Article Type: Review
J Name: Modern Phytomorphology
Short name: MP
ISSN: ISSN 2226-3063/eISSN 2227-9555
Year: 2025
Volume: 19
Page numbers: 117-120
DOI: 10.5281/zenodo.200121
(10.5281/zenodo.2025-19)
Short Title: Regenerative farming as a tool to combat climate change

REVIEW ARTICLE

Regenerative farming as a tool to combat climate change

Oksana Datsko[1]*, Nataliia Kovalenko[2], Anna Hotvianska[3], Iryna Sologub[3], Oksana Bondarenko[3], Oleksandr Hulenko[3], Ivan Dubovyk[1], Mykola Sakhoshko[1,4], Gennadiy Davydenko[1], Mykola Radchenko[1], Eduard Pidluzhnyi[1]

[1]Sumy National Agrarian University, H. Kondratieva Str., 160, Sumy, 40021, Ukraine
[2]National University of Life and Environmental Sciences of Ukraine, Heroiv Oborony Str., 11, Kyiv, 03041, Ukraine
[3]Dnipro State Agrarian and Economic University, Sergei Yefremov, Str., 25, Dnipro, 49009, Ukraine
[4]Sumy branch of the Ukrainian Institute of Plant Variety Examination, Sumy, 40021, Ukraine

***Corresponding author:** Oksana Datsko, Sumy National Agrarian University, H. Kondratieva Str., 160, Sumy, 40021, Ukraine
E-mail: datsko.oksana.nikol@gmail.com

Received: 16.01.2025, Manuscript No: mp-24-158826 | **Editor Assigned:** 18.01.2025, Pre-QC No. mp-24-158826(PQ) | **Reviewed:** 27.01.2025, QC No. mp-24-158826(Q) | **Revised:** 02.02.2025, Manuscript No. mp-24-158826(R) | **Accepted:** 08.02.2025 | **Published:** 14.02.2025

Abstract

Regenerative agriculture represents a transformative approach to modern farming, emphasizing ecological sustainability, soil health, and climate resilience. Unlike intensive agricultural practices, which often rely on excessive use of chemical inputs and can degrade natural ecosystems, regenerative methods aim to restore and enhance the environment while maintaining agricultural productivity. Core practices include zero tillage, strip tillage, crop rotation, and the use of cover crops. These methods prioritize soil structure preservation, improved organic matter content, reduced erosion, and enhanced biodiversity. Zero tillage minimizes soil disruption, promoting microbiota activity and moisture retention while reducing erosion. Similarly, strip tillage allows partial soil preparation, balancing crop productivity and environmental preservation. Crop rotation mitigates the risk of pathogens and pest infestations, improving long-term soil health. Cover crops play a crucial role in preventing soil degradation, reducing weeds, and optimizing moisture levels. These practices collectively contribute to increased carbon sequestration and improved water management, essential for mitigating climate change. Despite its environmental benefits, regenerative agriculture faces challenges, including higher initial costs, the need for specialized equipment, and potential short-term profit reductions. Nonetheless, its long-term ecological and economic advantages underscore its potential as a cornerstone of sustainable agricultural development.

Keywords: Sustainable farming, Soil health, Zero tillage, Crop rotation, Cover crops, Climate resilience

Introduction

Agriculture is one of the leading industries of today. Its history dates back to the 6th-5th centuries BCE (Prysyazhnyuk, 2013; Karpenko et al., 2020). Initially, ancient people engaged in hunting and gathering edible berries, mushrooms, or other vegetation. With the development of tools that allowed for more effective hunting, a food crisis and shortages began to emerge. This led to the development of plant cultivation practices during the Neolithic period to ensure adequate nutrition (Primak & Primak, 2009; Karpenko et al., 2023).

Gradually, humanity transitioned from extensive farming, which involved increasing agricultural productivity by expanding resources, typically arable land, to intensive farming. Intensive agriculture refers to the production of agricultural goods by improving specific characteristics, such as crop yields or grain quality, while simultaneously reducing production costs (Kolisnyk et al., 2020a; Boppart et al., 2023).

This shift was made possible through agricultural practices that are often difficult to classify as sustainable. For example, the use of large quantities of pesticides or excessively high fertilizer rates. While these methods yield the desired results for farmers, they have a negative impact on the ecological balance, particularly on soil biota, soil health, and other environmental factors.

To preserve the environment while maintaining productivity, the principles of regenerative agriculture have been developed. This term encompasses a wide range of practices that can be applied to achieve sustainable farming. In the article by Newton et al. (2020), various definitions of regenerative agriculture by numerous scholars are summarized. Regenerative agriculture is described as a means to improve soil health, water resources, and mitigate climate change. The latter is achieved by "capturing" carbon dioxide from the air and "storing" it in the soil, which increases soil organic matter content (Rhodes, 2017; Karpenko et al., 2021).

