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Problems and threats related to the quality of soils in rural areas in Poland in farmers' awareness – based on questionnaire surveys

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Abstract. The paper is based on the results of a survey conducted among the participants of 12 training courses organized within the project „Protection of soil biodiversity as a condition of health of present and future generations" No. POIS.02.04.00-00-0082/16 in 2018–2019. The aim of the survey was to assess the environmental awareness of the respondents in terms of the quality and productivity of cultivated soils in Poland and methods of their protection. The questionnaire included general questions about the specificity of the farm management and aspects of problems related to soil, fertilization, protection of plants against diseases and pests, and climate change. The analysis of the results was based on 307 correctly completed questionnaires. It was found that the users of agricultural soils in Poland take a conscious approach to soil management. They recognize serious problems related to maintenance of proper soil moisture and structure, protection against diseases and pests, use of proper fertilization and crop rotation.

Key words: soil, fertilization, degradation, protection

INTRODUCTION

Soil is a non-renewable natural resource, one of the most important components of the natural environment. It is primarily important as a means of crop production, producer and absorber of gases, natural environment for a huge number of organisms which break down organic matter, providing nutrients for plants. At the same time, it is one of those natural resources which are easily degraded, thereby leading to deterioration of the biological activity of the environment, with particular emphasis on agricultural production, ecological and sanitary conditions affecting plants, animals and humans, as well as landscape values. Microorganisms play an important role in the soil environment, as they create appropriate soil structure, are important in the process of humus formation, are responsible for the circulation of many chemical elements in nature, decompose organic matter and carry out disposal of harmful substances (Bünemann et al., 2018; Glick, 2018; Jankowska and Swędrzyńska, 2016; Schulz et al., 2013).

As a result of applying intensive cultivation methods, soil fertility is reduced in many regions of the country, which is characterized by the deterioration of its physical properties (excessive soil compaction, adverse changes in water conditions), limitation of biodiversity, accumulation of harmful microorganisms and plant pathogens in soils, accumulation of pesticide residues, their derivatives and other toxic substances (Wołejko et al., 2020). The quality of agricultural land in Poland is lower than the Europe's average in. Most soils are light (evaluation class IVb) and about 60% are acidic and very acidic (twice as much as in average in the EU). These soils contain less than 2% of humus (Niedźwiecki, 2019). Intensive cultivation in monoculture, lasting many years, causes degradation due to insufficient organic fertilization, excessive mineralization of the organic mass of the soil, loss of minerals, and increased susceptibility to erosion (Peralta et al., 2018; Pikuła, 2015; Tieman et al., 2015). It is predicted that these phenomena will intensify due to climatic changes, i.e., a temperature increase during the vegetation period and a decrease of precipitations.

The observed unfavourable phenomena should become a reason for undertaking measures leading to soil fertility restoration after a period of its intensive and improper use or its degradation due to other reasons (e.g., floods, droughts). The regeneration of degraded soils and proper quality maintenance of intensively cultivated soils requires comprehensive measures. It is essential to increase the content of organic matter in the soil. It determines the physical, biological, and chemical properties of the soil, primarily by increasing the content of soil humus. The EU requirements, introduced in 2008 in the Code of Good Agricultur-

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al Practice, require farmers to take care of soil humus. It is conducive to increasing soil biodiversity, because, depending on the chemical composition, it can be a food source for soil microorganisms. The availability of manure is hindered due to the concentration of pig and cattle production. The possibilities of utilising organic matter derived from agri-food industry waste are certainly underestimated. Due to the growing specialization of farms, problems are posed by the huge amount of waste generated after the production season. Pursuant to EU requirements, Poland must significantly reduce the amount of waste deposited. Organic matter contributes to the reduction of soil exhaustion, which improves its productivity. Increasing biodiversity, and thus the natural "resistance" of soils, will allow for reducing the use of synthetic plant protection products. Such environmentally safe methods of protection are particularly important in the recently developed ecological and integrated methods of plant cultivation (Hoffland et al., 2020; Stępień, 2019).

