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Abstract

The aim of this paper is to characterize the low-input farming considering the resources it uses, scale of farming operations to which it suits, and its environmental impacts along with sustainability issues. The research was conducted by literature review. Low input farming systems seek to optimize the management and use of on-farm resources and to minimize the use of production inputs as off-farm resources, such as purchased fossil fuels, chemical fertilizers, and pesticides. The research has shown that low-input farming can contribute to lessening the use of synthetic pesticides, fertilizers, and fossil fuels while enabling the recovery of soils' fertility, and biodiversity in the agroecosystems. Thanks to the expected recovery of soil fetility and porosity, there is anticipated greater resilience of low-input farming to extreme climatic events like droughts when compared with currently prevailing intensive farming. Therefore, the low-input farming can be much appreciated among the farming options for the improved sustainability.

Key words: low-input farming, soil fertility, pesticide emmissions, biodiversity, resilience

Introduction

Agriculture still provides the essential goods to humanity, including the majority of food, and some fiber and energy. However, at the same time it pollutes the ecosystems (by the use of synthetic fertilizers and by pesticides emmissions), causes biodiversity loss (by spread of arable farming and pesticides emmissions), loss of soil fertility (loss of soils' productive capacity by excessive use of mineral fertilizers, loss of humus content and soil compaction by heavy machinery), and contributes to the exhaustion of fossil resources (crude oil, natural gas and phosphate rocks) and carbon (CO_2) emmissions to the atmosphere (due to diesel fuel combustion, humus loss in arable soils and gas combustion in nitrogen fertilizers production). Sustainable development of humanity largely depends on the sustainability of agriculture, as well as on its impacts on ecosystems.

There is no doubt that chemization and mechanization of agriculture were associated with a great increase in food production and productivity of human labor (machines have largely replaced the labor), but in the view of contemporary threats to the sustainability, they have to be re-thinked. Besides the chemical-, machinery- and capital-intensive agriculture, during the last several decades there emerged some more sustainable options, including the integrated agriculture, organic agriculture, ecological agriculture, regenerative agriculture, permaculture and biodynamic agriculture. Besides the mentioned alternatives, there is general growth of interest for the low-input farming.

According to Poux (2007), low input farming systems should be considered as a core option for Europe. Low Input Farming Systems seek to optimize the management and use of on-farm resources and to minimize the use of production inputs as off-farm resources, such as purchased fossil fuels, chemical fertilizers, and pesticides (Parr et al., 1990; cit. Poux, 2007). Main advantages of low input farming systems over the high input ones are found to be the potentialy higher efficiency at the farm level, reduction of pollution risks and beneficial effects to biodiversity and lanscape (Poux, 2007). According to Garré (2022), the inclusion of work horses in sustainable transitions, can help increase the farm autonomy and sustainability of European smallholdings. Since the animal-drawn agronomy relies on the on-farm produced fodder as a source of clean and carbon-neutral bioenergy (Gantner et al., 2014), it perfectly fits into concepts of low-input farming systems and circular economy as well.

In shaping the future options for improved sustainability, there might be beneficial to consider the nowadays almost neglected traditional knowledge. Namely, indigenous and other long-resident peoples, have accumulated the knowledge, that has enabled them to live in one place, using the resources of their homelands sustainably, for countless generations (Turner et al., 2022).