To begin practicing regenerative agriculture, decisive steps must be taken. This includes supporting innovations emerging in the field and continuously learning to explore new opportunities for implementation. At the same time, it is important to understand that profits from regenerative agriculture may be lower compared to intensive farming.

So, what practices can be implemented to achieve the aforementioned positive environmental outcomes?

Literature Review

Maine body

The first practice that should be implemented in a farm practicing regenerative agriculture is zero tillage, or, if necessary, strip tillage.

Zero tillage, also known as the no-till technology, involves preserving the undisturbed structure of the soil. Under this approach, soil-tilling machinery is not used, leaving stubble and plant residues on the field. These residues serve as mulch, reducing soil erosion and increasing microbiota activity (Horowitz et al., 2010; Kolisnyk et al., 2020). The main features of this technology involve significant changes to traditional agricultural practices:

- Abandonment of any soil tillage (even shallow cultivation).
- Inability to use organic fertilizers, as they require plowing.
- Application of mineral fertilizers and plant protection products only during sowing.
- Use of special seed drills designed for sowing into stubble.
- Suitability only for fields with a flat soil surface (Dang et al., 2020).

This technology has both advantages and disadvantages. One advantage is that plants residues help retain moisture, thereby enhancing soil biota activity. However, these residues can also harbor diseases and pests, potentially affecting the next crop. For this reason, maintaining a rational crop rotation is crucial when using zero tillage.

Another benefit of zero tillage is the preservation of the soil's natural structure, which depends on soil fauna. The combined effects of plant residues, microorganisms, and soil fauna lead to an increase in organic matter.

An important aspect of using zero tillage technology is temperature regulation, which has both advantages and disadvantages. For instance, the mulch left on the field in spring prevents the soil from warming up, often leading to delayed sowing times. Conversely, in summer, the soil temperature under the mulch remains lower, which positively affects crop growth, particularly for root and tuber crops (Kolisnyk et al., 2020c; Blanco-Canqui et al., 2022)?

A somewhat different approach from zero tillage is strip tillage, also known as strip-till. While it shares similarities with zero tillage, strip tillage involves partial soil preparation, creating strips 15 cm–25 cm wide with row spacing for row crops, typically around 70 cm.

The advantages of this method include faster warming of the cultivated strips, which allows sowing times to remain unchanged. Additionally, it retains the anti-erosion effect and conserves moisture due to the mulch layer in the gaps between the strips. However, there are also notable challenges. For instance, strip tillage requires fields with flat surfaces. Other challenges include significant financial investments for machinery replacement and the implementation of GIS support systems (Fernández et al., 2015; Adamchyk et al., 2023).

Such practices have demonstrated their effectiveness, as described by numerous researchers (Parkhomenko, et al., 2021; Datsko, et al., 2024a). For instance, Kan et al. (2022) showed that using no-till technology compared to traditional methods significantly improves soil structure, reduces carbon mineralization processes, and enhances biota activity. Similar results were observed on Phaeozem soils by Polish scientists (Hewelke et al., 2024; Davydenko et al., 2024), who reported a substantial increase in total organic carbon content, improved soil structure, and enhanced water permeability. Studies on the impact of no-till on plant root systems indicate that root length in the 0 cm–10 cm soil layer is significantly greater compared to other tillage systems, while root length in the 10 cm–20 cm layer is lower. At the same time, root biomass in the 0–20 cm layer increases substantially, but it decreases at a depth of 20 cm–30 cm. While these results do not provide a definitive understanding of no-till effects, they highlight its significant influence (Ruis & Blanco-Canqui, 2024; Datsko, at al., 2024b; Dehtiar'ov, et al., 2021).

Similar positive characteristics have been noted in studies on strip-till. These include increases in earthworm populations, microbiota, available phosphorus and potassium, and other soil properties (Jaskulska et al., 2020; Lys et al., 2024). Polish researchers also confirmed that soil moisture under strip-till systems is significantly higher than under traditional tillage; while soil temperature is notably lower (Gałęzewski et al., 2022).

Crop rotation is equally important in regenerative agriculture. It not only ensures the rational use of soil resources but also reduces pathogen pressure on fields, which is relatively high when using no-till and strip-till systems. Plant residues left in the field often harbor fungal organisms and pests from the previous crop (Shah et al., 2021; Sobko et al., 2024).

