, all contribute to soil carbon conservation and stabilisation, and thus to soil resilience to erosion and carbon depletion (Zuber *et al*., 2015). The long-term effects of tillage on the size distribution of soil aggregates indicated that NT systems produced a higher proportion of larger aggregates than conventional tillage management practises (Hontoria *et al*., 2016).

Similarly, it has been demonstrated that switching from conventional (conventional or mouldboard tillage) to NT tillage practise increases aggregate stability and the percentage of soil macroaggregates (Zotarelli *et al*., 2005). Furthermore, literatures indicate that NT systems have higher aggregate-associated C and N concentrations due to the improved soil aggregation and protection of soil C from oxidation (Mikha *et al*., 2015; Zhao *et al*., 2017).

Effect of tillage practices on soil microbial properties

Tillage systems have a significant impact on the physical, chemical, and biological properties of soil and its productivity and sustainability (Mathew *et al*., 2012). In long-term conservation tillage systems, soil organic matter stratification and nutrient distribution differences have also been observed (Lal, 2004). Thus, changes in soil physical and chemical conditions associated with conservation tillage result in significantly different microorganism habitats and shifts in soil microbial community structure (Feng *et al*., 2003; Helgason *et al*., 2009). Conventional tillage practises can result in aerobic microorganism-dominated soil microbial communities, whereas conservation tillage practises increase microbial population and activity and

Table 1: Summary of some reviewed literature of tillage practises: effect on soil properties and land use from 2002 to 2021

S/N	Reference	Soil type	Tillage types	Properties measured	Duration	Crop type	Results	Conclusion
1	Li et al., 2020		NT and PT	Microbial biodiversity	–	–	NT increase and decrease bacterial and fungal biodiversity. The use of medium N fertilizer (100-200 kg hac^{-1}) increases bacterial biodiversity. NT increases the SOC and nitrogen level significantly.	Field management practises such as no-tillage, stubble, and moderate N application can help increase soil bacterial diversity over time.
2	Agbede, 2006	Oxic Tropuldalf	ZT, Manual clearing, Mounding, and Ridging	Physical, chemical, and yield parameters	2 years	Yam	Mounding and ridging resulted in increased leaf nitrogen, phosphorus, potassium, calcium, magnesium, and tuber length and girth when compared to ZT and manual clearing. ZT had higher carbon, nitrogen, phosphorus, potassium, and magnesium levels than the surface (0-20 cm) soil. Mounding and ridging increased mean tuber weight by 35% compared to ZT and manual cleaning in both years.	ZT is not favorable for yam production as tillage is required.

NT no till, CP chisel plow, MP mouldboard plow, DP deep tillage, MT minimum tillage, RT ridge tillage, CT conservation tillage, WR water retention, BD bulk density, Ksat saturated hydraulic conductivity, TP total porosity, CI cone index, PAW plant available water, – not available.

Table 1 (Continued)

S/N	Reference	Soil type	Tillage types	Properties measured	Duration	Crop type	Results	Conclusion
3	Celik et al., 2021		CT, RT, NT	Water retention (WR), resistance and resilience (RR), physical stability and support (PSS)	10 years	Corn-soybean-wheat	At 0-10 cm depth, RR and PSS function scores were significantly higher in RT and NT than in CT. In 10-30 cm, low nutrient content, compaction, aggregate size, and stability all reduce the functional potential. At 0-10 cm, the RR function in NT was 85 percent greater than in CT. Under RT and NT, all soil functions decrease with depth.	Higher soil quality indicators are obtained in 0 -10 cm for CT, and functional potentials of soils under RT and NT were significantly decrease with depth.
4	Sakolowski et al., 2020	Vertic Argiaqoll	Tillage and NT	Ksat, BD, GMC, OC, and aggregate stability	3 years	–	NT has higher OC, BD, GMC, and aggregate stability. Soil saturation (total porosity) was higher under tillage. The tillage did not affect Ksat, total N, extractable P from the surface. NT alleviate but not enough to mitigate the loss of soil OC and aggregate caused by continuous cropping in the soil	BD, OC, aggregate stability, and saturation are soil quality indicators to evaluate tillage systems under similar soil + climatic conditions.

