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POTENTIAL OF NO-TILL TECHNOLOGY FOR ENVIRONMENTAL PROTECTION

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Abstract
Reducing the negative impact of agricultural practices on the environment is essential. There is a growing need for the use and adoption of environmentally friendly and environmentally sound technologies in agriculture. Encouraging the adoption of agri-environmental practices will increase crop productivity, minimise labour time, improve biological control, reduce erosion, improve soil structure, increase infiltration and water retention properties and achieve environmental sustainability. The wide range of conditions under which the minimum tillage system works successfully worldwide are its economic, social and environmental advantages. No-till technology is often characterised as a means of tilling the soil and growing different crop species with positive environmental externalities. The purpose of this paper is to describe the importance of using the agroecological practice of no-till and its impact on land resources as well as its secondary environmental impacts. A literature review of the author's views related to the definitions of No-till technology is conducted. It is most commonly defined as no-till, minimum tillage or a technology such as planting in soil without prior preparation. The palette of benefits that agroecological practice brings to the soil, the environment, agriculture and farmers is rich, namely:

- does not disturb soil composition;
- improves the functions that occur in ecosystems;
- increases the availability of crop residues. Increased availability of crop residues and cover crops on cropland increases biomass production, with the maximized yield serving to store more C in the soil;
- improves water conveyance functions, moisture retention, and reduction of surface runoff and erosion, increases heat throughout the soil world;
- production quantities obtained are comparable to those of intensive tillage;
- reduces both labor time and the use of fuels and pesticides;
- minimizes depreciation of the equipment used;
- reduce investment in purchasing attachments;
- smaller capacity of the machinery and equipment used;
- reduce and simplify labour requirements;
- easy matching with crop rotation and improved nutrient cycling.

Key words:
JEL: *Q00, Q01, O13*

Introduction

Tillage is a major cause of farmland degradation – one of the world's most serious environmental problems – posing a threat to food production and rural livelihoods. The purpose of this development is to outline major issues of no-till technology and

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its potential for environmental protection, making recommendations for the development of this technology. The content of the paper is structured as follows: 1) Introduction 2) Literature review of the notion of No-till technology; 3) Methodological framework of the study; 4) Benefits and problems for the application of No-till technology and potential for achieving sustainable agriculture. In the reportoutlines the main problems facing the implementation of No-till technology and analyses its effects and benefits. The benefits are more than significant and are a prerequisite for stimulating the development of these agri-environmental practices and linking them to strategic plans for sustainable agricultural development. On the basis of the last part of the report, recommendations and opportunities for the development of no-till technology are summarised, which not only corresponds to the concept of sustainable agricultural development, but contributes to its real implementation.

Literature review of the concept of no-till technology

According (Griffith, D., Parsons, S., Mannering, J., 1990) No-till is a technology that minimizes or completely excludes any pre-sowing tillage and can reduce erosion by 80 to 90% compared to intensive tillage. The agroecological practice simultaneously reduces both labour requirements and machinery costs compared to other commonly used tillage methods.

In their scientific work, the researchers show that the yields obtained using no-till technology are fully comparable to intensive tillage. Although no-till technology, or also called zero-tillage, usually increases the cost of herbicide use, research in the field has shown that the technology considered in the report provides higher net returns.

In the literature, there are quite a few definitions related to what No-till technology is. (Baker, C., Saxton, K., Ritchie, W., Chamen, W., Reicosky, D., Ribeiro., F., Justice, S., Hobbs, P., 2007) considers it as conservation agriculture. This approach is mainly associated with the management of agroecosystems for improved and sustainable productivity, increased profit and food security, while preserving and improving the resource base and the environment. Using three basic principles, no-till technology and conservation agriculture are in sync and interchangeable, namely:

- minimum mechanical tillage;
- permanent coverage of the soil with organic matter;
- diversification of crops grown in sequence.

Positive impacts of the use of no-till technology are also evidenced by the study of (Commoner, 1972). Reducing the frequency or intensity of tillage allows the soil to retain more organic matter, which stores or „sinks“ carbon that does not contribute to global warming in the form of carbon dioxide (CO2), a greenhouse gas. The adoption of less intensive tillage practices on a large number of farms can result in

