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ECONOMIC ASPECTS OF ORGANIC SOY PRODUCTION IN UKRAINE

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Abstract. The *subject* of this work is the implementation of the strategy of sustainable development in Ukraine, which is based on ensuring national interests and fulfilling international obligations, it is envisaged to overcome imbalances that exist, in particular, in the environmental sphere, the harmonisation of global climate change trends with international standards through the introduction of scientific aspects of organic soybean production. The *objective* of the present study is to analyse the global soybean market and ascertain its particular significance within the global production of oil crops. This analysis will establish the sustainable soybean production zone in non-irrigated regions and the guaranteed production zone. The *research methodology* is based on European experience, taking into account the theoretical and methodological provisions of the scientific aspects of organic soybean production in Ukraine. The aim of this methodology is to greening agriculture, soil conservation and rational use of bioecosystems. It has been found that the rational use of natural resources through the organic production of soybeans, through the development and implementation of bio-organic farming technologies, improves the culture of agriculture, restores and improves soil fertility, and increases the amount of available protein products and nutritious fodder. The *findings* of the research indicate that the organic matter present in the soil functions as a vital indicator of its fertility. It plays a pivotal role in the nutritional sustenance of plants, the establishment of favourable physicochemical properties, and the migration of diverse chemical elements. The most significant soil processes are predominantly associated with the enhancement of the agricultural sector. It has been proven that a genuine source of organic matter for enhancing soil fertility is the development of organic models of soybean cultivation technology. Consequently, the substantiation of its agrobiological potential in selected areas of sustainable production on non-irrigated land will ensure the territorial transformation of the "soybean belt". A new stage in the production of soybean crops is substantiated, which will contribute to the rational use of hydrothermal resources of the region, increase the gross production of soybean seeds, biologisation of agriculture, and production of high-quality, environmentally friendly products.

Keywords: soybean, organic farming, soil fertility, soybean belt, gross production.

JEL Classification: Q17

1. Introduction

The global scientific community's awareness of the growing ecological threat posed by intensive agriculture has stimulated the development of alternative management models that are more in line with society's vital interests (Alaru et al., 2014). This is the model of organic soybean production, which provides the growing global market with certified, high-quality and environmentally safe products (Dumpis et al., 2021).

The practice of "organic production" is a science-based agricultural practice that eschews the use of synthetic plant protection products and fertilisers. Instead, it is based as much as possible on crop rotation, the use of plant residues, organic fertilisers, legumes, organic production waste, mechanical soil cultivation and contributes to increasing fertility and improving the structure of soil and ensuring full nutrition of plants (Babich et al., 1998; Bakhmat et al., 2023). It is evident that the organic production of soybeans constitutes a comprehensive system of management and production of food products and nutritious feed. This system integrates scientifically based aspects of cultivation technology with the objective of preserving natural resources and applying high standards of proper animal husbandry to ensure food security at the state level (Didur et al., 2024). The implementation of the proposed system of modernisation of the model of organic soybean production is intended to facilitate research into the European experience of adaptation to climate change and the possibility of its application in Ukraine under martial law. This will be achieved

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by studying the provision of ecological and social effects that will guarantee a reduction in the impact of degradation processes affecting the land cover of Ukraine. The implementation of the results will make it possible to increase the attractiveness of organic soybean cultivation and the production of high-protein food and nutritious feed from it by reducing production costs through the use of new bio-organic technologies, while at the same time reducing production costs.