On-farm produced soil fertilizers for low-input farming

Besides the main goals for which the livestock is reared (milk production, meat production, hides and fur production, work), there is at the same time unavoidable production of farmyard manure (FYM). FYM is recognized as a valuable resource for rising the soils' fertility and crops' yields, from the ancient times till the nowadays (Singh et al., 2020). According to the same group of authors, large-scale intensive farming has resulted in several physical and physiological problems in the soil and is also responsible for soil and environmental pollution. There is excess of chemical fertilizers in the unavailable form that are left in the soil, and these residuals cannot be absorbed by the plant. In the case of rainfall soon after application of chemical fertilizers, they come washed away and accumulated in water bodies and cause water pollution, resulting in algal bloom. Application of mineral N-fertilizers is proven to decrease the organic matter content in soils, thus degrading the soil fertility (Mulvaney et al., 2009). Contrary, rising the soils' fertility by FYM application and green manuring is known to improve chemical and physical properties of soils including the reduction of bulk density and increase of soil porosity and aeration (Singh et al., 2020), what is associated with increased rainwater infiltration rate. Increase of soils' porosity, water infiltration rate and water holding capacity becomes crucially important for mitigation of drought effects (because soil acts as a sponge for water storage), and therefore it is expected that the organic soil fertilization will rise its appreciation by farmers and conscient consumers. Annual production and quality of FYM varies with the livestock species, age, diet, productivity, use of bedding and storage. In the research of Ambrušec et al. (2021), green manuring with crimson clover was found competitive with chemical fertilizers for achieving the desired maize yields, but green manuring was associated with the need for additional field operations (i.e. energy consumption) for establishing the green manure crop and for incorporation of its herbage into soil. Therefore Ambrušec et al. (2021) proposed to consider the use of animal traction fuelled by the on-farm produced fodder in order to avoid the additional monetary expences for purchased fuel.

Soil compaction is one of the major problems faced by modern agriculture (Hamza and Anderson, 2005) since it threatens many determinants of soil fertility (Soane and Ouwerkerk, 1995; Horn et al., 1995). It is well documented that one of the main causes for soil compaction is the overuse of machinery (Hamza and Anderson, 2005). Oppositely, horses provide a tried and tested solution to prevent soil compaction (Herold et al., 2009; cit. Gantner et al., 2014). Although horses can under certain circumstances impose a higher ground pressure than tractor tyres, the compaction effect is limited to the top few centimetres of the soil profile because of the comparatively lower weight (Wyss, 1999; cit. Gantner et al., 2014). Therefore, there is anticipated the restoration of soil pores required for rainwater infiltration and accumulation for the drought periods, by reintroduction of animal traction into field works, what would enhance the adaptation to the forthcoming whether extremes, including droughts.

Findings of Jackson (1988) support the thesis that low-input farming style (Amish) is associated with greater soil fertility and water infiltration rate than in conventional farming (Table 1).

Table 1. Soil fertility parameters of two neighbouring farms: Amish and conventional no-till in Holmes County (Ohio, USA; Jackson, 1988)

Soil fertility parameter	Amish farm	No-till farm
Cathion exchange compley (meq)	7.5 +/- 0.8	7.0 +/- 2.0
Base saturation Ca^{2+} (meq)	67.0 +/- 12	50.0 +/- 19.0
Base saturation Mg^{2+} (meq)	12.0 +/- 3.0	8.0 +/- 4.0
pH	6.38	5.65
Organic matter (%)	2.6 +/- 0.3	1.9 +/- 0.1
Bulk density in maize fields (g/ccm)	1.29 +/- 0.06	1.5 +/- 0.01
Steady state infiltrability in maize fields (ml/hr)	6.88	0.93