NT no till, CP chisel plow, MP mouldboard plow, DP deep tillage, MT minimum tillage, RT ridge tillage, CT conservation tillage, WR water retention, BD bulk density, K*sat* saturated hydraulic conductivity, TP total porosity, CI cone index, PAW plant available water, – not available.

Table 1 (Continued)

S/N	Reference	Soil type	Tillage types	Properties measured	Duration	Crop type	Results	Conclusion
5	Monero et al., 2021	petrocalcic argiudoll	NT and CT	SOC, BR, and Urease	1 year	Pasture	Higher SOC in the summer irrespective of the tillage system. CT has higher SOC in the autumn. Higher BR in the summer pasture soil.	CT had higher SOC and BR favours pasture soils.
6	Jabro et al., 2021	Sandy Loam	NT and CT	Soil cone Index, BD, and GMC	7 years	Corn-Soybean	Soil cone index was significantly affected by tillage systems at 0-30 cm. for the 7 years, soil CI was smaller in CT than NT with 1.12 Mpa relative to NT. Lower BD values in CT than in NT. There was no significant difference in GMC between the two tillage systems when corn and soybean were grown. Reduced soil CI and BD values in CT under both crops may result from soil disturbance caused by intensive tilling compared to NT.	For seven years, NT increased SCI and BD in 0-30 cm under corn and soybean. In general, NT produced comparable or slightly lower GMC than CT. As a result, GMC had no discernible effect on soil CI or BD under corn or soybean. NT affected both CI and BD, which are indicators of soil compaction; thus, NT should be used cautiously in sandy loam soils to avoid soil compaction.
7	Secco et al., 2021		Chiseling and NT	BD and Porosity	3 years	Crambe	Chiseling decreases soil BD and increases porosity with a short-term effect on soil properties.	Chiseling improves the measured soil properties on a short-term study.

NT no till, CP chisel plow, MP mouldboard plow, DP deep tillage, MT minimum tillage, RT ridge tillage, CT conservation tillage, WR water retention, BD bulk density, K*sat* saturated hydraulic conductivity, TP total porosity, CI cone index, PAW plant available water, BR basal respiration.

Table 1 (Continued)

S/N	Reference	Soil type	Tillage types	Properties measured	Duration	Crop type	Results	Conclusion
8	Weidhuner et al., 2021		MP, conventional disk, NT, and alternate tillage (AT)	Soil aggregates and OC	49 years	Corn	MP has higher aggregates (2-4.75 mm) similar to NT. The percent of dry medium (aggregates) was higher in NT (1-2mm). Aggregates associated with OC and N were higher in NT. C: N ratio was similar among all treatments at all depths. Disturbing the soil periodically (AT) disrupts C and N accrual comp in NT. NT had low oxidizable OC. NT had higher C and N only at a depth of 0-5 cm, highlighting the need for tactics to increase the element to a lower depth	AT increased aggregate size and stability but was outperformed by CD, and NT benefits are restricted to topsoil.
9	Nnadi et al., 2019	Ultisols	Flat tillage, Mound tillage, and Ridge tillage alone and in combination with 4 tons hac^{-1} of wood ash.	Ksat, porosity, CEC, exch. Bases, OC, av. P, N, and pH.	–	Castor plant	Increase in the measured properties in wood ash amended tillage relative to the sole tillage. Ridge tillage + wood ash had a higher effect on the soil properties and yield of the castor plant.	The use of wood ash as soil amendment at 4 tons hac^{-1} improved the soil properties without any negative effect.

NT no till, CP chisel plow, MP mouldboard plow, DP deep tillage, MT minimum tillage, RT ridge tillage, CT conservation tillage, WR water retention, BD bulk density, Ksat saturated hydraulic conductivity, TP total porosity, CI cone index, PAW plant available water, – not available.