2. Materials and Methods

As part of the implementation of the strategy of sustainable development in Ukraine, based on the protection of national interests and the fulfilment of international obligations, it is planned to overcome the existing imbalances, especially in the environmental sphere, to bring the trends of global climate change into line with international standards through the introduction of scientific aspects of organic soybean production. The priority is to study the global soybean market; determine its share in the structure of global oilseed production; identify areas of sustainable soybean production on non-irrigated land and areas of guaranteed production; provide agroecological justification for the role of soy in solving the problem of vegetable protein in Ukraine and the world; increase the gross production of soybean seeds, biologisation of agriculture, production of high-quality, environmentally friendly products in accordance with the directions of the Strategy for Environmental Safety and Adaptation to Climate Change until 2030, the Law of Ukraine "On the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the Period up to 2030" and the European Green Deal; the Project of the Sustainable Development Strategy of Ukraine until 2030; provisions of the Economic Strategy of Ukraine 2030 (in the context of responding to risks in the field of agricultural production); the Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine on Creating Conditions for Ensuring Food Security under Martial Law" (Monarkh & Pantsyreva, 2019).

3. Results and Discussion

In terms of its biochemical composition, soybean is a unique, leading protein oil crop in world agriculture. The specific weight of soybean in the structure of global oilseed production is 58% (Hnatiuk et al., 2019). In terms of growth rates and production volumes, soybean has no equal in European countries (Figure 1). Soy is capable of rapidly increasing agricultural culture, reviving and improving soil fertility, increasing the amount of available products and fodder, it occupies a central place in the solution of protein (Kurhak et al., 2024).

Soybean production in European countries shows a clear upward trend from 2020 (Yanovich et al., 2018). The analysis of production volume data shows that the growth rate will reach 11.5 million tonnes in 2023, which is 16.2% more than in 2022. In the last decade, the lowest soybean harvest was in 2013 compared to 2023. The dynamics of soybean production in European countries increased by more than 113.0% (Table 1).

It should be noted that Ukraine is the leading producer of soybeans in Europe and will be one of the top ten producers in the world in 2013-2023 (Pawlewicz et al., 2020; Piwowar et al., 2021). According to the US Department of Agriculture

Figure 1. Dynamics of soybean production in European countries (2013-2023)

Source: authors' research based on data from the Austrian Development Agency, the State Statistics Service, and the Ministry of Agrarian Policy of Ukraine

Table 1
Volumes of soybean production in Ukraine and Europe, million tons

European country	Year		Change	
	2022	2023	million tons	%
Ukraine	3732	4410	+678	+18,2
Italy	610	1040	+430	+70,5
Serbia	440	404	-36	-8,3
France	380	420	+40	+10,5
Austria	244	275	+31	+12,7
Croatia	200	253	+53	+26,5
Hungary	127	165	+38	+29,9
Slovakia	130	165	+34	+26,5
Total	5863	7132	+1269	+17,8

Source: authors' research based on data from the Austrian Development Agency

(USDA), Ukraine moved up two places in the ranking, second only to Brazil – 39%, the US – 37%, India – 27%, Argentina – 11%, China – 10%, Paraguay and Canada (Jansson et al., 2019; Poore & Nemecek, 2019).

According to a report by the US Department of Agriculture's Foreign Agricultural Service (FAS), soybean production in India will reach 12 million tonnes in 2023, with 12.8 million hectares of the crop harvested. Over the past two decades, global soybean production has grown to nearly 50-55 million tonnes. Trade in processed soya products is also growing. According to FAO-AMIS research and data analysis, the forecast supply of soybeans for the current marketing season will be 426.4 million tonnes, up 6.3% from the previous period (Keres et al., 2020; Zhao et al., 2022).

Over the last decade, soybean area has increased by almost 50% (Figure 2). Lower fertiliser requirements, the use of saved seed, high EU demand and domestic market demand have made this crop favourable for many farms in Europe (Ramakrishnan et al., 2021).

In the course of processing statistical data, it was noted that the area sown to soybean has increased in recent years (Giampieri et al., 2022; Kuht et al., 2016).

Thus, in 2023, the sown area in Europe as a whole amounted to 5.1 million hectares, which is 8.5% more than in 2022. In the last decade, the smallest sown areas were recorded in 2013 compared to 2023. The production level in European countries increased by 88.9% (Mahmood et al., 2019).

