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ECOLOGICAL AND AGROCHEMICAL ASSESSMENT OF SOIL SUITABILITY OF AGRICULTURAL ENTERPRISE FOR ORGANIC PRODUCTS CULTIVATION

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The article highlights the results of investigating land agro-ecological condition by ecological and agrochemical indicators of agro-ecosystems in "Zhyva Zemlia Potutory" LLC (organic farming method) in Berezhany district of Ternopil region. Organic farming has to be based on the principles of natural environmental systems and cycles, working, coexisting with them and supporting them. The results are achieved by farm eco-balancing. For example, for plants it is live soil, for animals it is farm ecosystem, for fish and sea organisms – water environment. The Law "On the production and circulation of organic farm products and raw materials" is the basis of Ukrainian legislation governing the "organic" sphere. This Law as if prohibits the application of fertilizers, pesticides, but admits a number of exceptions. Organic production is one of the priority areas of agricultural development in the world, as it is almost the only one among a wide range of economic methods, which does not have a negative impact on the environment and human health. The article describes the statistical generalization of indicators of organic technologies development on the farm and draws conclusions about the relevance of this strategic technological direction for the region. Peculiarities of soil indicators on the farm from the position of the determined agrochemical indices as to cultivating organic products have been analyzed. The average indicators of the soil agrochemical properties on the farm in terms of humus content, labile forms of nitrogen, phosphorus and potassium, soil solution acidity have been grouped and determined. Based on the comparison of standard values of soil parameters and actual values of indicators on the farm, the state of soil suitability for introducing organic technologies of agricultural products manufacturing has been determined. This allowed find favorable and unfavorable factors for the transition to organic technologies of agrarian production. In view of the above mentioned, we think that the restoration of our most fertile and valuable black soils is not a myth, but a reality, which must be implemented today.

Key words: *organic technologies, suitability, standards, agrochemical assessment of soils, organic products.*

ЕКОЛОГО-АГРОХІМІЧНА ОЦІНКА ПРИДАТНОСТІ ҐРУНТІВ СІЛЬСЬКОГОСПОДАРСЬКОГО ПІДПРИЄМСТВА ДЛЯ ВИРОЩУВАННЯ ОРГАНІЧНОЇ ПРОДУКЦІЇ

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Відокремлений підрозділ Національного університету біоресурсів і природокористування України «Бережанський агротехнічний інститут», м. Бережани, Україна

У статті висвітлено результати вивчення агроекологічного стану земель за еколого-агрохімічними показниками агроекосистем у ТзОВ «Жива земля Потутори» (органічний метод землеробства) у Бережанському районі Тернопільської області. Органічне сільське господарство має ґрунтуватися на принципах природних екологічних систем і циклів, працюючи, співіснуючи з ними та підтримуючи їх. Результати досягаються шляхом екологізації агрогосподарства. Наприклад, для рослин – це живий ґрунт, для тварин – екосистема ферми, для риби та морських організмів – це водне середовище. В основі українського законодавства, яке регулює «органік» сферу, полягає закон «Про виробництво та обіг органічної сільськогосподарської продукції та сировини», який начебто і забороняє використання добрив, пестицидів, проте допускає цілий перелік винятків. Органічне виробництво є одним із пріоритетних напрямів розвитку сільського господарства у світі, оскільки серед широкого спектра методів господарювання є чи не єдиним, що не завдає негативного впливу навколишньому природному середовищу та здоров'ю людини. У статті описано статистичне узагальнення показників розвитку органічних технологій господарства та зроблено висновки щодо актуальності цього стратегічного технологічного напряму для області. Проаналізовано особливості ґрунтових показників господарства з позиції визначених агрохімічних показників щодо вирощування органічної продукції. Згруповано і визначено середні показники агрохімічних властивостей ґрунтів господарства за вмістом гумусу, рухомих форм азоту, фосфору та калію, кислотності ґрунтового розчину. На підставі зіставлення нормативних значень ґрунтових параметрів і фактичних значень показників у межах господарства визначено стан придатності ґрунтів до запровадження органічних технологій виробництва сільськогосподарської продукції. Це дало змогу провести аналіз сприятливих і несприятливих факторів для переходу на органічні технології аграрного виробництва. З огляду на вищезазначене, ми вважаємо, що відновлення наших найродючіших та найцінніших чорноземів це не міф, а реалії, які необхідно втілювати в життя вже сьогодні.

