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SWOT ANALYSIS OF THE POLISH ORGANIC FOOD SECTOR IN THE CONTEXT OF ITS IMPACT ON THE ENVIRONMENT AND HUMAN HEALTH

Summary

The organic food sector is one of the most dynamically developing food sector branches nowadays. Increased interest in organic food production and consumption is a response to the growing negative effects of agriculture intensification, which has contributed to environmental degradation and reduced food safety. The aim of the study was to identify and analyse the strengths and weaknesses, as well as the opportunities and threats of the organic food sector in the context of its impact on the environment and human health. The research material consisted of data collected by analysing literature of the subject. The results are presented using a SWOT matrix. It was found that organic agriculture has more strengths than weaknesses, and that taking advantage of the identified opportunities and minimizing existing threats would affect its further development, with benefits to the environment and humans.
***Key words**: SWOT analysis, organic farming, organic food, natural environment, human health*

ANALIZA SWOT POLSKIEGO SEKTORA ŻYWNOŚCI EKOLOGICZNEJ W KONTEKŚCIE WPŁYWU NA ŚRODOWISKO NATURALNE I ZDROWIE CZŁOWIEKA

Streszczenie

Sektor żywności ekologicznej jest jednym z najdynamiczniej rozwijających się sektorów branży spożywczej. Wzrost zainteresowania produkcją ekologiczną jest m.in. odpowiedzią na narastające negatywne skutki intensyfikacji rolnictwa, która przyczyniła się do degradacji środowiska i zmniejszenia bezpieczeństwa żywności. Celem niniejszej pracy była identyfikacja i analiza mocnych i słabych stron oraz szans i zagrożeń sektora żywności ekologicznej, w kontekście wpływu na środowisko naturalne oraz zdrowie człowieka. Materiał badawczy stanowiły dane zebrane na podstawie analizy literatury przedmiotu. Wyniki zostały przedstawione w formie macierzy analizy SWOT. W wyniku przeprowadzonej analizy stwierdzono, że w rolnictwie ekologicznym mocne strony przeważają nad słabymi, a wykorzystanie zidentyfikowanych szans i minimalizowanie istniejących zagrożeń wpłynęłoby na jego dalszy rozwój, z korzyścią dla środowiska naturalnego i zdrowia ludzi.
***Słowa kluczowe**: analiza SWOT, produkcja ekologiczna, żywność ekologiczna, środowisko naturalne, zdrowie człowieka*

1. Introduction

The organic food sector is one of the most dynamically developing food sectors worldwide [1]. Increased interest in organic food production and consumption is a response to the growing negative effects of the agriculture intensification. Large scale agricultural production, based to a huge extent on non-renewable resources, and dependent on the massive use of chemical fertilizers, pesticides and other invasive agricultural practices, strongly contributed to environmental degradation, including such aspects as e.g. water eutrophication, biodiversity loss, soil degradation, effects on the atmosphere, as well as to the food safety violation caused by pesticide residues, nitrates, antibiotics, heavy metals and other significant food contaminations. Organic agriculture, as an alternative, is based on natural fertilizers and crop protection practices, building long-lasting soil fertility, protecting biodiversity, animal welfare and generally aiming at sustaining and supporting the quality of natural environment [2]. More and more consumers search for organic food trusting in its positive impact on the environment and human health [3]. The aim of the study was therefore to identify and to analyse the strengths and weaknesses, as well as the opportunities and threats of the organic food sector in the context of its impact on the environment and human health, thus to verify if the above mentioned consumers believes are truly justified.

2. Material and methods

The study investigates different aspects of the impacts of the organic food production and consumption on the natural environment and human health. The research material consisted of data and information collected by analysing available published scientific literature of the subject. The results are presented using a SWOT matrix. External and internal factors determining the environmental and health-related impacts of organic food production and consumption were considered: internal strengths and weaknesses of the sector were identified together with the external opportunities that could be used to support the sector, and threats hindering the implementation of the objectives of organic farming.

3. Results and discussion

As a result of the undertaken literature analysis, the strengths, weaknesses, opportunities and threats of the organic food sector in the context of its impact on the natural environment and human health were identified. The results have been presented using a SWOT matrix (Table 1).