significant amounts of carbon being sequestered, allowing agriculture to contribute to efforts to reduce and control greenhouse gas emissions.
Activities beneficial to climate and environmental protection include encouraging farmers and other landowners to reduce tillage intensity, reducing the amount of nitrogen applied to crops, switching to lower-emission fertilizer application methods, changing livestock or manure management practices to reduce methane emissions, and changing crop rotations to include a greater proportion of perennial crops (Johnson, J., Franzluebbers, A., Weyers, S.,, 2007).
No-tillage technologies have great potential to increase soil organic matter content and sequester carbon while growing and maintaining good soil structure and health compared to intensive tillage systems.
Important amongst these are erosion control, water, environmental protection, nutrient cycling, time-saving, reduced fossil fuel use, less wear and tear on machinery, stable and sustainable crop yields, and soil carbon, along with an additional source of income for farmers through carbon (C) credit trading.
Such beneficial impacts of switching to no-till technology have been documented since the 1960s in the USA and the 1970s in West Africa, South America and Australia. The agro-ecological technology is practised on less than 100 million hectares (Mha) worldwide, or on only 6% of the world's cultivated area. Monoculture cultivation of maize, wheat, soybean, etc. is typical in these areas (Wolters, I., Pismennaya, E., Vlasova, O., Perederieva, V., 2021)
The most complete definition of what no-till technology is is given by the author (Lucien, L., Chabanne, A., 2005). For him, no-till farming practices were developed to protect the soil surface from being sealed by rainfall, to achieve and maintain an open internal soil structure, and to improve soil biological processes. No-till farming practices encompass four interrelated soil and crop management techniques:

- minimal soil disturbance – limited to planting/sowing, i.e. no ploughing, disking or other forms of tillage;
- permanent vegetative ground cover – crop residues, cover crops and weeds are kept on the surface and not burnt;
- direct seeding – specialised equipment introduces seed and fertiliser (chemical, organic) through/under the residue, with non-nitrogenous fertiliser mainly applied at the surface;
- reasonable crop rotation- use and application of crop rotation (e.g. cereals and legumes), generation of suitable biomass and continuous use of arable land.

Methodological framework of the study

The aim of this paper is to analyze the impact of agroecological practice in particular no-tillage on environmental protection. The methodological framework of the

study includes : 1) Literature review of the concept of No-till technology 2) Investigation of the effects of No-till technology application on agriculture 3) Determination of the perspectives of No-till technology on environmental protection.

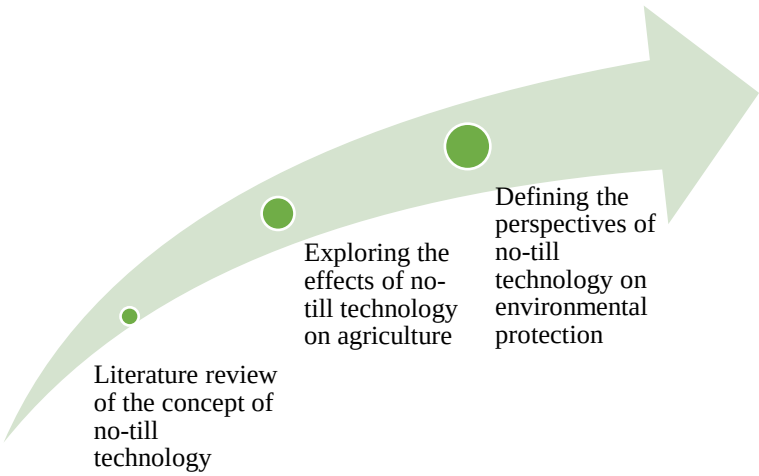

Figure 1. Methodological framework of the study
Source: Author study

Benefits and challenges for the application of no-till technologies and potential for achieving sustainable agriculture

Agricultural practices affect soil characteristics and functions, and therefore have the potential to enhance environmental benefits or minimise negative impacts on the environment. The wide range of conditions under which the minimum tillage system works successfully worldwide are its economic, social and environmental advantages (Branzova, 2022). One of the evolving agroecological practices being implemented by farmers is the adoption of no-till technology, which contributes to positive agroecological effects. Undisturbed soil that is protected by vegetative cover enhances the functions that occur in ecosystems including maintenance of loose and soft soil layers through waste accumulation, intense biological activity, movement of soil fauna and root growth. These functions enhance the efficient transport of water, heat throughout the soil world. Such nutrient recycling system and improved water use efficiency resembles the natural forest environment.

The application and development of no-till technologies is driven by multiple factors. Some of these factors stem from the external environment – politics, markets, financing, others are related to the specifics and characteristics of the used technology – climatic factor, small-scale production, need for land and water resources,

others from the inclusion of the concept of sustainable development (Dimitrova. A., 2022). Some of these factors have a partial or total impact on the implementation of this technology in farms, society, quality of life and, to a large extent, the environment.

The economic advantages of no-till technology are also numerous.

The quantities of agricultural production obtained can be compared with intensive tillage, with the main difference being that a more sustainable method is obtained when applying no-till technology (Sorokina, S., Sorokin, N., Sychev, S., Okorokova, F., 2021).

It is among the main operations in which minimum tillage can save between 30-40% of both labour time and the execution of the different technological processes, but at the same time will reduce the use of fuels and pesticides compared to intensive agriculture.