Ключові слова: *органічні технології, придатність, нормативи, агрохімічна оцінка ґрунтів, органічна продукція.*

Introduction

In order to ensure the balanced development of agro-ecosystems and rational using of nature, the transition of the agrarian sector to alternative management methods is important. The self-regulating ability of organic agro-ecosystems can be characterized as the ability to withstand high external anthropogenic interference (the applying of chemical plant protection products). The absence of a paradigm of social and natural development of the noosphere level today is confirmed by almost complete failure of the concept of sustainable development (especially after Rio + 20). The main reason for this is incorrect location of "Homo" species in the biosphere of the planet. The "ecotype" of Homo Sapiens goes far beyond the level of organisms of the species organization and covers the level of the ecosystem, forming an agro-ecosystem as an ecological niche with moving spatial boundaries [1, 4, 9].

Land degradation and environmental processes, in their turn, create potentially dangerous consequences (e.g., desertification; salinization) and pose a long-term threat to agricultural production and human well-being [2]. In general, humanity is deprived of age-old achievements of nature, namely the most valuable fertile layers of soil, including its component – humus [3]. The first alternative economy began to develop abroad in the early 70s of last century. International scientists differently interpret the equivalent of ecological farms in terms of the content. American scientists Y. D. Maxfelt, J. P. Reaganold, R. I. Papendik, J. F. Parr emphasize on the balance of agriculture, which includes some variants of non-traditional agriculture, commonly referred to as organic, alternative, regenerative, ecological, but "organic" or "alternative" which does not mean balanced. In order for a farm to be called balanced, it must produce high-quality food, conserve its resources, not harm the environment and be profitable. N. Lampskin stresses that the foundation

of ecological farming on the Earth as a living system reflects the essence between the earth, plants, animals and human. Both in nature in general and in agriculture, the change of one component of such a system can strongly affect others [5, 6, 14, 15]. According to Ukrainian scientists (Shykula M. K., Dolia M. M., Hnatenko O. F., Zaika V. V., Chaika T. O.) alternative farming is a new approach to crop production, ethics of land.

Its essence is the complete or partial rejection of synthetic fertilizers, pesticides, growth regulators, strict following crop rotation, the introduction of legumes, preservation of crop residues, the application of organic fertilizers (manure, compost, green manure), plant protection by biological methods [7, 8]. Based on a certain relevance of the development of organic farming at the regional level, the relevance of monitoring the soil resources of the region for suitability for organic production is undeniable and urgent.

Mainly this important segment of modern problems of soils suitability for growing organic products became the aim of our publication [10].

At the same time, key publications emphasize that detailed soil monitoring of the territory remains relevant to ensure the introduction of efficient organic farming in order to identify clear raw material areas for growing and producing agricultural products of various categories, development of effective organic technologies. Therefore, *the purpose* of the study is to substantiate environmental approaches to determine the quality of land, the state of soil cover, which is used for agricultural production.

Agricultural land plots are located in the settlements of the village of Potutory of Ternopil region and the task was to analyze the theoretical foundations of environmentally friendly farming, taking into account the world experience of land use eco-balancing.

Material and methods of the research

The object of research was the soil cover at agricultural enterprise "Zhyva Zemlia Potutory" LLC in Potutory village of Ternopil region, which is represented by dark gray podzolic soils.

Analyses were performed according to current methods and the State Standard of Ukraine: humus according to the method of Tyurin in the modification of Simakova (the State Standard of Ukraine 4289: 2004); mobile phosphorus and exchangeable potassium by the Chirikov method (the State Standard of Ukraine – 4115–2002); alkaline hydrolyzed nitrogen content – by the method of Cornfield; the degree of acidity (pH) – potentiometrically by the method of CINAO (the State Standard 26483–85) and hydrolytic by the method of Kapenn – (the State Standard 26212–91). Agrochemical survey of soils on the farm of "Zhyva Zemlia Potutory" LLC was conducted on an area of 309.6 hectares, for the selection of soil samples for agronomic experimental fields were divided into elementary plots of 9–10 hectares.