It is worth emphasizing that the proper use of soils does not only reduce the degradation process and allows for obtaining high yields of crops but is also an important factor in binding carbon compounds in the humus form, contributing to the reduction of the greenhouse effect. The use of correct farming technique on arable land increases the biomass of microorganisms in the soil and the enzymatic activity, which is directly related to the increase of yields, soil fertility and the improvement of the soil ecosystem functioning.

An important issue from the agricultural point of view is the biological diversity of the soil environment. It assumes that the entire richness of life is valuable, which means that all species are equally important, each organism in the soil environment performs a specific, irreplaceable function. Soil improvement can be achieved by inducing changes in the populations of soil microorganisms towards the maintenance of an appropriate level of dynamic equilibrium. Their variety of species, population size, activity in organic matter decomposition and activating non-digestible forms of chemical elements are essential for maintaining appropriate quality of the soil and creating optimal growth conditions for plants. The microbial diversity of soil is considered to be the basis of the ecosystem functioning, as it ensures the proper course of all processes. Additionally, it is important for the ecosystem stability and resistance to external stresses (Frąc et al., 2018; Glick, 2018; Jankowska, Swędrzyńska, 2016; Kowalska, 2019; Wolińska, et al. 2017, 2018ab).

One of the methods allowing the microbial biodiversity of soils to be preserved is the use of biological plant protection products. These measures positively affect the quality of soils, improve their structure, and accelerate organic matter decomposition (Mosa et al., 2016; Trzciński et al., 2018). Biopreparations also have a positive impact on plants, including growth support, enhancing root system development and increasing stress resistance (Gałązka, 2019; Pylak et al., 2019; Szczech et al., 2017).

It is worth drawing attention to the issue of climate change in Poland, which has a huge impact on the soil environment. This phenomenon is often manifested in prolonged periods of drought during plant vegetation and the lack of snow cover, which causes a decrease in soil moisture and a lowering of the groundwater level. Recently in the literature, there have occurred numerous reports on the impact of water shortage on the decrease in the activity and biodiversity of soil microorganisms, and thus on the reduction of soil fertility and productivity (Abatenh et al. 2018; Compant et al. 2010; Pylak et al. 2019; Siebielec et al. 2020). This problem, in relation to agricultural, vegetable, and fruit crops, is discussed and addressed in many national research facilities.

In order to maintain the proper quality of the soil, it is very important for farmers to be ecologically aware of the causes of soil degradation and the methods of their improvement. It is especially important to educate the public on the role of microorganisms in maintaining the fertility of the soil and preventing its degradation. To an extent greater than before, the responsibility for soil care rests with the people who use the soil on a daily basis.

The subject of the research described in this article was the assessment of the respondents' awareness of the quality and productivity of arable soils in Poland and the methods of their protection. The research results obtained were intended to help in answering the question: Do farmers and gardeners perceive possible threats to the soil environment and crops related to improper soil management on their own farms? The main problems related to the soil and crops faced by farmers were also of interest.

MATERIALS AND METHODS

The study was based on the data collected over the years 2018/2019 in the survey entitled "Problems with the quality of arable soils" prepared as part of the project "Protection of soil biodiversity as a condition of health of present and future generations" No. POIS.02.04.00-00-0082/16. The questionnaire in the shape of a fill-in form was sent to participants of 12 training courses – 521 people. The participants of the training were mainly farmers, but also gardeners, agricultural advisors, representatives of companies from the sector of agriculture and horticulture. These people took part in the training voluntarily. Correctly filled-in questionnaires, which were the subject of the analysis, were obtained from 307 people, which constituted 59% of all participants. Apart from farm owners, group of respondents covered 95 agricultural advisors and representatives of horticulture and agriculture companies, who also provided data significant in terms of study subject. The training courses had a nationwide reach. The locations of the training courses and the number of respond-

ents from each training group are presented in Table 1. The thematic scope of the training included the following topics: soil degradation and methods of counteracting this phenomenon; the importance of biological life of soils in maintaining their fertility and production value; microbiological preparations and vaccines and their use in plant cultivation; management of organic waste; current methods of soil decontamination and prevention of the spread of soil pathogens; threats related to contamination of agricultural soils; the use of rational methods of mineral fertilization and agrotechnical treatments in terms of protecting soil resources; the impact of climate change on growing conditions and microorganisms in plant production; the role of microorganisms in the formation of humus; microbiological hazards in food production and their effects; beneficial and harmful soil microorganisms.

