International Journal of Biological Engineering and Agriculture
ISSN: 2833-5376
Volume 04 Number 01 (2025)
Impact Factor: 9.51
SJIF (2023): 3.916

www.inter-publishing.com

Article

The Impact of Using Tractors and Conventional Plows on Soil Fertility and Plant Growth

Abdul Jalil[1]*, Faridatul Munawaroh[1], Muhammad Alfarizi Dio Prabowo[1], Bagus Tripama[1], Pio Tivar Ananda[1], Dwika Nano Hariyanto[2]

Citation: Jalil, A. The Impact of Using Tractors and Conventional Plows on Soil Fertility and Plant Growth . International Journal of Biological Engineering and Agriculture 2025, 4(1), 60-63.

Received: 22th Oct 2024
Revised: 10th Dec 2024
Accepted: 13th Dec 2024
Published: 25th Dec 2024

Copyright: © 2024 by the authors. Submitted for open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/)

1. Universitas Muhammadiyah Jember
2. Universitas Mochammad Sroedji Jember
* Correspondence: abduljalil@unmuhjember.ac.id

Abstract: Indonesia, as an agricultural country, relies heavily on the agricultural sector for its economic development. The development of agricultural tools, from traditional animal-powered plows to the use of modern tractors, has had a significant impact on soil fertility and plant growth. This study compares the use of tractors and conventional plowing methods in terms of their effects on soil structure, aeration, and soil fertility. Tractors allow for deeper and faster tillage, increasing aeration, water infiltration, and organic matter mixing that support overall soil fertility, but continuous use can cause soil compaction or "hardpan." In contrast, conventional methods are more friendly to soil structure and microorganisms, although they are slower and require more labor. To maximize agricultural yields and maintain long-term soil fertility, farmers need to consider the specific conditions of their land in selecting the right tillage method. This study emphasizes the importance of balance in soil management to maintain agricultural sustainability.

Keywords: Fertility land; processing Land; Tractor; Plow conventional

1. Introduction

Indonesia is an agricultural country where most of its population works in agriculture. The agricultural sector is a very important sector for economic development in an agricultural country like Indonesia (Partowijoto, 2003), (Setyadi , 2017), (Mukhtar et al., 2024). Progress in field agriculture No limited to in sector agriculture scale big but also in agriculture small in the countryside. Therefore Lots happen changes to systems and tools agriculture used start from plow traditional with buffalo to use of tractors, (Mukhtari, 2024).

The world of agriculture, from ancient times to the present, has always been closely tied to soil conditions. Soil, as a growing medium for plants, is the main determinant of harvest success. Soil structure, mineral content, acidity level, and water content directly affect root growth, nutrient absorption, and plant resistance to pests and diseases.

Soil is a natural element found on the earth's surface, consisting of mineral materials resulting from weathering of rocks and the remains of plants and animals. Soil plays an important role in life on earth because it supports plant growth by providing organic matter and nutrients (Azzuhra et al., 2019). Soil fertility levels vary from low to high, with textures ranging from medium to coarse. Organic matter content also varies, from low to high. Soil pH can range from acidic, neutral, to alkaline. Base saturation and cation exchange capacity also vary, depending on the parent material. One way to increase soil fertility is by cultivating the soil (H & AR, 2022).

One of the key factors in increasing crop production is soil cultivation (Rizki , et al., 2024). The purpose of soil cultivation is to improve soil conditions so that there is good air circulation, increase water absorption, and facilitate the entry of sunlight by turning the subsoil to the surface. Soil cultivation creates optimal conditions for plant growth, provides a good place for seeds, and eradicates weeds (H et al., 2024) . This process can be carried out using manual or mechanical soil cultivation tools such as tractors. The use of tractors is the result of adjustments to industrial developments. Tractors were adopted as a solution to overcome difficulties in meeting labor needs for soil cultivation. With tractors, the costs and energy required in rice farming can be saved compared to the use of traditional plows that depend on livestock or human power (Suswati et al., 2023) .