One mixed sample was taken from each of such plot, which was obtained from 20–25 individual samples taken along the axis of the elementary plot to a depth of 25–30 cm [20]. Gradation according to the degree of providing soils with agrochemical indicators was approved by the Center for Fertility in 2019. The analysis of regulatory documents on issues of ecologically safe agricultural land using was used.

Research findings and their discussion

Organic farming is based on stable self-regulatory production system on the concept of farming as an agro-ecosystem. Agro-ecosystem, defined as an ecological system in the agricultural context (i.e. with costs, withdrawal of products, and farmer intervention), is formed through strong interaction (variation) of abiotic and biotic environment, genetic composition of species involved and management resources available to farmers [12–14].

The challenge for the organic farmer is to manage and maintain all these interactions at different levels of the production system so that his (her) farm can use the ecosystem functions provided by agro-biodiversity such as biological pest control, nutrient and water and soil conservation, yield stability and efficiency of using [10, 15]. In addition to differences in environmental conditions and social-economic context of each farm, differences in cultivation practices, knowledge, skills and motivation of each farmer result in certain farming styles, the farmer himself (herself) is a part of agro-biodiversity.

In organic farming, the basis of healthy crop production is to care for increasing soil fertility, which is based on three inextricably linked components of soil functioning: physical (water conservation capacity, structure, etc.), chemical (nutrient dynamics, pH) and biological (soil biota). The idea of organically well-managed soil is that the farmer can eventually increase the buffering capacity and resistance to imbalance in cultivation conditions as part of a strategy to strengthen the capacity of the self-regulating ecosystem [10,

19]. In this system, the basis of productivity is the vital activity of the soil, the genetic heredity of plants, animals, and landscape.

Thus, environmental management optimizes the dependence of all quality factors on each other, optimally when a closed cycle of energy metabolism is created. This system destroys or to a greater extent limits the application of complex synthetic fertilizers, pesticides, herbicides, growth stimulants, thus increasing the viability of food and forage.

In 2007, Ukrainian citizen Ivan Boiko and the Swiss Rainer Zachs founded "Zhyva Zemlya Potutory" LLC (the current owner of the company is Zhyva Zemlia Association of Switzerland). Ukrainian realities with roads typical of our villages and a landscape that is a bit like the Swiss in their homeland, are superimposed on a slightly different way of life than our peasants. 300 hectares of land, of which 200 are arable, 34 dairy cows, a garden with vegetables and herbs – this farm is cared for by 15 people, two of whom are the Swiss (Elias de Boer and Christina Liberger). It not only follows the principles of organic farming, but also applies the system of bio-dynamic agriculture, developed by the Austrian philosopher-mystic Rudolf Steiner, known in particular as the creator of Waldorf pedagogy. Worldview bio-dynamic agriculture involves the perception of the farm as a whole organism, the interpretation of soil as living and the using of natural, specially made materials for working with soil, compost and plants. On "Zhyva Zemlia Potutory" farm today, there are three areas, which are actively and effectively developing: crop production, dairy farming, and herb growing. Christina Liberger taught gardening at Waldorf School in Switzerland, and oversees herb growing in Potutory. Taking into account her wide experience, she creates a recipe for teas, which can be purchased, including in some Lviv stores. Oregano, lovage, sage, mint, lemon balm, mallow, chamomile, thyme, fennel, basil, marjoram and other plants grow in an orderly garden: there are alternating beds and twenty-centimeter paths between them.

Bio-dynamic agriculture in herb cultivation consists in using compost and a lot of manual labor. To confirm that the products have organic certificates, it is necessary to conduct an ecological and agrochemical assessment of the suitability of the farm's soils for growing organic products. According to the research data, the tables show the grouping of soils by the degree of acidity (Table 1).