During the registration process, which took place just before the training, the participants received a questionnaire along with training materials. The following questions were included in the survey:

1. What is the area of the farm?
2. What kind of crops does the farm cultivate?
   A selection of the following options was included: cereal, rapeseed, maize, meadows and pastures, root plants, vegetables, fruit, nursery crops, others.
3. Is crop rotation applied?
4. Is organic fertilization used?
5. What organic fertilizers are used the most?
6. Which groups of chemicals (herbicides, insecticides, fungicides) are used the most?
7. Are biological preparations used and in the cultivation of what crops?
8. What are the most serious problems in crop cultivation?
   A selection of the following options was included: soil quality deterioration, poor plant growth, and low yields, irrigation, fertilization, soil nutrient abundance, pest protection, disease protection, weed protection, soil decontamination, crop rotation. Each respondent was allowed to select any number of responses.
9. What are the most serious problems regarding soil?
   The following options were included: soil erosion, maintaining the proper pH of the soil, maintaining humidity, damaged granular structure of the soil, compact subsoil, isolated water pools, low soil nutrient abundance, loss of humus, poor plant growth, accumulation of pathogens in the soil, high salinity. Each respondent was allowed to select any number of responses.
10. How is the condition of the soil assessed on the farm?
    Possible answers: a/ abundant and in good condition; b/ good condition, but there are already some problems; c/ degraded.
11. What information about the soil would the respondents like to obtain?

The questionnaires were collected from the training participants after the completion of each training session. Therefore, the respondents, when answering the questions above, had basic knowledge and awareness of the potential threats to the proper functioning of processes occurring in the soil.

The responses obtained from the questionnaires in individual locations were analysed and summarised. The results were presented as percentage point figures, where 100% was always constituted by the number of the respondents – 307 people. The farms, in terms of their size in hectares, were classified according to the following criteria: small <10 ha; medium: 11–30 ha; big: 31–100 ha; large area > 100 ha.

RESULTS AND DISCUSSION

The survey demonstrated that the respondents were aware of the problems and threats related to the quality of soil and crops on their farms.

The analysis of 307 correctly completed questionnaires showed that the greatest number of respondents came from voivodeships: Łódzkie – 47 people, Małopolskie – 35 people, Lubelskie – 34 people and Podlaskie – 32 people. In the remaining voivodeships, the number of respondents was as follows: Świętokrzyskie – 30, Kujawsko-Pomorskie – 29, Podkarpackie – 26, Śląskie – 22, Wielkopolskie – 21, Opolskie – 17, Mazowieckie – 14 (Table 1). Farms, which owners completed questionnaires correctly, were classified as small (108, 35.2%), medium (22.6%), big (7.5%) and large (3.8%).

The respondents declared cultivating the following crops: cereals – 58.5%, rapeseed – 23.8%, maize – 24.5%, meadows and pastures – 34.8%, root crops – 32.4%, vegetables – 30.3 %, fruit plants – 24.1%, nursery crops – 12.6% and others – 14.2% (Table 2).

Rotation is a very important and indispensable element of proper plant cultivation. It prevents the multiplication and accumulation of pathogenic organisms in the soil, reduces the loss of nutrients, enriches the microbiological composition, reduces the occurrence of pests and has a positive effect on plant yield (Selim, 2019). In the study, when asked about crops rotation, 62.7% of the respondents answered that they used it, 30% – used it occasionally, 7.3% – did not use it (Table 3).

Another issue that was covered in the study is fertilization, which in modern agriculture is considered to be one of the most important cultivation techniques determining the size and quality of the obtained crops. In the survey, 19.7% of respondents answered that they did not use organic fertilization, and 12.1% – used such type of fertilization occasionally (Table 3). The obtained results are in accordance with the existing trend. A constant decrease in the use of organic fertilizers on farms could be observed.