Two-wheeled tractors (Hand Tractors) and their equipment play an important role in soil cultivation, where the tractor functions as a driver and equipment in the form of a single plow is used to cultivate the soil to the desired depth. With mechanical tools like this, the soil cultivation process becomes faster and the depth of soil cultivation becomes more uniform compared to using conventional tools such as hoes. However, intensive soil cultivation using tractors can have an impact on soil compaction and can affect the physical-mechanical properties of the soil due to the depth of soil cultivation carried out with a plow (Azzuhra et al., 2019) . Soil cultivation needs are influenced by the level of density and aeration. Soil with a high level of density because it has never been cultivated can inhibit plant growth, so that the root absorption zone is limited. On the other hand, continuous soil cultivation can reduce the rate of water infiltration into the soil due to compaction (Unique, 2017).

In agricultural efforts, soil cultivation is carried out with the aim of creating better physical, chemical, and biological conditions of the soil to a certain depth so that it is suitable for plant growth (Nizatillah et al., 2019). There are several soil cultivation methods that meet the criteria for soil conservation (OTK) including no tillage (zero tillage), reduced tillage, and strip tillage. However, the application of these three types of OTK must always be accompanied by the use of organic mulch because it can suppress weed growth, reduce the rate of water loss, and reduce soil compaction. In addition, the application of OTK can also save labor (Unique, 2017). The general purpose of soil cultivation is to create optimal soil conditions for plant growth with minimal effort and to form a soil structure that is suitable for nurseries or seedling growth, increase infiltration rates, reduce runoff, and reduce the risk of erosion. Soil cultivation can also inhibit and kill weeds, increase soil fertility by burying plants above the soil, and kill insects, larvae, or insect eggs through habitat changes and exposure to sunlight (Suswati et al., 2023). The purpose of writing this article is to determine the impact of soil cultivation using tractor plows and confectionary plows on plant fertility and growth.

2. Materials and Methods

The method used in writing a literature review is by using the technique of collecting articles obtained from searching for Scientific Articles using Google Scholar. This review only includes articles that contain full text. Data analysis techniques include data reduction, data presentation, and drawing conclusions.

3. Results and Discussion

Land cultivation using tractor plows and conventional plows has a significant impact on soil fertility and plant growth, and each method has its own advantages and disadvantages. Tractor plows, as a modern innovation in agriculture, are able to cultivate the soil faster and deeper than conventional plows. This deep cultivation allows for increased soil aeration, which is the circulation of air in the soil, which is important for the respiration of roots and soil microorganisms. In addition, the use of tractors helps increase water infiltration into the soil, making it easier for water to reach plant roots. The process of mixing organic matter is also more efficient with tractors, so that nutrients from the organic matter can be distributed evenly and support overall soil fertility.

Continuous use of heavy equipment such as tractors can also accelerate the formation of the plowpan due to the heavy force of the tractor (Chyba et al., 2014). Besides that , continuous use of tractors can cause soil compaction in the lower layers, a condition called "hardpan". This compaction occurs due to the heavy pressure of the tractor repeatedly passing over the land. Hardpan can block the movement of water and plant roots, reducing the ability of plants to absorb water and nutrients from deeper soil layers. In the long term, this can inhibit plant growth and reduce land productivity. In agricultural efforts, soil cultivation is carried out with the aim of creating better physical, chemical, and biological soil conditions to a certain depth so that it is suitable for plant growth (Nizatillah et al., 2019). According to (Unique, 2017), there are several soil cultivation methods that meet the criteria for soil conservation (OTK) including no

tillage (zero tillage), reduced tillage (reduced tillage), and strip tillage (strip tillage). However, the application of these three types of OTK must always be accompanied by the use of organic mulch because it can suppress weed growth, reduce the rate of water loss, and reduce soil compaction.