Despite the state of war, Ukraine is actively increasing its soybean area (Figure 3). Soybeans account for 20% of the oilseed area this year (19% in 2022 and 15% in 2021). This is mainly due to the price situation on the oilseed market.

A similar trend in the dynamics of sown area occupied by soybean cultivation was also observed in Ukraine (Marconi et al., 2015). Analysing the statistical data of the State Statistics Service, it was found that in 2023, 1.81 million hectares of Ukrainian land will be planted with soybeans, which is 19.9% more than in 2022. Over the last decade, the smallest areas were recorded in 2020, compared to 2023, the dynamics increased by more than 37.2%.

Demand for soybeans remains strong (Maxwell et al., 2016). In 2023, soybean prices increased by 500 UAH/t and, accordingly, amounted to 460-470 USD/t. Therefore, soybean production in Ukraine reached 4.78 million tonnes in 2023 (Figure 4).

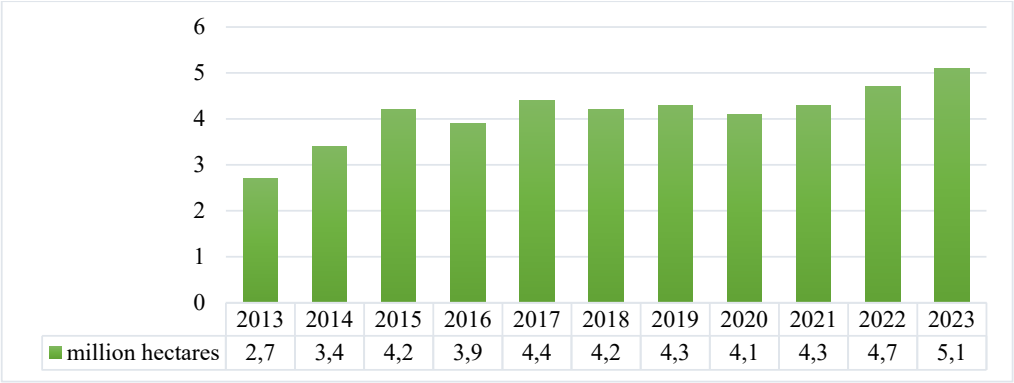

Figure 2. Dynamics of soybean acreage in European countries (2013-2023)

Source: authors' research based on data from the Austrian Development Agency

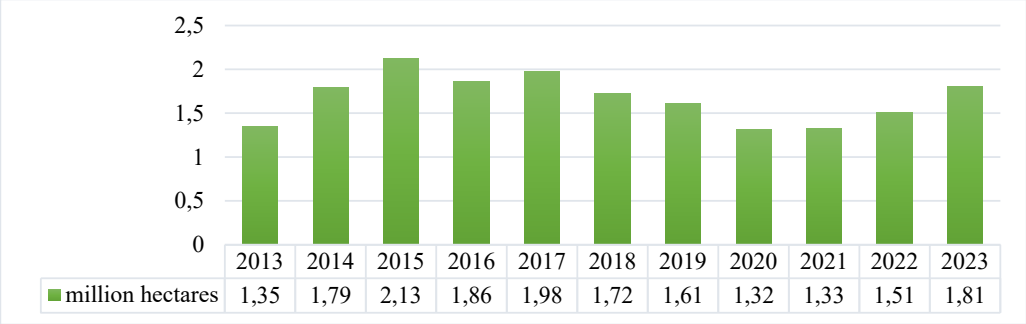

Figure 3. Dynamics of soybean acreage in Ukraine (2013-2023)

Source: authors' research based on data from the State Statistics Service and the Ministry of Agrarian Policy of Ukraine