1. Grouping soils by the degree of acidity

Number	Rate	Hydrolytic acidity,– eq. / 100 g of soil	Degree of acidity
1	< 4.1	> 6,0	very strongly acidic
2	4,1–4,5	5,1–6,0	strongly acidic
3	4,6–5,0	4,1–5,0	medium acid
4	5,1–5,5	3,1–4,0	slightly acidic
5	5,6–6,0	2,1–3,0	close to neutral
6	> 6,0	< 2,1	neutral

Humus as the most representative and stable agrochemical indicator best reflects soil fertility (Table 2).

2. Grouping of soils by humus and microelement content

Number	Humus content, %	Exchange potassium	Phosphorus	Contents	Alkaline hydrolyzed nitrogen	Content
		mg / kg of soil				
1	< 1,1	< 40	< 25	very low	< 100	very low
2	1,1–2,0	41–80	26–50	low	101–150	low
3	2,1–3,0	81–120	51–100	medium	151–200	medium
4	3,1–4,0	121–170	101–150	increased	> 200	
5	4,1–5,0	171–250	151–250	high		
6	> 5	> 250	> 250	very high		

As it can be seen from table 2, the studied soils are characterized by the average content of humus – the weighted average for the entire surveyed area of "Zhyva Zemlia Potutory" LLC is 2.41 % (for each field separately on the farm are given in Table 3).

3. Agrochemical indicators of soils of agricultural lands of "Zhyva Zemlia Potutory" LLC

№ land	Depth of selection samples, cm	Examined area, ha	Humus content, %	pH salt	Hydrolytic acidity	Alkaline hydrolyzed nitrogen	Phosphorus	Exchangable potassium
						mg / kg of soil		
1	25–30	53,50	2,35	6,3	1,81	133	74	123
2		83,40	2,48	6,4	1,62	124	62	120
3		29,60	2,40	6,6	1,37	138	113	131
4		9,70	1,86	6,3	1,74	136	77	145
5		13,30	2,24	6,4	1,63	130	80	165
6	25–30	24,70	2,40	5,4	3,26	144	57	161
7		13,10	2,34	5,8	2,46	125	38	158
9		22,50	2,00	6,2	1,90	144	35	143
Cultural pasture								
13	25–30	16,00	2,72	7,0	0,95	132	109	105
12		25,00	2,85	6,9	1,08	99	74	70
Total on the farm		309,60						

Regarding to "Zhyva Zemlia Potutory" LLC, 24.70 ha (about 8 %) of the surveyed area is characterized by an increased humus content – less than 4.0 %, 252.70 ha (81.6 %) of the surveyed area is characterized by an average humus content – less than 3.0 %, 32.20 ha (10.4 %) of the surveyed area is characterized by a low humus content – less than 2.0 % [20].

Alkaline hydrolyzed nitrogen is a dynamic indicator, which is characterized by significant temporal and spatial variability during the growing season. About 85.9 % of the surveyed area of "Zhyva Zemlia Potutory" LLC are characterized by low nitrogen content – 124–144 mg per 1 kg of soil, 14.1 % – are characterized by very low nitrogen content – 85–99 mg per 1 kg. The weighted average content of hydrolyzed nitrogen over the entire area of "Zhyva Zemlia Potutory" LLC is 127 mg/kg and is insufficient to obtain high crop yields. The significant spatial heterogeneity of nitrogen supply even within one field should be mentioned (Table 3), which requires a differentiated approach during the development of the fertilization system. Due to the acute shortage of nitrogen in the soils on the farm, it becomes a limiting factor and during the development of the cultivation system the application of this element should be a priority. Nitrogen deficiency severely inhibits plant growth and development, which is manifested in the form of chlorosis. The leaves become light green, small prematurely yellow from the tips. In cereals slowing down tillering, short stems are observed. Crops show deterioration of flowering, early fall of the ovary. Also, given the high ability of nitrogen to re-utilize and well-developed grass vegetation, we can assume that at the beginning of the growing season stocks of alkaline hydrolyzed nitrogen in the studied soils may increase by 15–20 % as compared with the recorded values. Yields can be significantly reduced if nitrogen deficiency accompanies the entire growing season [17].