Zero tillage is a soil processing method without direct disturbance to the soil structure, maintaining soil biota and natural structure. Seeds are planted on previous crop residues without prior tillage. Reduced tillage is a soil processing method that reduces the intensity of soil processing compared to conventional methods, minimizing disturbance to the soil structure and microorganism ecosystem. Only the top of the soil is processed with lighter tools or reduced number of times of processing. While strip tillage is a soil processing method where only certain parts of the land are processed in the form of strips or paths where seeds will be planted, while the rest of the land is not disturbed. This method combines the advantages of zero tillage and reduced tillage by reducing soil erosion, increasing water retention, and aeration in the processed strip. Strip tillage also helps reduce soil compaction and facilitates plant root penetration.

On the other hand, conventional plows powered by livestock or humans tend to be more friendly to soil structure. This method usually disturbs the soil only on the surface layer, so the risk of soil compaction in the lower layers is smaller. In addition, this conventional method is also more friendly to soil microorganisms, which play an important role in the process of organic matter decomposition and nutrient cycling. The efficiency of processing with conventional plows is lower than with tractors. The process is slower and requires more labor, which can be a constraint especially on larger farms. Shallower processing with conventional plows may not be effective enough in controlling weeds and ensuring even mixing of organic matter throughout the soil profile.

The BOT content processed with three plowings and 5 tons/ha of manure was significantly lower compared to the land processed with one plowing and two plowings, each given 10 tons/ha of manure. The negative impact of intensive soil processing (three plowings, produces finer and very loose soil, so that soil aeration and drainage are much better and cause BO decomposition to run faster, while less organic fertilizer is given (5 tons/ha). The soil processing system with two hoeings (human power) provides potato productivity, density, rate and soil infiltration capacity relatively the same as the soil processing system with two plowings using a tractor (two plowings) and is better than one or three tractor passes (one or three plowings) each using 5 tons/ha of manure (Luthfiyatunnisa et al., 2024). Soil processing is accompanied by the provision of associations, and the interaction of the two can increase the number of pods per plant (Unique, 2017).

The depth of the use of the hoe and the working speed greatly affect the bulk density, porosity, permeability and stability of the aggregate, but the treatment of the depth of use of the hoe does not have much effect on the resistance of soil penetration. Meanwhile, the field capacity affects fuel consumption. The theoretical field capacity at a soil plowing depth of 20 cm is the same as a soil plowing depth of 30 cm, which is 0.15 Ha/hour. The highest effective field capacity is at a plowing depth of 20 cm of 0.127 Ha/hour and the lowest capacity is at a depth of 30 cm of 0.095 Ha/hour. The best field efficiency is found in soil processing with a plowing depth of 20 cm, which is 81.33%. The most efficient fuel consumption for plowing is using a plowing depth (Nizatillah et al., 2019).

To maximize the benefits of both methods, farmers should consider the specific conditions of their land. For example, land that tends to have compaction problems may be better suited to conventional methods, while land that requires deep tillage to improve aeration and water infiltration may benefit from the use of a tractor. A good understanding of the needs of the soil and crop, as well as the long-term impacts of the chosen tillage method, is essential to ensuring optimal soil fertility and healthy plant growth.

4. Conclusion

Land preparation using tractors and conventional plows has a significant impact on soil fertility and plant growth. The use of tractors allows for faster and deeper cultivation, which improves soil aeration, water infiltration, and distribution of organic matter that supports soil fertility. However, excessive use of tractors can cause soil compaction (hardpan) which inhibits root movement and reduces water and nutrient absorption. On the other hand, conventional plows are more friendly to soil structure and microorganisms, but are less efficient in terms of time and labor. Therefore, in choosing a land preparation method, farmers need to consider the specific conditions of their land to maximize yields and maintain long-term soil fertility.