Table 1 (Continued)

S/N	Reference	Soil type	Tillage types	Properties measured	Duration	Crop type	Results	Conclusion
10	Vogeler et al., 2009		Chisel tillage and conservation tillage	Soil physical and chemical properties, P accumulation in soil, yield and uptake of various crops	6 years		Conservation tillage has better pore connectivity, higher Ksat, and OM. No significant difference between the 2 tillage systems	While tillage intensity reduction affected soil properties, it had a negligible effect on yield and nutrient uptake.
11	Shirani et al., 2002	Silt clay loam	CT and RT in combination with 0, 30, and 60 Mg ha-1	OM, BD, Ksat, MWD	2 years	corn	The application of manure increases the soil OM. 60 Mg ha-1 increase MWD; 0.33, 0.4, 0.75mm at 5 cm layer only. The application of manure at all levels decreases BD and increases Ksat. CT increases root penetration depth but no significant difference in physical properties.	The effect of the tillage practises is mainly on the soil surfaces
12	Martinez et al., 2008	(Sandy clay alluvial soil) Entic Haploxeroll	CT and NT	PD, BD, PR, Infiltration, MWD, and root length density (RLD)	4 and 7 years	Wheat	Higher RLD in NT. A higher effect of most properties was obtained in the near-surface than lower > 15 cm depth. In contrast, higher PD, infiltration, macropores were higher in CT than under NT. No effect between the tillage systems on BD and yield. While using NT for a longer period improves aggregate stability, it has a detrimental effect on other soil physical properties.	The effects are mainly at 5 cm depth of the soils irrespective of the TS

NT no till, CP chisel plow, MP mouldboard plow, DP deep tillage, MT minimum tillage, RT ridge tillage, CT conservation tillage, WR water retention, BD bulk density, K*sat* saturated hydraulic conductivity, TP total porosity, CI cone index, PAW plant available water.

Table 1 (Continued)

S/N	Reference	Soil type	Tillage types	Properties measured	Duration	Crop type	Results	Conclusion
13	Castellini and Ventrella, 2012	Clay soil	CT and MT	Infiltration, Porosity, and Ksat	33 years	wheat	There is an equivalence of Ksat between the 2 TS. Shallow tillage is considered the best due to lower cost and minimum GHG's. There is no significant difference in Ksat between the 2.	The differences in tillage types did not influence the Ksat of the soil differently, however, conservation tillage is considered the best due to the lower labour cost.
14	Jabro et al., 2016	Sandy-loam	ZT, shallow tillage, and deep tillage	BD, Ksat, and MC	4 years	Sugar beet	BD is lower under DT. No significant difference in total porosity between the TS. Ksat was higher in ST (27.6 mm hr-1) than ZT (17.21) and DT (12.46 mm hr-1). MC has no effect across the depth among the TP.	The fact that TS had no significant effect on BD, Ksat, or MC is likely due to the constant nature of total porosity in sandy loam soils regardless of tillage type. The soil texture is the primary factor that determines the total porosity of the soil and thus the BD, Ksat, and MC values. By and large, sandy-loam soils are more prone to compaction, resulting in suboptimal soil physical and hydraulic properties regardless of tillage practise. ZT and ST are promising agricultural practises that offer an alternative to conventional tillage.

NT no till, CP chisel plow, MP mouldboard plow, DP deep tillage, MT minimum tillage, RT ridge tillage, CT conservation tillage, WR water retention, BD bulk density, K*sat* saturated hydraulic conductivity, TP total porosity, CI cone index, PAW plant available water.

Table 1 (Continued)

S/N	Reference	Soil type	Tillage types	Properties measured	Duration	Crop type	Results	Conclusion
15	Blanco-canqui et al., 2017	Silt-clay loam	NT, CP, DT, and MP	Porosity, infiltration, Ksat, and WR	35 years	Corn	MP had a significantly higher ponded infiltration rate (21.6 and 8.8 cm hr-1 at 5 and 60 minutes, respectively) than NT; however, compared to CP and CP, MP had a significantly higher ponded infiltration rate at all measured times (3 hours). After three hours, MP had a higher cumulative infiltration of 26.9 cm to 39 cm than other tillage systems. MP has a higher rate of infiltration due to the presence of voids or fractions (>125 um) created by full inversion tillage. There was no significant difference among the TS in terms of TP, Ksat, and WR.	Overall, there was no significant difference among the TS regarding soil hydraulic properties except for water infiltration in silt-clay loam after 35 years.
16	Mathew et al., 2012	Silt-loam	CT and NT	Microbial community structure, enzymes activities, and physico-chemical properties	–	–	NT had higher soil OC and nitrogen and phosphatase activities at 0-5 cm than under CT. The differences between the TS in terms of SOC, N, and phosphatase are negligible. NT had a higher microbial community which shifted with tillage and depth.	Tillage and depth are the main determining factors for the soil microbial community.