Another commonly applied practice is the use of cover crops. These are grown on agricultural fields to protect the soil from erosion and improve its properties (Koudahe et al., 2022; Zakharchenko et al., 2024). Cover crops help reduce weed growth, optimize soil moisture, and lower soil temperature, which ultimately increases the productivity of the primary crop.

Conclusion

Regenerative agriculture is a crucial direction in the sustainable development of the agricultural sector, aimed at improving soil health, conserving natural resources, and mitigating climate change. Key practices, such as no-till and strip-till farming, crop rotation, and the use of cover crops, contribute to enhancing soil fertility, preserving moisture, and promoting biodiversity. Despite requiring significant investments and facing implementation challenges, these technologies demonstrate positive outcomes for both the environment and agriculture, laying the foundation for a sustainable future.

References

Adamchyk Y., Kravchenko N. Kolisnyk O., Aralova T., Protasov O., Dubovyk O., Dubovyk I., Stavytskyi A. (2023). The efficiency of urea-ammonium nitrate application in inter-row feeding in maize cultivation. *Mod. Phytomorpholog.* **17:**113–117.

Blanco-Canqui H., Hassim R., Shapiro C., Jasa P., Klopp H. (2022). How does no-till affect soil-profile compactibility in the long term? *Geoderma.* **425:** 116016.

Boppart T., Kiernan P., Krusell P., Malmberg H. (2023). The Macroeconomics of Intensive Agriculture. *Natl. Bur. Econ. Res.*1-67.

Dang Y. P., Page K. L., Dalal R. C., Menzies N. W. (2020). No-till farming systems for sustainable agriculture: an overview. No-till Farming Systems for Sustainable Agriculture: Challenges and Opportunities. 3-20.

Datsko O., Kovalenko V., Yatsenko V., Sakhoshko M., Hotvianska A., Solohub I., Horshchar V., Dubovyk I., Kriuchko L., Tkachenko R. (2024b). Increasing soil fertility as a factor in the sustainability of agriculture and resilience to climate change. *Mod. Phytomorphology.* **18:**110-113.

Datsko O., Zakharchenko E., Butenko Y., Rozhko V., Karpenko O., Kravchenko N., Sakhoshko M., Davydenko M., Hnitetskiy M., Khtystenko A. (2024a). Environmental Aspects of Sustainable Corn Production and its Impact on Grain Quality. *Ecol. Eng. Environ. Technol.* **25:**163–167.

Davydenko Gennadiy, Rozhko Valentina, Karpenko Olena, Podhaietskyi Anatoliy, Kravchenko Nataliia, Toryanik Valentina, Shvets Bohdan, Hordiienko Vladyslav, Vasylenko Serhii, Badzym Roman, Zubko Sergiy. (2024). Mitigating the impact of intensive farming on the climate change. *Mod. Phytomorphology* .**18:**219-223.

Dehtiar'ov Y., Havva D., Kovalzhy N., Rieznik S. (2021). Transformation of Physical Indicators of Soil Fertility in Typical Chernozem of the Eastern Forest-Steppe of Ukraine. *Soils Under Stress, Springer Cham.* 105-110.

Fernández F. G., Sorensen B. A., Villamil M. B. (2015). A Comparison of Soil Properties after Five Years of No-Till and Strip-Till. *Agron. J.* **107:**1339-1346.

Gałęzewski L., Jaskulska I., Kotwica K., Lewandowski Ł. (2022). The Dynamics of Soil Moisture and Temperature-Strip-Till vs. Plowing - A Case Study. *Agronomy.* **13:** 83.

Hewelke E., Mielnik L., Weber J., Perzanowska A., Jamroz E., Gozdowski D., Szacki P. (2024). Chemical and Physical Aspects of Soil Health Resulting from Long-Term No-Till Management. *Sustainability.* **16:** 9682.

Horowitz J. K., Ebel R. M., Ueda K. (2010). No-Till Farming Is a Growing Practice. 1-22.

Jaskulska I., Romaneckas K., Jaskulski D., Gałęzewski L., Breza-Boruta B., Dębska B., Lemanowicz J. (2020). Soil Properties after Eight Years of the Use of Strip-Till One-Pass Technology. *Agronomy*, **10(10):** 1596.

Kan Z., Liu W., Liu W., Lal R., Dang Y. P., Zhao X., Zhang H. (2022). Mechanisms of soil organic carbon stability and its response to no-till: A global synthesis and perspective. *Glob. Change Biol.* **28:** 693-710.

Karpenko O. Yu., Rozhko V. M, Sobko M. G., Medvid S., Amons S., Zakharchenko E. A. (2023). Weed infestation of winter wheat in organic crop rotation and economic efficiency of its cultivation. *Mod.Phytomorphology.* **17:** 127-131.