Other economic benefits of zero tillage are:

- minimising depreciation of the machinery used;
- reduction of investment in the purchase of implements;
- lower capacity of the machinery and equipment used;
- reduction and simplification of labour requirements (Baker, C., Saxton, K., Ritchie, W., Chamen, W., Reicosky, D., Ribeiro., F., Justice, S., Hobbs, P., 2007).

Implementation of no-till technology would lead to multiple environmental benefits for the environmental impact.

The combination of no-till technology and crop rotation results in a high improvement of biological control of weeds, insects, pests and diseases.

The use of agro-ecological technology leads to the preservation of the habitats of beneficial micro-organisms and animals in the underground world. These beneficial animals feed on plant residues left on the soil. They introduce the residues into the soil without the need to carry out various techno-logical processes (Kutovaya, O., Nikitin, D., Geraskina, A., 2020).

Figure 2 presents the main environmental benefits of the application of no-till technology. Soil cover reduces erosion and favours water infiltration, reducing the likelihood of landslides in hilly areas and reducing groundwater pollution. Soil has a high water-holding capacity, which means it can better absorb and retain water during periods of heavy rainfall and drought, making farms more resilient to extreme weather conditions.

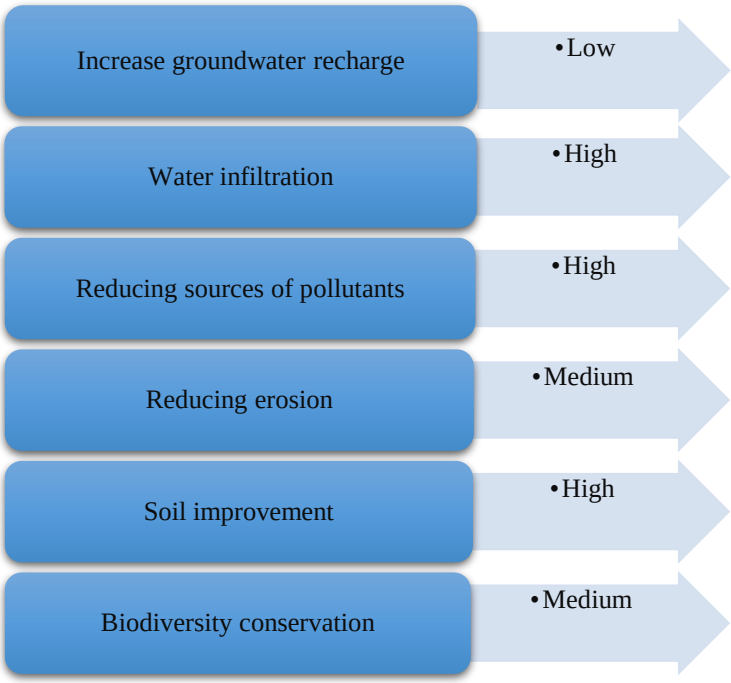

Figure 2. Main effects of no-till technology and its level on environmental protection
Source: adapted from (Krause, M., Black, J., 1995)

The greatest impact is also the reduction of greenhouse gas emissions, lower consumption of fossil fuels, less co-liquids of organic matter that are transformed into carbon dioxide and its absorption. The sequestration of carbon in the soil is crucial, given that climate change is caused by the release of greenhouse gases. The technology used creates favourable conditions for seed germination due to the effect contributed by other plant remains on the soil surface. The abrupt changes in the seasons result in an increasing need to maintain the necessary temperature for the development of the plant root system in the soil. One of the main effects of technology is the prevention and control of soil erosion. The main negative features due to erosion are:

- loss of soil horizon;
- loss of humus and organic matter;
- soil susceptibility to crusting;
- impaired infiltration of air and water (Belobrov, V., Yudin, S., Yaroslavtseva, N., Yudina, A., Dridiger, V., Stukalov, R., 2020).

Soil erosion is caused by two factors. The first has to do with the timing and method of tillage itself; soil loss due to wind erosion occurs because of soil disturbance.

The second factor is due to the amount of rainfall, due to the washing away of nutrients and the alteration of the soil structure (Dridiger, V., Gadzhiumarov, R., 2021).
The reduced quality of the used farmland is also due to the lack of plant residues on the surface topsoil, intensive cultivation, climatic changes, (Blanco-Canqui, H., Francis, C., 2016). By switching to no-till technology, the natural structure of the soil is restored and its strength and organic matter content is increased.
One of the common objectives of no-till technology is to reduce soil compaction. Difficult water infiltration and root development can lead to lower yields.

Conclusion

The fulfilment and development of the potential of no-till technology is among the main prerequisites for the emergence of a number of economic, social, environmental and other effects that influence the sustainable development of agriculture. Zero tillage leads to the creation of prerequisites for sustainable development through the production of environmentally friendly food products, minimal use of natural resources, saving of working time, reduction of depreciation of the machinery used.

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