Table 1. Number of people participating in surveys during trainings conducted in different institutions in Poland.

Training place	Number of respondents (Percent of respondens)
Małopolski Ośrodek Doradztwa Rolniczego w Karniowicach, woj. małopolskie Karniowice, Małopolskie voivodeship	35 (11.4%)
Lubelski Ośrodek Doradztwa Rolniczego w Końskowoli woj. lubelskie Końskowola, Lubelskie voivodeship	34 (11.0%)
Podlaski Ośrodek Doradztwa Rolniczego w Szepietowie, woj. podlaskie Szepietowo, Podlaskie voivodeship	32 (10.4%)
Świętokrzyski Ośrodek Doradztwa Rolniczego w Modliszewicach, woj. świętokrzyskie Modliszewice, Świętokrzyskie voivodeship	30 (9.8%)
Kujawsko-Pomorski Ośrodek Doradztwa Rolniczego w Minikowie, woj. kujawsko-pomorskie Minikowo, Kujawsko-Pomorskie voivodeship	29 (9.5%)
Podkarpacki Ośrodek Doradztwa Rolniczego w Boguchwale, woj. podkarpackie Boguchwała, Podkarpackie voivodeship	26 (8.5%)
Łódzki Ośrodek Doradztwa Rolniczego w Bratoszewicach, woj. łódzkie Bratoszewice, Łódzkie voivodeship	25 (8.1%)
Instytut Ogrodnictwa-PIB, Skierniewice, woj. łódzkie Skierniewice, Łódzkie voivodeship	22 (7.2%)
Śląski Ośrodek Doradztwa Rolniczego w Częstochowie, woj. śląskie Częstochowa, Śląskie voivodeship	22 (7.2%)
Wielkopolski Ośrodek Doradztwa Rolniczego w Marszewie, woj. wielkopolskie Marszew, Wielkopolskie voivodeship	21 (6.8%)
Opolski Ośrodek Doradztwa Rolniczego w Łosiowie, woj. opolskie Łosiów, Opolskie voivodeship	17 (5.5%)
Centrum Doradztwa Rolniczego w Radomiu, woj. mazowieckie Radom, Mazowieckie voivodeship	14 (4.6%)
Sum	307 (100%)

Table 2. Structure of crops conducted by the respondents.

Type of crop	Number of responses [%]
Cereals	58.5
Rapeseed	23.8
Maize	24.5
Meadows	34.8
Root crops	32.4
Vegetables	30.3
Fruit growing	24.1
Nurseries	12.6
Other	14.2

Table 3. Data on respondents' use of crop rotation, organic fertilizer and biological plant protection products.

Answers	Number of responses [%]		
	rotation	organic fertilization	biological plant protection products
Yes	62.7	68.2	68
No	7.3	19.7	32
Sometimes	30.0	12.1	0

This happens, among others, due to the lack of access to manure. In recent years, an increase in many regions of the country have been observed in the area of agricultural land used by non-livestock farms, i.e., without an inflow of own natural fertilizers, which are a significant element in shaping soil humus resources (Pałosz, 2009; Wrzaszcz, Prandecki, 2019). 68.2% of the respondents replied that they used organic fertilization regularly (Table 3), while 55.3% – used mainly manure, 13.1% – compost, 10.6% – green fertilizers and 21% – other organic fertilizers (Table 4). In the studies conducted by Kopiński and Wrzaszcz (2020) it was concluded that the use of natural fertilizers in Poland is strictly dependent on the voivodeship where the farm is located. In the following voivodeships: Podlaskie, Wielkopolskie, Mazowieckie and Kujawsko-Pomorskie, over 50% of farms use fertilization, while Podlaskie voivodeship dominates in terms of the intensity of applying such fertilization. In the described research, as many as 78% of the respondents in Podlaskie voivodeship answered that they used organic fertilization, 62% of which used manure. This trend is related to the high cattle and pig headcount compared to other voivodeships. In Dolnośląskie and Zachodniopomorskie voivodeships, natural fertilization is used by only about 20% of farmers (Kopiński, Wrzaszcz 2020). In the case of limited access to manure the solution may be the use of exogenous

Table 4. Organic fertilizers used in farms.