Karpenko O.Y., Butenko A.O., Rozhko V.M., Tsyz O.M., Tkachenko M.A., Asanishvili N.M., Zadubynna E.V., Masyk I.M., Sobran I.V. (2021). Assimilation apparatus indices of maize plants under conditions of the right bank forest steppe of Ukraine. *Mod. Phytomorphology.* **15:** 1-5.

Kolisnyk O.M, Onopriienko V.P., Onopriienko I.M., Kandyba N.M., Khomenko L.M., Kyrychenko T.O., Tymchuk D.S., Tymchuk N.F., Terokhina N.O. (2020c). Study of correlations between yield inheritance and resistance of corn self-pollinating lines and hybrids to pathogens. *Ukr. J. Ecol.* **10:** 220-225.

Kolisnyk O.M., Khodanitska O.O., Butenko A.O., Lebedieva N.A., Yakovets L.A., Tkachenko O.M., Ihnatieva O.L., Kurinnyi O.V. (2020b). Influence offoliar feeding on the grain productivity of corn hybrids in the conditions of the Right-bank forest-steppe of Ukraine. *Ukr. J. Ecol.* **10:** 40-44.

Kolisnyk O.O., Vatamaniuk O.V., Butenko A.O., Onychko V.I., Onychko T.O., Dubovyk V.I., Radchenko M.V., Ihnatieva O.L., Cherkasova T.A. (2020a). Analysis of strategies for combining productivity with disease and pest resistance in the genotype of base breeding lines of maize in the system of diallel crosses. *Mod. Phytomorphology.* **14:** 49-55.

Koudahe K., Allen S. C., Djaman K. (2022). Critical review of the impact of cover crops on soil properties. *Int. Soil Water Conserv. Res.* **10:**343-354.

Lys N., Kolisnyk O., Klymchuk O., Verheles P., Tkachuk N., Sakhoshko M., Rozhko V., Karpenko O., Kriuchko L., Bordun R. (2024). Economic and energy assessment of willow and poplar cultivation depending on the density of the plantation and the nutritional background. *Mod. Phytomorphology.* **18:** 130-137.

Newton P., Civita N., Frankel-Goldwater L., Bartel K., Johns C. (2020). What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes. *Front. Sustain. Food Syst.* **4:**577723.

Parkhomenko M. M., Lychuk A. I., Butenko A. O., Karpenko O. Yu., Rozhko V. M., Tsyz O. M., Chernega T. O., Tymoshenko O. P., Chmel O. P. (2021). Nitrogen balance in short crop rotations undervarious systems forrestoringsod-podzolic soil fertility. *Ukr. J. Ecol.* **11:**67-71.

Prymak I. D., Prymak, O. I. (2009). Historical aspects of the emergence of agriculture. *Sci. Bull. Uzhhorod Univ. Biol. Ser.* **25:**130-136.

Prysyazhnyuk M. V. (2013). History of the development of agriculture as a branch and science. *Collect. sci. works Natl. Sci. Cent. Inst. Agric. NAAS.* **1-2:**174-182.

Rhodes C. J. (2017). The Imperative for Regenerative Agriculture. *Sci. Prog*, **100:**80-129.

Ruis S. J., Blanco-Canqui H. (2024). How does no-till affect soil-profile distribution of roots? *Can. J. Soil Sci.* **2023**:0099.

Shah K. K., Modi B., Pandey H. P., Subedi A., Aryal G., Pandey M., Shrestha J. (2021). Diversified Crop Rotation: An Approach for Sustainable Agriculture Production. *Adv. Agric.* 1-9.

Sobko Mykola, Zakharchenko Elina, Kolisnyk Oleg, Medvid Svitlana, Kysylchuk Andrii, Krokhin Stanislav, Rudska Nina, Amons Sergey, Omelianenko Oleksandr, Bondarets Roman, Surzhykov Mykola. (2024). Yield and energy efficiency of sunflower cultivation under different primary soil tillage methods. *Mod. Phytomorphology.* **18:** 200-204.

Zakharchenko Elina, Sobko Mykola, Kolisnyk Oleg, Medvid Svitlana, Kriuchko Lyudmyla, Aralova Tetiana, Mostovenko Voldemar, Badzym Roman, Mikitchenko Sergiy, Hordiienko Vladyslav. (2024). Weed infestation of corn in organic crop rotation in the North-Eastern forest steppe of Ukraine. B Weed infestation of corn in organic crop rotation in the North-Eastern forest steppe of Ukraine. *Mod. Phytomorphology.* **18:** 224-227.