REFERENCES

Azzuhra, F., Devianti, D., & Yunus, Y. (2019). Analisis Beberapa Sifat Fisika - Mekanika dan Kinerja Traktor Roda Dua Akibat Pemberian Pupuk Organik dan Kedalaman Pengolahan Tanah Ordo Entisols. *Jurnal Ilmiah Mahasiswa Pertanian*, *4*(1), 598–607. https://doi.org/10.17969/jimfp.v4i1.10409

Chyba, J., Kroulík, M., Krištof, K., Misiewicz, P. A., & Chaney, K. J. A. R. (2014). Influence of soil compaction by farm machinery and livestock on water infiltration rate on grassland.

H, H., & AR, A. (2022). Pengaruh Pengolahan Tanah Menggunakan Traktor dan Pupuk Organik terhadap Infiltrasi Tanah Andisol serta Produktivitas Kentang. *Jurnal Keteknikan Pertanian Tropis Dan Biosistem*, *10*(1), 29–36. https://doi.org/10.21776/ub.jkptb.2022.010.01.04

H, H., Dianita, R., & AR, A. (2024). Dampak Penggunaan dan Pengolahan Tanah dalam Usahatani Sayuran Terhadap Infiltrasi Tanah Andisol di Kabupaten Kerinci. *Jurnal Ilmiah Universitas Batanghari Jambi*, *24*(1), 214. https://doi.org/10.33087/jiubj.v24i1.5024

Luthfiyatunnisa, Z., Hayati, E., & Hasanuddin. (2024). Pengaruh Jenis Media Tanam dan Varietas Terhadap Viabilitas Benih Kopi (Coffea sp.). *Jurnal Ilmiah Mahasiswa Pertanian*, *9*(1), 60–69. https://doi.org/10.17969/jimfp.v9i1.27931

Mukhtar, H., Syafutri, T. M., Rahman, R. A., Putra, A., & Hafsari, R. (2024). Analisis Kesuburan Pertanian Melalui Irigasi Dengan Menggunakan Metode K-Means Clustering. Journal of Software Engineering and Information System (SEIS), 4(2), 102-107.

Mukhtari, W., & Sos, S. (2022). Dampak Penggunaan Traktor Terhadap Perubahan Sosial Dan Ekonomi Masyarakat Petani Di Kecamatan Setia Kabupaten Aceh Barat Daya (Doctoral Dissertation, Uin Sunan Kalijaga Yogyakarta).

Nizatillah, D., Bulan, R., & Yunus, Y. (2019). Kajian kedalaman Penggunaan Bajak Singkal Terhadap Perubahan Sifat Fisika-Mekanika, Kapasitas Lapang dan Kebutuhan Bahan Bakar. *Jurnal Ilmiah Mahasiswa Pertanian*, *4*(1), 608–617. https://doi.org/10.17969/jimfp.v4i1.10381

Partowijoto, A. (2003). Peningkatan Produksi Sebagai Salah Satu Faktor Ketahanan Pangan. Majalah Dunia Insinyur. Jakarta.

Rizki, F. C., Wicaksono, P. R., & Wijayanti, F. (2024). Peningkatan Kesuburan Tanah Dan Produktivitas Sebagai Hasil Pengolahan Lahan Di Dusun Ngadilegi, Pandaan. Jurnal Informasi Pengabdian Masyarakat, 2(1), 01-09.

Setyadi, F. (2017). Subjective Well-Being Pada Petani Muda (Doctoral dissertation, Unika Soegijapranata Semarang).

Suswati, D., Dolorosa, E., & Indrawati, U. S. Y. V. (2023). Teknik Pengolahan Tanah Untuk Budidaya Tanaman Padi Di Desa Saing Rambi Kecamatan Sambas Kabupaten Sambas. *Jurnal Pengabdian Kepada Masyarakat Nusantara*, *4*(4), 4088–4095.

Unique, A. (2017). *Pertumbuhan dan Produksi Kacang Tanah (Arachis hypogea L.) Dengan Beberapa Sistem Olah Tanah dan dan Asosiasi Mikroba*. *5*(1), 202–207.