Table 1. Strengths, weaknesses, opportunities and threats of the organic food sector in the context of its impact on the natural environment and human health

Tab. 1. Siły, słabości, możliwości i niebezpieczeństwa organicznego sektora spożywczego w kontekście jego wpływu na środowisko przyrodnicze i zdrowie ludzkie

STRENGTHS	**WEAKNESSES**
1. Responsible use of non-renewable resources 2. Sustaining and enhancing soil biological activity and fertility 3. Limitation of ground and surface water pollution 4. Protection of biodiversity 5. Protection of the agricultural landscape 6. Supporting animal welfare 7. High nutritional quality of organic foods 8. Low and less frequent chemical contamination of organic foods 9. Limited number of food additives in the organic processing 10. Positive health impacts of the organic foods 11. Preventing antibiotic resistance of microbes	1. Air pollution in the effect of animal manure applications 2. Increased risk of biological contamination of organic foods 3. Increased risk of parasitic diseases in organic animal farming 4. Allowing food additives with the adverse health effects 5. Allowing crop protection treatments with a strong toxicity for humans and other organisms 6. Difficulties in the effectiveness of the control and certification system in organic farming 7. High prices and limited availability of organic products 8. Limited consumers trust in the sector
OPPORTUNITIES	**THREATS**
1. Farmers' education 2. Research into the possibilities of replacing some substances used in organic crop protection and food processing with safer ones 3. Consumers' education about the advantages related to the organic food production and consumption 4. Trend to 'healthy eating', increased consumer interest in natural and regional food with special health-related values 5. Diversification of the products assortment and the development of new and existing distribution channels 6. Increasing consumers' wealth 7. Permanent subsidising of the organic sector	1. Lack of complete isolation from the external contaminations 2. Reduction of subsidies for organic farmers 3. Frequent changes of legal regulations and the possibility of their misinterpretation 4. Competition with the imported foods

Source: own elaboration / Źródło: opracowanie własne

Each of the above identified strengths has been explained below.

S1: Responsible use of non-renewable resources

Organic farming promotes the reduction of non-renewable resources use. The responsible use of energy, water and other natural resources is one of its main principles. The water management in organic farming is more sustainable due to the agronomic treatments used. The constant presence of soil plant cover, green manures and optimal crop rotation can also be listed among agronomic practices limiting the use of non-renewable resources, such as water and fertilizers, in organic agricultural production. Similarly, the non-use of synthetic fertilizers and plant protection products reduces the pollution of ground and surface waters. In addition, protection of the soil structure and building the amount of humus in the soil, increases the soil fertility and water holding capacity [2].

According to the IFOAM principles for organic farming, this type of agriculture should also support local food production systems, which would not only allow the regions to keep their food sovereignty, but would also limit the use of fossil fuels associated with long-distance food transportation. However, European regulations on organic farming [2] are not fully in line with the above principle, and many organic products on the EU market come from the imports [1].

S2: Sustaining and enhancing soil biological activity and fertility

The biological activity of soil, determining its fertility, is built to a large extent by the microorganisms and enzymes they produce. The higher the number of soil microbes, the more intensive the decomposition of organic matter, thanks to which nutrients are made available to plants. The total number and diversity of microorganisms is impacted by many factors (e.g. organic matter content, pH) that strongly depend on the soil cultivation system. The decline in fertility and deterioration of the soil is a side effect of i.e. the use of synthetic plant protection products. The decrease in the number of bacteria and the disturbance of soil microbial balance was observed in the studies of Jastrzębska [4] after the application of fungicides and insecticides. Nitrogen-fixing bacteria have been proven to be particularly sensitive to pesticides. Wyszkowska and Kucharski [5] have observed reduced number of bacteria and fungi as well as a reduction in enzyme activity as a result of herbicide use.

The use of intercrops, post-harvest residues, non-tillage cultivation and organic fertilizers increase the organic matter content, which results in greater biological activity and fertility of the soil cultivated in the organic agricultural systems. This has been confirmed by 13-year study by Kuś and Jończyk [6] on the environmental impact of various agricultural management systems. The beneficial impact of organic farming on the biological activity of soil has been noted. The results showed that the indicators characterizing the enzymatic and biological activity of soil (i.e. the number of bacteria and fungi, biomass of microorganisms, enzyme activity) reached higher values in the organic system. Moreover, Natywa et al. [7] showed the negative effect of higher doses of ammonium nitrate (mineral nitrogen fertilizer) on the dehydrogenase activity and the number of bacteria and actinomyces in the soil. Gajda et al. [8] confirmed the beneficial effect of reduced tillage on the biological activity of soils. They found a bigger carbon pool in the soils

cultivated according to the reduced tillage technology than in the soils cultivated in plow technology.

S3: Limitation of ground and surface water pollution

The organic management system contributes to the limitation of the adverse impact of agriculture on water quality. It reduces the outflow of nutrients through the use of organic fertilizers, intercrops, undersown crops, thus increasing soil fertility and water holding capacity. Moreover, the adequate crop rotation and other organic agricultural practices as well as actions taken to protect the agricultural landscape (e.g. field margins, water reservoirs etc.) prevent water erosion.