On-farm produced plant protection preparations for low-input farming

Synthetic pesticides have provided very efficient crop protection from various pests since the Green Revolution. However, there are rising problems of emmissions of toxic compounds into environment and loss of biodiversity associated with the excessive use of synthetic pesticides. Another arising problem is the loss of efficiency of these pesticides due to achieved resistants of pests. All above mentioned pushes the researchers and practical farmers to search for more sustainable options. Luckily, many plant-derived and natural preparations have shown the more or less acceptable efficiency in controlling the losses caused by insect pests (Ignacimuthu, 2012) and fungal pathogens (FAO, 2015), and they can be prepared on-farm. In this way the reliance on the on-farm resources would help to lessen the emmissions of toxic substances into environment, while providing the safe food free of toxic residues. Moreover, this rises the autonomy and resilience of farmers what might be very advantegous in circumstances of disturbed supply chains. However, the use of on-farm produced resources for plant protection is more convenient for small farmers than for large agricultural enterprises since it requires much labor for their preparation. And, there should also be pointed, that the research of the on-farm produced plant-protection and pest-control agents has to be continued in order to find more efficient methods and preparations. Collection of knowledge from the old native and indigenous people (even in Europe) can much help in getting the ideas for scientific testing, as already noted by the authors (not published data about preparation and effectivity of traditional herbal brews for plant pests control). The research of assisting the predatory birds activity for the control of field rodents was inspired by the told memories of old farmers of eastern Croatia (Simunić et al., 2020).

Lessening the consumption of energy from fossil resources and reducing the CO_2 emmissions

Lessening or even avoidance of the consumption of energy from fossil resources in crop production can be achieved by partial or even complete substitution of mechanical tractors with the animal traction (e.g. with draft horses), thus also reducing the CO_2 emmissions to the atmosphere and achieving the farmers' self-reliance and improved resilience in cases of disturbed supply chains. Namely, all the fodder consumed by draft animals can be produced on-farm, and it is produced by the recent photosynthesis (i.e. recent binding of the atmospheric CO_2 into organic compounds comprised in fodder; Gantner et al., 2014). Vegetable, vine and orchard/fruit farmers are more likely to accept the animal work because thay already employ much labor, despite the modern extensive mechanization in cereals, oilseeds and pulses production. A greater hesitancy is expected for farmers that produce cereals, oilseeds and pulse grains because the harvest without diesel-powered combine-harvesters is hard and excessive labor (namely, the mowing and separation of grains from the straw), unless there are being used mehanized solutions driven by animal force. However, modern Amish communities that adhere strictly to solely animal and human power have proven that all the operations in food production still can be done without the fossil fuel powered machinery. Despite the shown feasibility and attractivity of animal work in agriculture, according to the authors' knowledge, experienced people who can train and efficiently use the draft horses in agricultural work are rare in most of the modern societies (not published data). In Croatia, this traditional knowledge can be collected from the little number of old people, and can be transmited only through the direct in-person teaching and practical work, thus proving the importance of long-resident peoples as stated by Turner et al. (2022). On the other hand, there are emerging professional associations that collect knowledge on the training and use of animal work, improve the welfare of draft animals and develop the improved implements for greater work efficiency and more comfort both to animals and men (Schmit et al., 2022).

Saving the fossil energy and lessening the CO_2 emmissions in livestock production can be achieved by increased reliance on grazing instead of feeding the stored forages. Namely, for harvested perennial forages (lucerne hay and haylage, grass-clover mixes hay and silage, meadow hay and silage) the greatest part of total production costs, as well as of the used energy is associated with mowing, spreading, collecting, baling and transporting of harvested herbage. Also, considering the maize for the whole-crop silage (which is currently the most important annual forage crop), much fossil fuel is being consumed for soil preparation, crop establishment, and cultivation each year, besides for the harvesting. In the case of grazing, all mentioned jobs are omitted. Namely, the livestock does all job instead of us. Thus, not only the diesel fuel is being saved, but also the CO_2 emmissions are reduced. However, if there is aimed to maintain the constant output of livestock products, with shift to the grazing, there has to be increased number of livestock and increased pasture area due to lesser per-head productivity of grazed livestock when compared to TMR fed ones. Increased pasture area can be obtained either by establishing leys on arable soil or by spread of livestock to the currently much abandoned seminatural grasslands of WB-countries, or both. Establishing short- or mid-term grazed leys (2-5 years) on arable soils will likely improve the overall fertility of already degraded arable soils by increase of the soil organic matter content and recovery of soil porosity, while simultaneously enabling for the improvement of biodiversity in agroecosystem (Gantner et al., 2022). Since the rise in soil organic matter is consequence of plant biomass growth and deposition (live roots and litter), it simultaneously sinks the carbon from atmosphere and sequesters it into the soil, thus fulfilling some of the main aims of current environmental policies.