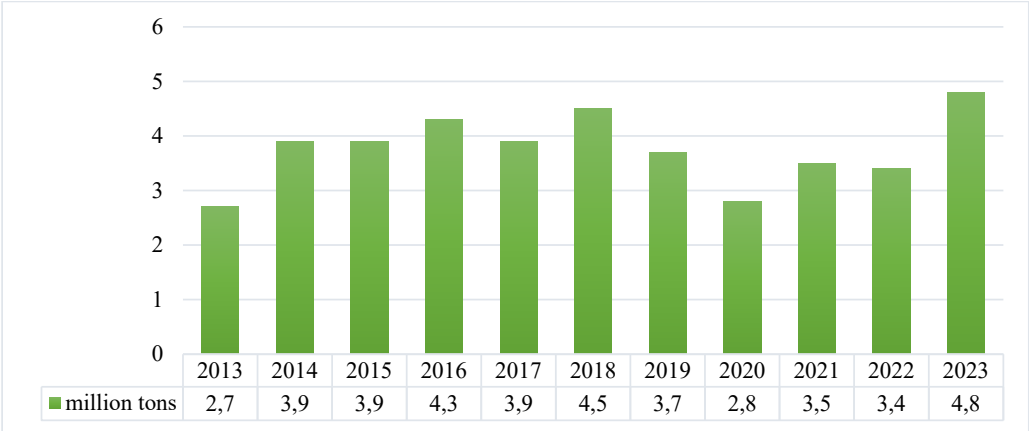

Figure 4. Gross harvest of soybeans in Ukraine (2013-2023)

Source: authors' research based on data from the State Statistics Service and the Ministry of Agrarian Policy of Ukraine

The average yield of soybeans is 2.6 t/ha, although it accounts for only 11% of the total area sown to cereals and oilseeds (Figure 5). With a 7% increase in the area under soybeans on the European continent as a whole, the gross harvest in Europe is forecast to be 16.3% higher than last year.

The maximum yield of soybeans was attained in 2023 (2.73 t/ha) over the past decade. The phenomenon of this culture is that during the growing season, two crops are synthesised – protein and fat – and almost all organic substances that are in the plant world. Soybean seeds and products of its processing have been utilised for a considerable period in large and developed countries to address the pivotal issue of protein and renew food resources. Soy provides in excess of 1.2 tons of protein per 1 ha, is efficiently absorbed by the body and is water-soluble (Parizad & Bera, 2021).

The "soybean belt" of Ukraine, where zones of sustainable soybean production on non-irrigated lands are identified, is scientifically substantiated at the Podillia Institute of Agricultural Feeds of the National Academy of Sciences (Babich et al., 1998) (Figure 6).

In terms of development prospects, soybeans can be grown in quite large areas of the right-bank and left-bank forest-steppe of Ukraine, i.e., in the country's "soybean belt", which includes 8 regions of the forest-steppe zone and two steppe regions, where 79% of soybeans are currently grown, and about 10% are in southern and central Polissia, as well as western regions of Ukraine. Thus, in the conditions of climate change, the territorial transformation of the "soybean belt" is a prerequisite for the establishment of a new stage in the production of soya culture, it will contribute to the rational use of hydrothermal resources of the region, an increase in the production of soybean seeds, the biologisation of agriculture and the obtaining of high-quality organic products (Petrychenko et al., 2024).

In light of the agroecological substantiation of the role of soybeans in addressing the issue of plant protein in Ukraine, future research endeavours should focus on the advancement and development of varietal technologies for soybean cultivation. The accumulation of protein and fat in soybean seeds, as posited by numerous authors, is contingent on a multitude of agrotechnical techniques. Among these, the variety plays a pivotal role as the biological foundation of the technology. The extant literature provides conflicting data on the influence of sowing