According to the obtained data, motile phosphorus on farm lands of "Zhyva Zemlia Potutory" LLC has a low content (2 groups) on 54.40 ha (17.6 %) of the surveyed area. On 209.60 ha (67.7 %) of the surveyed area the content of this nutrient is average (3 groups), and on 45.60 ha (14.7 %). The lowest content of motile phosphorus was recorded in 7.9 % of the surveyed fields – 38–35 mg/kg of the soil. Fields 3 and 13 are best provided. The need for phosphorus is especially high at the beginning of the season for root formation, as well as later during flowering and fruit set [17].

The soils of the studied farm are well supplied with exchangeable potassium, namely more than 92 % of the surveyed soils of "Zhyva Zemlia Potutory" are characterized by high potassium content – (groups 4 and 5). This nutrient plays a crucial role in water distribution and enzymatic processes for crop physiology. Adequate available potassium can alleviate the stress, which plants tolerate during heat, cold or drought. Potassium is an element affecting the yield of many crops, vegetables and fruit trees [18].

About 82 % of the surveyed lands of "Zhyva Zemlia Potutory" LLC have a neutral acidity and 10 % are close to a neutral acidity, and only about 8 % are slightly acidic. Regarding the other farms we studied, it

should be noted the following: about 80 % of the surveyed lands are neutral and close to neutral, and about 20 % are slightly acidic.

Many studies have confirmed that for many crops the weakly acidic reaction of the soil solution is favorable (rapeseed, barley, rye, most vegetables, clover, lupine, buckwheat, etc.). As a result of the obtained data, taking into account the difficult social-economic conditions, it is advisable to recommend short-succession specialized crop rotations, which do not require the presence of the whole complex of farm machinery and ensure high profitability [19]. When developing crop rotations, it is also necessary to keep in mind the peculiarities of the morphometric structure of the slopes on which the surveyed fields are located. Given the significant steepness of the slopes and the vertical and horizontal dismemberment of the terrain for the surveyed area, the saturation of crop rotation with row crops should not exceed 10–15 %. Dense crops and grasses should be the basis of crop rotations here.

Conclusions

Thus, dark gray podzolic soils are generally characterized by satisfactory conditions for obtaining high and stable yields and raw materials. The results of the research confirm that "Zhyva Zemlia Potutory" LLC is dominated by soils with low (127 mg/kg and 116 mg/kg of soil) degree of nitrogen supply in alkaline hydrolyzed compounds, medium (69 mg/kg of soil) and elevated (127 mg/kg) – motile phosphates, high (125.124 mg/kg of soil) – exchangeable potassium. The reaction of the soil solution on the territory of farm is neutral. According to the weighted average humus content, the soils correspond to the average degree of provision. A limiting factor, which can reduce yield formation by up to 20 %, is the low supply of nutrients, namely easily hydrolyzed nitrogen compounds. In general, the studied soils have satisfactory properties for the formation of high environmentally friendly and high-quality yields.

Prospects for further research. These surveys will further help to calculate the appropriate and most optimal doses of organic and mineral fertilizers, conduct systematic work to increase soil fertility and predict, which plants are profitable to cultivate in agro-ecosystems of the studied farm.

References

1. Berlach, N. A. (2010). Rozvytok orhanichnoho napriamu u silskomu hospodarstvi Ukrainy (administratyvnopravovi osnovy). *Extended abstract of candidate's thesi*s. Kyiv [In Ukrainian].

2. Laslo, O. O. (2009). Orhanichne zemlerobstvo – shliakh do ekolohichno bezpechnoi produktsii. *Visnyk Poltavskoi Derzhavnoi Ahrarnoi Akademii*, 1, 137–139 [In Ukrainian].

3. FAQ – ORGANIC UA. Retrieved from: http://organic.ua/uk/organicworld/faq.

4. Vovk, V. I. (2004). Sertyfikatsiia orhanichnoho silskoho hospodarstva v Ukraini: suchasnyi stan, perspektyvy, stratehiia na maibutnie. *Materialy Mizhnarodnoho seminaru «Orhanichni produkty kharchuvannia. Suchasni tendentsii vyrobnytstva i marketynhu»*. Lviv [In Ukrainian].