Organic fertilizers	Number of responses [%]
Manure	55.3
Composts	13.1
Green manures	10.6
Other	21.0

Table 5. Groups of chemicals used on farms.

Chemical plant protection products	Number of responses [%]
Herbicides	49.4
Fungicides	41.1
Insecticides	25.4

sources of organic matter, i.e., for example, waste from the agri-food industry, agricultural waste, biochar, waste from biogas plants (Stępień 2019). Technologies aimed at their natural use, mainly at fertilization and improvement of usable soil properties hold a special place in agriculture and are a part of the circular economy. Many wastes can be used in agriculture as their physical properties and chemical structure (e.g., high content of organic matter, nutrients, clay and dust fractions, etc.) allow them to positively impact biological and physicochemical soil properties, growth and yielding of cultivation crops (Jędrczak, 2008; Srivastava et al., 2016; Stępień, 2019; Torres et al., 2015).

The use of plant protection products is another issue raised in the survey. Sixty eight percent of the respondents answered that they used biological agents on their farms, while the rest – 32% did not use biopreparations (Table 3). The results of the survey and the data obtained by Maciejczak (2019) indicate that farmers use biological agents more and more consciously. The respondents also perceive a direct economic effect. The majority of farmers believe that such innovations can reduce both protection and cultivation costs and also increase direct benefits.

The respondents reported that herbicides and fungicides constituted the dominant group among chemical plant protection products (Table 5). As stated in the document "Agriculture 2019" issued by the Statistics Poland, imported pesticides dominated the sales on market (approx. 74%). In the structure of domestic production, approx. 3.5% were anti-sprouting preparations and growth regulators, 4.8% – insecticides and acaricides, and approx. 24.7% fungicides, bactericides and seed treatments. Experts from the Statistics Poland emphasize that the use of plant protection products for individual crop types is quite varied, with the largest amount per unit area being used for fruit and vegetable cultivation.

In the question of the survey related to plant cultivation problems, most of the respondents indicated problems with irrigation (43.2%), protection against diseases and pests (30.6 and 29.7%), soil quality deterioration (28.2%), reduced plant growth (27.8), weed infestation (27.7%) and insufficient soil fertility (21.7%) (Table 6). On the other hand, the respondents identified the following as the main issues related to the soil: maintaining humidity (57.5%), maintaining the proper pH of the soil (37.5%), loss of humus (26.4%), poor plant growth (25.6%), dense subsoil (23.6%) and low soil nutrient content (20.9%). The remaining problems, such as damaged granular structure, isolated water pools, erosion, accumulation of pathogens in the soil and high salinity were pointed out by a smaller number of respondents – fewer than 17% (Table 7).

From Tables 6 and 7 it can be inferred that problems with irrigation were listed first as the main issue related to cultivation and maintaining a proper condition of the soil. In consequence, there is an urgent need to implement methods to improve soil moisture, e.g., the use of systems common in other countries with much warmer climates, such as Italy or Spain.

An important issue is maintaining the proper pH of the soil, which was noted by 37.5% of the respondents (Table 7). Therefore, it can be assumed that these people are aware that soil acidification causes a number of negative

Table 6. The main problems in crops mentioned by respondents in surveys.

Problem	Number of responses [%]
Irrigation	43.2
Protection against diseases	30.6
Protection against pests	29.7
Decrease in soil quality	28.2
Decrease in plant growth and low yields	27.8
Weeds	27.7
Soil fertility	21.7
Crop rotation	13.2
Soil disinfection	10.7
Fertilization	7.5

Table 7. Main soil problems indicated in surveys.

Problem	Number of responses [%]
Moisture retention	57.5
Maintaining proper soil pH	37.5
Decrease of humus layer	26.4
Poor plant growth	25.6
Compacted subsoil	23.6
Low soil nutrient abundance	20.9
Damaged soil structure	16.9
Waterlogging	16.4
Erosion	13.7
Accumulation of pathogens in soil	13.4
High salinity	7.6

outcomes consisting in the reduction of soil productivity and fertility, limiting the availability of mineral nutrients for plants, and reducing the buffering capacity and resistance of soil to processes ultimately leading to their degradation (Niedźwiecki, 2019).