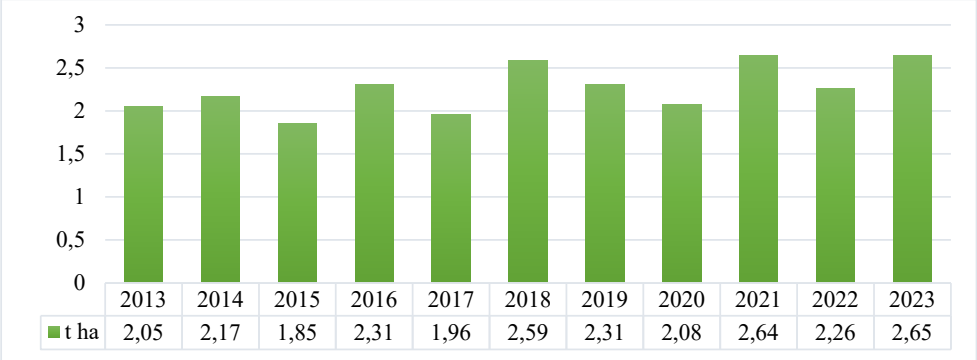

Figure 5. Average seed yield soybean in Ukraine (2013-2023)

Source: authors' research based on data from the State Statistics Service and the Ministry of Agrarian Policy of Ukraine

Figure 6. "Soybean Belt" of Ukraine, 2023

Source: developed at the Institute of Agricultural Fodder of the Podillia National Academy of Sciences

dates and rates on the protein and fat content of soybean seeds. Some scientists have posited that these factors do indeed impact the chemical composition of seeds, while others have advanced the notion that the content of protein and fat is not contingent on the timing of sowing and sowing rates. It is noteworthy that during the phase of full flowering (R1-R2), hydrolytic processes intensify in these organs, and the outflow of the formed decomposition products into the reproductive organs commences. A significant amount of amino acids and amides enter the ripening seeds from the roots due to the introduction of nutrients, where atmospheric nitrogen is bound by symbiotic fixation and restored to the ammonium form. Consequently, the administration of elevated doses of nitrogen fertilisers, which exert a deleterious effect on nitrogen metabolism in plants, results in the inhibition of protein synthesis. For the agroecological justification of organic soybean cultivation in Ukraine, it is especially important to determine the impact of fixed nitrogen from the air and foliar fertilisation with complex biofertilisers on the growth, development and seed productivity of soybeans.

The dominant trends in world agriculture over the past decade have been the improvement of technologies for growing leguminous crops based on the achievements of biotechnology and organic farming systems. It is characteristic that the use of such technologies is increasing in the fields of Ukraine, despite the military situation. The pioneers of eco-innovative technologies are first and foremost large, financially independent farms. Not only do they produce high yields, but they also significantly reduce soil pollution. The expansion of organic farming systems is a positive factor as it contributes to raising the level of general agricultural culture. According to published data, around 70% of soybeans are genetically modified varieties. In terms of yield, these products are superior to the development of domestic breeding, and their cultivation technologies, thanks to the use of bacterial preparations and microfertilisers, have a significant advantage in the plant care system. The expansion of the soybean sowing area can be attributed to the implementation of these technologies. At this juncture, the association is unable to compete with the achievements of foreign research centres,

even on their own markets in the field of biotechnology of European countries. Hence, the primary objective of the European Green Course is to transform Europe into a climate-neutral continent. In order to maintain its influence on the domestic soybean production market, it is necessary to explore opportunities for collaboration with leading research centres and agricultural enterprises. Concomitantly, considerable attention is being directed towards sustainable agriculture in a number of countries, notably the EU, with a view to greening and reducing the negative impact of intensive crop cultivation technologies on the environment. The primary means of achieving this objective is the reduction of pesticide and mineral fertiliser usage, alongside the exploration of methodologies for augmenting biological measures, inoculation techniques, and the mitigation of soil cultivation intensity, in accordance with the transition to environmentally sustainable technologies, namely No-Till, Strip-Till and Mini-Till. The role of the crop rotation factor and the role of organic fertilisers are increasing (Petrychenko et al., 2024).