NT no till, CP chisel plow, MP mouldboard plow, DP deep tillage, MT minimum tillage, RT ridge tillage, CT conservation tillage, WR water retention, BD bulk density, K*sat* saturated hydraulic conductivity, TP total porosity, CI cone index, PAW plant available water, – not available.

Table 1 (Continued)

S/N	Reference	Soil type	Tillage types	Properties measured	Duration	Crop type	Results	Conclusion
17	Abu-Hamdeh, 2004	Clay-loam soil	MP, CP, and DP	BD, Infiltration, and WR	–	–	WR and WHC and BD were affected by the TS with CP<DP<MP, which increases with depth. The higher the compaction, the lower the moisture content and higher the BD irrespective of the TS.	TS affects the soil's ability to retain moisture and available water capacity.
18	Mhazo et al., 2016	Variety of soils	NT and CT	Water runoff, sediments concentration, and soil losses	–	Variety of crops	NT had a 56 % lower sediments concentration. NT had 60 % lower soil losses	NT had improved the soil structure thereby reducing the risk of erosion.
19	Nabayi et al., 2019a		ZT, MT, CT, and DT	BD, TP, Ksat, Volumetric moisture content, and PAW			the study showed the importance of zero tillage among other soil TS and the results of the research indicated that ZT attributes can be obtained beyond upper depth.	Higher soil moisture content retained at all soil water pressure was found in ZT which differed significantly (p<0.01) form other TP. The research concluded that the best TP to be adopted in terms of improvement in physical and hydraulic properties is ZT practice.

NT no till, CP chisel plow, MP mouldboard plow, DP deep tillage, MT minimum tillage, RT ridge tillage, CT conservation tillage, WR water retention, BD bulk density, K*sat* saturated hydraulic conductivity, TP total porosity, CI cone index, PAW plant available water, – not available.

microbial biomass (Mathew *et al*., 2012).

Microbial communities are critical for ecosystem function because they alter the biochemical soil environment and influence soil organic matter dynamics and nutrient cycling in agroecosystems by inducing micro-aggregation and changing the biochemical soil environment (Ashworth *et al*., 2017; Lammel *et al*., 2018). Microorganisms exhibit significant functional redundancy and complex interactions, resulting in community diversity and species composition, which are critical determinants of ecological function (Allison & Martiny, 2008). The impact of agricultural practises on the activity and composition of soil microbial communities must be considered (Nannipieri *et al*., 2003). Tillage practises have the potential to alter soil microbes by modifying the microclimate and the availability of organic matter inputs (Zuber *et al*., 2016). NT soils have a higher moisture content and cooler temperatures than plowed soils, making them more conducive to microbe colonisation and growth (Wang *et al*., 2016, 2017). The effects of tillage practices on soil microbial biomass and related extracellular enzyme activities have been studied (Roldan *et al*., 2005; White & Rice, 2009). However, some studies have indicated that NT improves soil microbial activity compared to conventional tillage systems (Hungria *et al*., 2009; Silva *et al*., 2013; Guo *et al*., 2016). Therefore table 1 summarises the influence of different tillage systems on different soil properties and crop yield

Conclusion

This paper review studie conventional and conservational tillage practises effects on some soil physical and biological soil properties. The paper summarises the results of the past studies from 2000 to 2021. The review shows that NT practise improve soil physical and microbial properties by increasing the soil organic carbon, porosity, K*sat*, bacterial diversity over time as well as decreasing the soil BD and cone Index after a minimum period of 5 years under various soil types. NT is therefore recommended to prevent the negative effect of the conventional tillage practices by improving soil water conservation which would lead to a higher crop yield.

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