5. Federatsiia orhanichnoho rukhu Ukrainy. Retrieved from: http://www.organic.com.ua [In Ukrainian].

6. Pro osnovni zasady (stratehiiu) derzhavnoi ekolohichnoi polityky Ukrainy na period do 2020 roku: Zakon Ukrainy (2011). *Vidomosti Verkhovnoi Rady Ukrainy*, St. 21885, 26 [In Ukrainian].

7. Pysarenko, V. M., Pysarenko, V. V., Antonets, A. S., Luk'ianenko, H. V., & Pysarenko, P. V. (2016). *Systema orhanichnoho zemlerobstva ahroekoloha S. S. Antontsia*. Poltava [In Ukrainian].

8. Pysarenko, V. M., Pysarenko, P. V., Ponomarenko, S. V., & Shapoval, V. F. (2017). *Orhanichne zemlerobstvo dlia pryvatnoho sektora*. Poltava [In Ukrainian].

9. Dehodiuk, E. H., Vitvitska, O. I., & Dehodiuk, T. S. (2014). Suchasni pidkhody do optymizatsii mineralnoho zhyvlennia roslyn v orhanichnomu zemlerobstvi. *Zbirnyk Naukovykh Prats Natsionalnoho Naukovoho Tsentru «Instytut Zemlerobstva NAAN*, 1–2, 33–39 [In Ukrainian].

10. Willer, H., & Lernoud, J. (Eds.). (2018). *The World of organic agriculture. Statistics and emerging trends 2018*. Germany: Medienhaus Plump

11. Antonets, S. S., & Pysarenko, V. M. (2011). Koly Ukraina zrozumiie svoiu planetarnu misiiu. *Visnyk Poltavskoi Derzhavnoi Ahrarnoi Akademii*, 2, 5–8 [In Ukrainian].

12. Altieri, M., Nicholls, C., & Montalba, R. (2017). Technological approaches to sustainable agriculture at a crossroads: An agroecological perspective. *Sustainability*, 9 (3), 349. doi: 10.3390/su9030349

13. Sonko, S. (2019). Man in Noosphere: Evolution and Further Development. *Philosophy and Cosmology*, 22, 51–74. doi: 10.29202/phil-cosm/22/5

14. Chielo, L., Pike, T., & Cooper, J. (2016). Ranging Behaviour of Commercial Free-Range Laying Hens. *Animals*, 6 (5), 28. doi: 10.3390/ani6050028

15. Zeltner, E., & Hirt, H. (2003). Effect of artificial structuring on the use of laying hen runs in a free-range system. *British Poultry Science*, 44 (4), 533–537. doi: 10.1080/00071660310001616264

16. Abasova, E. M. (2020). The Effect of biohumus on increasing of the fertility gray-brown soils in Mountainous Shirvan. *Bulletin of Science and Practice*, 6 (12), 100–104. doi: 10.33619/2414-2948/61/11 [In Russian].

17. Tsytsiura, Y. (2020). Assessment of soils of the vinnytsia region for organic production application. *Agriculture and Forestry*, (1), 13–27. doi: 10.37128/2707-5826-2020-1-2

18. Kobets, M. I. (2004). Orhanichne zemlerobstvo v konteksti staloho rozvytku. *Proekt «Ahrarna polityka dlia liudskoho rozvytku»*. Kyiv [In Ukrainian].

19. Makarenko, N. A., & Podzerei, R. V. (2015). Naukovi osnovy otsiniuvannia stanu silskohospodarskykh terytorii ta uhid shchodo mozhlyvosti vedennia orhanichnoho vyrobnytstva. *Naukovi dopovidi Natsionalnoho universytetu bioresursiv i pryrodokorystuvannia Ukrainy*, 4 (53). Retrieved from: http://nd.nubip.edu.ua/2015_4/7.pdf [In Ukrainian].

20. Patyka, V. P., & Tarariko, O. H. (2002). *Ahroekolohichnyi monitorynh ta pasportyzatsiia silskohospodarskykh zemel*. Kyiv: Fitosotsiotsentr [In Ukrainian].

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