SECTION 10.
AGRICULTURAL SCIENCES AND FOODSTUFFS

Bala Muhammad Ibrahim
Master student, Agrotechnologies and Natural Resources Management Faculty
Sumy National Agrarian University, Ukraine

Zakharchenko Elina
PhD in Agrarian sciences, Ass. Professor of Department of Agrotechologies and Soil Science
Sumy National Agrarian University, Ukraine

WHICH WAYS OF SOIL TILLAGE ARE THE BEST FOR CROPS?

Various tillage operations create lots of impact at different intensities on soil physical and chemical properties, such as bulk density, soil porosity and water-holding capacity, infiltration rates, hydraulic conductivity, soil temperature and organic matter content, nutrient distribution amongst others. So many researchers have been carried out on the impacts of different tillage techniques on soil physical and chemical properties and there is a substantial interest and emphasis on the shift to conservation and no-tillage methods. Thus, the objective of this study was to review the various works done on the impacts of different tillage practices on soil fertility properties and compare the no-tillage to the conventional tillage system.

Conventional Tillage (CT). Conventional tillage practices cause change in soil structure by modifying soil bulk density and soil moisture content [1-6]. In addition, repeated disturbance by conventional tillage gives birth to a finer and loose-setting soil structure while conservation and no-tillage methods leave the soil intact [7]. This difference results in a change of characteristics of the pores network. The ability of the soil to store and diffuse air, water, and agricultural chemicals and, thus, in turn, regulate erosion, runoff, and crop performance is controlled by the network of pores [8]. Onwualu and Anazodo [9] mentioned a higher porosity of soils under conventional treatments (52.9%) than under no-till (40.3%) as tillage loosens the soil. But the larger pore volume of tilled soils is only temporary and collapses rapidly under the impact of rainfall and runoff during the rainy season.

Conservation Tillage. Soil conservation concept entails all measures and techniques employed to maintain soil fertility at the lowest cost possible without significant decrease in crop yields. Conservation tillage is any tillage system that leaves at least 30% of the soil surface covered with crop residue after planting to reduce soil erosion by water [10]. This tillage practice therefore, involves seedbed preparation in the presence of residue, mulch and an increase in surface roughness. The practices therefore range from reduced or no-till to more intensive tillage depending on several factors, such as climate, soil properties, crop characteristics, and socioeconomic factors. Conservation tillage is the most important aspect of conservation agriculture thought to take care of the soil health, plant growth and the environment [11].

Conservation tillage practices range from zero tillage (No-till), reduced (minimum) tillage, mulch tillage, ridge tillage to contour tillage.

Minimum tillage means reduced level of soil manipulation involving ploughing using primary tillage implements. Minimum tillage describes a practice where soil preparation is reduced to the minimum necessary for crop production and where 15 to 25% of residues remain

on the soil surface [11]. Several studies showed that reduced and zero-tillage systems contribute to long-term maintenance of the soil structure as pores from root growth and the activity of the soil fauna and the soil aggregates from the previous years are less or not at all disturbed [12]. Soils with reduced tillage are characterized by less total pore space but have more stable fine pores and fewer air-filled pores than tilled farmland soils [13].

Ridge tillage is the practice of planting or seeding crops in rows on the top, along both sides or in the furrows between the ridges which are prepared at the beginning of every cropping season. Tied ridging or furrow diking includes the construction of additional cross-ties in the furrows between neighboring contour ridges [14]. Eziakor [15] recommends ridge tillage for shallow soils, where hardpan seriously restricts root development and crop production. The accumulation of soil material increases the rooting zone and the mixture of the topsoil with nutrients and moisture from the subsoil facilitates the growth of crops in addition.

In ***mulch tillage***, the soil is prepared or tilled in such a way that the plant residues or other materials are left to cover the surface to a maximum extent.

When tillage is done at right angles to the direction of the slope it is referred to as ***contour tillage.***

Contour ridging, the preparation and cultivation across the slope, is a simple approach to erosion control in areas with small slope gradient but its effectiveness decreases with an increase in slope gradient, slope length, and increasing rain intensity. Soils with high erodibility factor that are characterized by a high percentage of fines sand and silt tend to be problematic soils for ridge tillage as they are more susceptible to water erosion if not covered with residues or crops [16].

No-till or zero-tillage is characterized by the elimination of all mechanical seed bed preparation except for the opening of a narrow strip or hole on the ground for seed placement. The surface of the soil is covered by crop residue or mulch. Many studies have shown that with continuous no-tillage soil organic matter increases, soil structure improves, soil erosion is controlled, and in time crop yields increase substantially from what they were under intensive tillage management [17]. As a result of reduced soil disturbance, zero tillage improves soil organic carbon and benefits the overall soil quality. There is overwhelming evidence from several scientific studies that continuous no tillage is the most effective and practical approach for restoring and improving soil quality, which is vital for sustained food production and a healthy environment.