Moreover, the resurgence of animal husbandry has the potential to serve as a stabilising factor in the intensification of the production of seeds and protein-oil crops during the post-war reconstruction of the state. Soybean seeds contain anti-nutrients, which are predominantly protein in nature, rendering them amenable to neutralisation through the application of elevated temperatures. These are: protease inhibitors – trypsin and chymotrypsin inhibitors; antivitamins A, D, E, B12; compounds that reduce the availability of trace elements such as zinc, manganese, copper and iron; alkaloids; phytohaemagglutenins; allergens; goitrogenic antihormones and estrogenic isoflavones – genistein and daidzein; oligosaccharides – stachyose, raffinose and verbascose, which cause flatulence; enzymes – urease, lipase and lipoxygenase (Tkachuk et al., 2024). In animals, antinutrients cause growth retardation, reduced feed efficiency, goiter, pancreatic hyperfunction and hypertrophy, loss of fertility, allergies, rickets, osteoporosis, anaemia and parakeratosis. The maximum permissible activity of trypsin inhibitors that is safe for young animals is 3 mg/g, or no more than 1 mg/g of trypsin inhibitors per 10% of protein. The urease activity provides an indirect measure of the required degree of heat treatment of soya beans. Safe urease activity in heat-treated grain, meal and other soybean products, except soy milk and paste, for young animals should be no more than 0.05 pH units, for fattening – 0.1 pH units, for cows – 0.2-0.3 pH units. The rapid destruction of urease in soy milk and paste, in comparison with trypsin inhibitors, necessitates the control of antinutrient neutralisation in these feeds by trypsin inhibitor activity. During barothermal processing, a loss of up to 15-20% of lysine can occur, and during roasting, its content can be reduced by half. Consequently, it is considered appropriate to supplement diets for monogastric animals with lysine when such diets consist of thermally processed soybean feed.

4. Conclusions

Ukraine is the leader in the production of soybeans in Europe and is one of the ten largest producing countries in the world for 2013-2023. In the conditions of climate change, the territorial transformation of the "soybean belt" is a prerequisite for the establishment of a new stage in the production of soybean culture, which will contribute to the rational use of hydrothermal resources of the region, increase the volume of production of soybean seeds, biologicalization of agriculture, obtaining high-quality, organic products. The organic production of soybean seeds is one of the strategic directions of the accelerated development of the agro-industrial complex of Ukraine and the main goal of the European Green Course, which regulates the transformation of Europe into a climate-neutral continent. In order to achieve this objective, it is imperative to direct attention towards the development of high-yielding varieties of soybeans, encompassing diverse groups of ripeness, whilst elucidating the zone of sustainable production. Furthermore, there is a necessity to optimise the structure of the sown areas of leading agricultural crops, in addition to developing and implementing knowledge-intensive, eco-innovative technologies for their cultivation, the development of regulations for the legal regulation of the cultivation of genetically modified varieties of soybeans in Ukraine, an in-depth study of the economic problems of production and use of soybeans for fodder purposes. The integrated development of crop and livestock farming will not only contribute to increasing the overall level of agricultural production, but will also become one of the prerequisites for the sustainable development of rural areas.

References:

Alaru, M., Talgre, L., Eremeev, V., Tein, B., Luik, A., Nemvalts, A., & Loit, E. (2014). Crop yields and supply of nitrogen compared in conventional and organic farming systems. *Agricultural and Food Science*, Vol. 23(4), p. 317–326. DOI: https://doi.org/10.23986/afsci.46422

Dumpis, J., Lagzdins, A., & Sics, I. (2021). Delineation of catchment area for the lake Kisezers for environmental sustainability. *Agronomy Research*, Vol. 19(4), p. 1718–1733. DOI: https://doi.org/10.15159/AR.21.137

Babich A. O., Petrychenko V. F., Kulyk M. F., & Makarenko P. S. (1998). Methods of conducting experiments on fodder production and animal feeding. Kyiv: Agrarian Science, 78 p.