Producers and consumers attitudes considering the low-input farming

According to the preliminary research (not published yet), farmers attitudes vary in a broad spectrum, from sympathies to the reluctance. Sympathies are mainly due to the expectations for improved resilience and self-reliance for low-input farmers, and due to improved overal sustainability of agriculture and societies. Reluctance stems from the anticipated much greater involvement of human labor that is needed for guiding the draft animals, handling the simple soil-tillage implements, making the on-farm preparations for crop protection, poor work efficiency (only small farms can be operated in this manner) and lack of convenience and comfort that modern tractors provide to farmers. If the low-input farming is to be a significant contributor to the sustainable development of agriculture and societies, along with other more sustainable farming options, there would be needed personal inner transformation of farmers and potential new farmers. In line with this are the findings of Woiwode et al. (2021) who stated that, besides the technological solutions, there would be required an inner transformation for system change towards sustainability. In this context, the inner transformation relates to consciousness, mindsets, values, worldviews, beliefs, spirituality and human–nature connectedness. In order to inspire the changes considering the reluctant attitudes, there will be required upgraded education of all stakeholders in agri-food sector. Considering the consumers, they mainly show much sympathies but with some scepticism about the acceptance of low-input farming by modern farmers.

The old natives' wisdom that the land is not inherited from our ancestors but is borrowed from our descendants might be helpful in motivating the required transformational thinking.

Conclusion

The research has shown that low-input farming can contribute to lessening the use of synthetic pesticides, fertilizers, and fossil fuels while enabling the recovery of soils' fertility, and biodiversity in the agroecosystems. Thanks to the expected recovery of soil fetility and porosity, there is anticipated greater resilience of farming to extreme climatic events like droughts. Through the reliance predominantly on the on-farm produced resources, low-input farming is expected to contribute to self-reliance of farmers and better tolerance of the supply-chain disturbances. Besides the expected lesser emmissions of toxic compounds and CO_2, there is also expected greater sequestration of atmospheric CO_2 into soil organic matter due to employment of organic soil fertilization and livestock grazing in low-input farms. Due to all bove mentioned, the low-input farming can be much appreciated among the farming options for the improved sustainability.

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“Poljoprivreda s niskim ulaganjima” za poboljšanu održivost poljoprivrede

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Sažetak

Cilj ovog rada je okarakterizirati poljoprivredu s niskim ulaganjima s obzirom na resurse koje koristi, opseg poljoprivrednih poduzeća kojima odgovara i njezin utjecaj na okoliš zajedno s pitanjima održivosti. Poljoprivreda s niskim ulaganjima nastoji optimizirati korištenje reursa porijeklom s farme, a minimizirati korištenje resursa porijeklom izvan farme, kao što su kupljena fosilna goriva, kemijska gnojiva i pesticidi. Istraživanje je provedeno pregledom literature. Istraživanje je pokazalo da poljoprivreda s niskim ulaganjima može pridonijeti smanjenju upotrebe sintetičkih pesticida, gnojiva i fosilnih goriva, a istovremeno omogućiti oporavak plodnosti tla i bioraznolikosti u agroekosustavima. Zahvaljujući očekivanom oporavku plodnosti i poroznosti tla, očekuje se veća otpornost poljoprivrede s niskim ulaganjima na ekstremne klimatske događaje poput suša u usporedbi s trenutno prevladavajućom intenzivnom poljoprivredom. Zbog svega navedenog, poljoprivreda s niskim ulaganjima može biti vrlo cijenjena među poljoprivrednim opcijama za poboljšanu održivost.

Ključne riječi: poljoprivreda s malim ulaganjima, plodnost tla, emisije pesticida, bioraznolikost, otpornost