References:

1. Hryhoriv Ya.Ya., Butenko A.O., Kovalenko V.M., Zakharchenko E.A., Kriuchko L.V., Pshychenko O.I., Radchenko M.V., Trotska S.S., Terokhina N.O. (2021). Productivity of oat (Avena sativa L.) with different methods of cultivation on soddy podzolic soils. Agricultural mechanization in Asia (AMA). 51 (03), 1793-1799.
2. Захарченко Е.А., Дацько О.М. (2018). Вміст легкогідролізованого азоту та структурність грунту за різних способів основного обробітку грунту. Вісник Сумського національного аграрного університету. Сер. «Агрономія і біологія», 9 (36). 119-124.
3. Mishchenko Y.G., Zakharchenko E.A., Berdin S.I. et.al. (2019). Herbological monitoring of efficiency of tillage practice and green manure in potato agrocenosis. Український журнал екології, 9(1), 210-219.
4. Mishchenko, Y. & Zakharchenko, E. (2019). The effect of green manures on weediness of sugar beet. Bulletin of Sumy National Agrarian University. The Series: Agronomy and Biology, 4(38), 41-49. https://doi.org/10.32845/agrobio.2019.4.6
5. Yaroshchuk, R., Zakharchenko, E., Kovalenko, I., Yaroshchuk, S., & Klymenko, H. (2020). Soil aggregation with various cover crops in Ginkgo biloba L. plantations. Bulletin of Sumy National Agrarian University. The Series: Agronomy and Biology, 42(4), 23-32. https://doi.org/10.32845/agrobio.2020.4.4.
6. Mishchenko, Y., Kovalenko, I., Butenko, A., Danko, Y., Trotsenko, V., Masyk, I., Zakharchenko, E., Hotvianska, A., Kyrsanova, G., and Datsko, O. (2022). Post-Harvest Siderates and Soil Hardness.

Ecological Engineering & Environmental Technology, 23(3), 54-63. https://doi.org/10.12912/27197050/147148.
7. Rashidi, M., Keshavarzpour F. (2007). Effect of different tillage methods on grain yield and yield components of maize (Zea mays L.). International Journal of Agriculture & Biology. 9 (2), 278–281.
8. Khan, F. U. H. Tahir, A. R. and Yule, I. J. (2001). Intrinsic implication of different tillage practices on soil penetration resistance and crop growth. International Journal of Agriculture and Biology, 1, 23–26.
9. Onwualu A. P., Anazodo U. G. N. (1989). Soil Compaction Effect on Maize Production under Various Tillage Methods in a Derived Savanna Zone of Nigeria, Soil & Tillage Research, 14 (2), 99-114. doi:10.1016/0167-1987(89)90025-1.
10. National crop residue management survey (2004). Conservation Technology Information Center, West Lafayette, Ind., accessed September 2009 at www.ctic.purdue.edu.
11. Busari M.A., Kukal S. S., Kaur Amanpreet, Bhatt R., Dulazi A. A. (2015). Conservation tillage impacts on soil, crop and the environment, International Soil and Water Conservation Research, 3(2), 119-129, https://doi.org/10.1016/j.iswcr.2015.05.002.
12. Omeke J. O., Augustine A.J. (2016). SLM 306. Soil erosion and conservation National Open University of Nigeria. 60-159.
13. Osunbitan J., Durodoluwa J. O., Adekalu K.O. (2005). Tillage effects on bulk density, hydraulic conductivity and strength of a loamy sand soil in southwestern Nigeria. Soil and Tillage Research. 82(1), 57-64. doi: 10.1016/j.still.2004.05.007.
14. Lal R. (1993). Tillage effects on soil degradation, soil resilience, soil quality, and sustainability. Soil and Tillage Research. 27, Issues 1–4, 1-8. https://doi.org/10.1016/0167-1987(93)90059-X.
15. Eziakor I. G. (1990). Comparative analysis of the effectiveness of manual versus mechanized tillage among Third World smallholders: a case study in Bauchi State of Nigeria. Agriculture, Ecosystems and Environment, 31(4), 301-312.
16. Lal, R. (1990). Soil erosion in the tropics: principles and management. McGraw Hill. 580.
17. Parr, J. F., & Papendick, R. I. (1997). Introduction: Improving the sustainability of dryland farming systems in the Middle East. American Journal of Alternative Agriculture, 12(3), 98–99. http://www.jstor.org/stable/44503014.