Bakhmat, M., Padalko, T., Krachan, T., Tkach, O., Pantsyreva, H., & Tkach, L. (2023). Formation of the Yield of Matricaria recutita and Indicators of Food Value of Sychorium intybus by Technological Methods of Co-Cultivation in the Interrows of an Orchard. *Journal of Ecological Engineering*. Vol. 24, Issue 8. P. 250–259. DOI: https://doi.org/10.12911/22998993/166553

Didur, I., Tsyhanskyi, V., & Tsyhanska, O. (2024). The influence of biologization of the nutrition system on the formation of photosynthetic productivity of soybean crops. *Modern Phytomorphology*. Vol. 18. Issue 4. P. 119–123.

Monarkh, V. V., & Pantsyreva, H. V. (2019). Stages of the Environmental Risk Assessment. *Ukrainian Journal of Ecology.* Vol. 9, № 4. P. 484–492. DOI: https://doi.org/10.15421/2019_779

Hnatiuk, T. T., Zhitkevich, N. V., Petrychenko, V. F., Kalinichenko, A. V., & Patyka, V. P. (2019). Soybean Diseases Caused by Genus Pseudomonas Phytopathenes Bacteria. *Mikrobiol. Z.* 81(3):68–83. DOI: https://doi.org/10.15407/microbiolj81.03.068

Kurhak, V., Kolomiiets, L., Tkachenko, A., Senyk, I., & Stotska, S. (2024). Selection of perennial grasses for an extended pasture in the autumn period. *Scientific Horizons*, Vol. 27(5), p. 88–98.

Yanovich, V., Honcharuk, T., Honcharuk, I., & Kovalova, K. (2018). Engineering management of vibrating machines for targeted mechanical activation of premix components. *INMATEH – Agricultural Engineering*. Vol. 54. № 1. P. 25–32.

Pawlewicz, A., Brodzinska, K., Zvirbule, A., & Popluga, D. (2020). Trends in the development of organic farming in Poland and Latvia compared to the EU. *Rural Sustainability Research,* Vol. 43(388), p. 1–8. DOI: https://doi.org/10.2478/plua-2020-0001

Piwowar, A., Dzikuć, M., & Dzikuć, M. (2021). Water management in Poland in terms of reducing the emissions from agricultural sources – current status and challenges. Cleaner Engineering and Technology 2(March). DOI: https://doi.org/10.1016/j.clet.2021.100082

Jansson, T., Andersen, H.E., Gustafsson, B.G., Hasler, B., Höglind, L., & Choi, H. (2019). Baltic Sea eutrophication status is not improved by the first pillar of the European Union Common Agricultural Policy. *Regional Environmental Change*, Vol. 19(8), p. 2465–2476. DOI: https://doi.org/10.1007/s10113-019-01559-8

Poore, J., & Nemecek, T. (2019). Reducing food's environmental impacts through producers and consumers. DOI: https://doi.org/10.1126/science.aaq0216

Keres, I., Alaru, M., Eremeev, V., Talgre, L., Luik, A., & Loit, E. (2020). Long-term effect of farming systems on the yield of crop rotation and soil nutrient content. *Agricultural and Food Science*, Vol. 29(3), p. 210–221. DOI: https://doi.org/10.23986/afsci.85221

Zhao, J., Bindi, M., Eitzinger, J., Ferrise, R., Gaile, Z., Gobin, A., Holzkämper, A., Kersebaum, K–C., Kozyra, J., Kriaučiūnienė, Z., Loit, E., Nejedlik, P., Nendel, C., Niinemets, Ü., Palosuo, T., Peltonen–Sainio, P., Potopová, V., Ruiz–Ramos, M., Reidsma, P., Rijk, B., Trnka, M., van Ittersum, M. K. & Olesen, J. E. (2022). Priority for climate adaptation measures in European crop production systems. *European Journal of Agronomy,* 138, 126516. DOI: https://doi.org/10.1016/j.eja.2022.126516