Open-ended questions were an important part of the survey, enabling the respondents to express their own opinion on the problems that arose during plant cultivation. The following issues dominated among the responses obtained:

1. Inadequate effect of plant protection products, i.a. resistance to pathogens (10.4% of respondents).
2. Problems with determining the dosage of mineral fertilizers (7.5% of the respondents).
3. Problems with the proper arrangement of crop rotation (5.5% of the respondents).
4. Chemical contamination of soils (4.9% of respondents).
5. Lack of reliable information on biological preparations (4.6% of the respondents).
6. Reservations with regard to the reliability of the chemical soil analyses (4.6% of respondents).
7. Limited availability of manure (4% of respondents).
8. High cost of liming (4% of respondents).
9. Phytotoxic effects of herbicides on succeeding crops (4% of respondents).

It is worth noting that the issues No. 5 and 6 are related to institutional neglect, while No. 2, 3, or 9 – testify to insufficient knowledge of the respondents. In addition, the respondents indicated that they lack basic information, such as the content of macro-and micronutrients and soil pH or the availability of plant protection products on the market. They also asked what kind of organic fertilization and what biological preparations should be applied. Some respondents would like to learn about microorganisms inhabiting their soils in a quantitative and qualitative approach, as well as methods to improve their activity. Interest was taken in the content of humus in soils and in the methods contributing to its increase.

The improper management of fertilizers in Poland results from their disproportionate use, i.e., the excessive use of some and scant use of others. It is usually associated with the excessive application of nitrogen fertilizers, the use of which often exceeds the absorption capacity of plants, and with a deficiency of phosphorus (Niedźwiecki, 2019; Prandecki, 2015). The use of nitrogen in Polish agriculture improved at the beginning of the 21st century. In 2012–2014, the total (gross) inflow of nitrogen was used in 64% (Kopiński, 2017). Still, despite the improvement of the agrochemical condition of soils, there are still significant reserves in a better utilisation of this component, leading to the improvement of agricultural productivity and reducing the effects of its adverse environmental impact. Low consumption of calcium fertilizers on a national scale (Statistics Poland, 2020) and unfavourable proportions of the main fertilizing macronutrients (N:P:K) lead to a significant limitation of plant productivity, technical and economic efficiency of nitrogen use (Kopiński, 2017; Stępień, 2019).

The respondents also pointed to the issue of insufficient performance of plant protection products. The phenomenon is widely studied in the scientific community. The phenomenon of agrophages becoming resistant to the active substances in pesticides is increasingly noticeable, which in turn leads to the low effectiveness of chemical plant protection products and the need to use a wide range of pesticides containing various active substances (Żak, 2016). New solutions that can be implemented in plant protection are being sought. It is worth noting that initially the negative impact of pesticide use on the natural environment was not noticed. Pesticides were thought to help in tackling the problem of food scarcity. However, the indiscriminate use of these agents has contributed to irreversible changes in the natural environment (Wołejko et al., 2020).

The respondents emphasized the problem of the phytotoxic effects of herbicides. Herbicides can have a phytotoxic effect on a crop, causing damage during vegetation and a reduction in yield (Kieloch, 2018). A cultivated plant has the ability to detoxify an herbicide, i.e., to break down its active substance into compounds which are harmless to itself or only slightly noxious. This process does not function efficiently in plants with reduced tolerance to a given herbicide and in conditions unfavourable to the metabolism of the agent, e.g., in low temperature, which results in disturbances to the biochemical processes of plants. The phytotoxic effect of herbicides on the quality of the yield depends on a given variety and the development of the weather during the growing season. Many years of work carried out in scientific and research institutions provide a basis for concluding that the negative impact of herbicides on the quality of crops occurs sporadically. It was also observed that this effect was more pronounced in years with unfavourable weather patterns for plant vegetation when a crop being in a worse condition showed an increased sensitivity to herbicides. The risk of deteriorating the quality of the crop is much greater when herbicide protection is not applied than when the herbicide turns out to be less than fully selective for a given crop (Kieloch, 2018).

The respondents were aware of the potential presence of heavy metals and other pollutants in soils, but they would like to know whether these pollutants exceeded the acceptable standards. Monitoring studies of agricultural soils carried out in our country for twenty years have provided key information on the content of pollutants and their changes over time (Smreczak et al., 2018). According to the data, the content of harmful substances in most of the arable lands is low and does not adversely affect soil functions or the potential for the production of high-quality food. The results of monitoring the chemistry of Polish arable soils are available on the website of the Chief Inspectorate of Environmental Protection, therefore they are of great im-

portance for shaping the public opinion in the field of soil quality assessment. Identifying areas with contaminated soils allows for implementing environmental risk analysis and remediation treatments as well as mitigation practices (Smreczak et al., 2018).

The above-mentioned problems should become the subject of research for scientists, but also an inspiration to act for agricultural advisors and decision-makers on legal issues related to, i.a., approving biological plant protection products for use. Prandecki (2015) identified similar problems and described them in his work. He believes that the measures taken should be aimed at reducing the pressure of agriculture on the environment, and the priority should be given to counteracting excessive soil changes and stopping the processes of biodiversity reduction (Prandecki, 2015).

In the presented survey, a significant proportion of respondents – 74.5% state that their soil is in good condition, but there are problems, 18.4% of respondents consider their soil fertile and of good quality, while 7.1% of people assess their soil as degraded (Table 8). These answers prove that the farmers enquired were fully aware of the condition of their soils.

Table 8. Opinion on soil expressed by respondents.

Opinion	Number of responses [%]
Soil in good condition, but problems arise	74.5
Soil in good condition	18.4
Degraded soil	7.1

The analyses aimed at assessing farmers' perception of the impact of agriculture on the natural environment, carried out by Sulewski and Gołaś (2019), point to the conclusion that only some of the surveyed farmers were aware of the negative impact of agriculture on the natural environment (from 30 to over 60% of respondents depending on the assessed element of the environment). The main motivation justifying the need for nature protection was, according to the surveyed farmers, the concern for their health. The analyses carried out by these authors also demonstrated that farmers who were aware of the negative impact of agricultural production on the natural environment ran farms with higher production potential, higher intensity, and better economic results on average (Sulewski, Gołaś, 2019).

Summarizing the results obtained on the basis of the conducted surveys, it can be stated that the respondents, mainly the users of agricultural soils in Poland, approach soil management with full awareness. They perceive the problems and threats related to the use of the soil. They know that properly conducted agrotechnical treatments, rational fertilization, in accordance with the needs of plants, preceded by soil condition tests, contribute to improving the quality of agricultural products and increasing yield, while maintaining the soil in good condition and without negative impact on the natural environment. Substantive support from qualified personnel and assistance in the form of professional training and specialist consultancy are still very important for farmers.

CONCLUSIONS

1. The respondents of the survey can discern the problems and threats associated with the intensive use of the soil.
2. Over 68% of respondents declared using organic fertilizers, mainly in the form of manure. However, an increasingly limited access to manure was pointed out. The remaining types of organic fertilizers are used to a much lesser extent; therefore, it is advisable to work on implementing other options for using organic fertilization.
3. The dominant group of plant protection products are herbicides and fungicides. However, attention was drawn to the insufficient effectiveness of these measures. More than half of the respondents (68%) also declared the use of biological agents. However, they also pointed to the lack of reliable information on these measures.
4. Irrigation was identified as the main problem faced by producers in cultivating crops, followed by the protection of plants against pests and diseases.
5. The respondents declared problems with maintaining an appropriate soil pH. Many of them also have problems with determining the proper fertilization, because they do not perform chemical analyses of the soil or are unable to determine the dosage of fertilizers on the basis of the obtained results of the analysis. Therefore, it is necessary to provide adequate advice to support the introduction of a rational fertilization system in crops.
6. Weak and patchy plant growth is increasingly often observed on the fields. Farmers also find a loss of humus deteriorating the soil structure.
7. For farmers, it is important to provide substantive support by qualified experts as well as assistance in the form of training and specialist advice.

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