Ramakrishnan, B., Maddela, N. R., Venkateswarlu, K., & Megharaj, M. (2021). Organic farming: Does it contribute to contaminant-free produce and ensure food safety? *Science of the Total Environment*, 769, 145079. DOI: https://doi.org/10.1016/j.scitotenv.2021.145079

Giampieri, F., Mazzoni, L., Cianciosi, D., Alvarez-Suarez, J. M., Regolo, L., SánchezGonzález, C., Capocasa, F., Xiao, J., Mezzetti, B., & Battino, M. (2022). Organic vs conventional plant-based foods: A review. Food Chemistry 383(December 2021). DOI: https://doi.org/10.1016/j.foodchem.2022.132352

Kuht, J., Eremeev, V., Talgre, L., Madsen, H., Toom, M., Maeorg, E., & Luik, A. (2016). Soil weed seed bank and factors influencing the number of weeds at the end of conversion period to organic production. *Agronomy Research,* Vol. 14(4), p. 1372–1379.

Mahmood, N., Arshad, M., Kächele, H., Ma, H., Ullah, A. & Müller, K. (2019). Wheat yield response to input and socioeconomic factors under changing climate: Evidence from rainfed environments of Pakistan. *Science of the Total Environment,* Vol. 688, p. 1275–1285. DOI: https://doi.org/10.1016/j.scitotenv.2019.06.266

Nicholas, K. A., Villemoes, F., Lehsten, E.A., Brady, M. V., & Scown, M. W. (2021). A harmonized and spatially explicit dataset from 16 million payments from the European Union's Common Agricultural Policy for 2015. Patterns 2(4), 100236. DOI: https://doi.org/10.1016/j.patter.2021.100236

Marconi, V., Raggi, M., & Viaggi, D. (2015). Assessing the impact of RDP agri-environment measures on the use of nitrogen-based mineral fertilizers through spatial econometrics: The case study of Emilia-Romagna (Italy). *Ecological Indicators*, Vol. 59(2015), p. 27–40. DOI: https://doi.org/10.1016/j.ecolind.2015.02.037

Maxwell, S. L., Fuller, R. A., Brooks, T. M., & Watson, J. E. M. (2016). Biodiversity: The ravages of guns, nets and bulldozers. *Nature*, Vol. 536(7615), p. 143–145. DOI: https://doi.org/10.1038/536143a

Parga, E., Carolina, A., Dacal, A., Zumbado, M., & Alonso, P. (2022). Differences in the levels of sulphites and pesticide residues in soils and wines and under organic and conventional production methods. *Journal of Food Composition and Analysis* 112(February). DOI: https://doi.org/10.1016/j.jfca.2022.104714

Parizad, S., & Bera, S. (2021). The effect of organic farming on water reusability, sustainable ecosystem, and food toxicity. *Environmental Science and Pollution Research*. DOI: https://doi.org/10.1007/s11356-021-15258-7

Petrychenko, V., Korniychuk, O., Lykhochvor, V., Kobak, S., & Pantsyrev O. (2024). Study of Sowing Quality of Soybean Seeds Dependingon Pre-Sowing Treatment of Seed and Microfertilizers. *Journal of Ecological Engineering*, Vol. 25(7), p. 332–339. DOI: https://doi.org/10.12911/22998993/188932

Petrychenko, V., Kobak, S., Kolisnyk, S., Chorna, V., Korniychuk, O., & Pantsyrev, O. (2024). Agroecological Assessment of Soybean Varieties under the Conditions of the Right Bank Forest Steppe of Ukraine. *Journal of Ecological Engineering*, Vol. 25(9), p. 60–69.

Tkachuk, O., Pantsyreva, H., Kupchuk, I., & Volynets, Y. (2024). Soybean Productivity in the Forest-Steppe of Ukraine under Ecologization of' Cultivation Technology. *Journal of Ecological Engineering*, Vol. 25(5), p. 279–293. DOI: https://doi.org/10.12911/22998993/186494

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