Unlike intensive farming, organic system does not create a problem of the excessive amounts of slurry, due to the limited animal stocking density. Otherwise, it contributes to the water pollution with synthetic plant protection products. Czyżyk et al. [9] presented the results of a 6-year study on the effect of light soil fertilization with compost *versus* mineral fertilizers on the amount of nitrogen and phosphorus leaching. There were definitely lower concentrations of nitrogen in the leachate from the soil fertilized with compost compared to the equivalent doses of synthetic nitrogen fertilizers. At the same time the leaching of phosphorus was independent of the type of fertilizer. The research has also shown an increase in the nitrogen leaching and in the formation of its excess in the soil along with increasing doses of fertilizers.

S4: Protection of biodiversity

Organic farmers, by taking care of the agricultural landscape elements such as ponds, field margins etc., and by protecting natural enemies of pests (e.g. by not using synthetic pesticides), create ecosystem for many species of animals and increase the diversity of flora and fauna. In addition, as a result of agronomic practices including e.g. optimal crop rotation, they increase soil biodiversity. Research conducted by Tuck et al. [10] showed that the overall species richness in organic farms is higher by 34% than in conventional farms. It has been observed that organic farming has the most beneficial effect on the diversity of plants, arthropods, birds and microorganisms. Organic farms are also distinguished by a larger forest area, density and richness of butterfly species [11] and spiders [12], as well as an increased occurrence of birds [13].

S5: Protection of the agricultural landscape

Organic farming protects the characteristic agricultural landscape features. It promotes the protection of field margins, ponds, pastures and meadows, sustaining biodiversity and protecting against surface water pollution, disappearance of wetlands and degradation of soils. It shapes rich agricultural ecosystems, facilitating the development of agritourism, and supporting the comfort and quality of peoples' life.

S6: Supporting animal welfare

In organic animal husbandry, great attention is paid to animal welfare. Their health is maintained by supporting the body's natural resilience, by giving them access to pastures and outdoor areas and providing with the quality, natural feeds. Radkowska [14] has described the beneficial effect of dairy cows outdoors grazing on their health. Cattle kept indoors, without access to pastures, showed significantly higher incidence of mastitis (35% compared to 21% in case of outdoor grazing). Significantly more frequent occurrence of lameness was also observed in the animals kept in the barn (30%) compared to those with access to pastures (13%). Moreover, the incidence of milk fever in the organic animal farms is usually lower, probably due to the lower milk production intensity compared to the intensive animal husbandry [15]. The animal density in organic farms is also limited, providing appropriate conditions to the animals, ensuring comfort and meeting the needs of a given species. Animal breeds in organic farming should be generally selected with a consideration of the local environmental conditions, which helps limiting health problems. Animal feeds should come from the organic farms, which also impact the quality of food products of animal origin.

S7: High nutritional quality of organic foods

Compared to conventional foods, organic crops and plant-based products are often characterized by a higher content of total carbohydrates and reducing sugars and lower concentration of protein, and at the same time show a superior biological value represented by higher up to 60% concentration of antioxidants such as e.g. flavonoids (including anthocyanins), phenolic acids, stilbenes and other groups of phenolic compounds [16]. Organic fruit and vegetable are also often characterised by higher concentrations of carotenoids (including xanthophylls and lutein) and some vitamins (e.g. vitamin C). Organic meat is usually richer in polyunsaturated fatty acids, including n-3, while organic milk is often characterized by a more favourable ratio of n-3 to n-6 fatty acids, and higher CLA concentrations. The compositional characteristics of organic products of animal origin were found to be related mainly to outdoor grazing [17, 18].

S8: Low and less frequent chemical contamination of organic foods

Organic plant-based foods are usually less frequently contaminated with pesticide residues and contain lower concentrations of heavy metals, nitrates and nitrites when compared to the conventionally cultivated crops. Moreover, animal products from organic husbandry systems are known to be free from antibiotics.

Nitrates in the digestive tract can be reduced to nitrites, the excess of which may be associated with methaemoglobinaemia, as well as with the formation of carcinogenic nitrosamines. Accumulation of nitrates in vegetables is caused by the excessive supply of easily accessible nitrogen to the soil, which often happens in conventional farming. Jarych-Szyszka [19] showed the effect of intensive fertilization with synthetic nitrogen on a significant increase in the nitrates content in potato tubers. Wichrowska and Wojdyła [20] additionally found a relation between the use of herbicides and the increase in the nitrates content in potatoes. However, they also confirmed that the initially high nitrates concentrations significantly decreased during heat treatment and storage of the raw material. Even though organic crops usually contain less nitrates when compared to the conventional ones, the risk of increased accumulation of these compounds in potatoes from organic farming was also demonstrated in some studies, as a result of inappropriate crop rotation. This applies mainly to early varieties, which do not have time to convert a large dose of nitrogen into yield [21].

As mentioned above, pesticide residues are detected less frequently and in smaller quantities in organic compared to the conventional crops. The frequency of their occurrence in organic crops is on average four times lower. A report published by EFSA [22] shows that food from the European Union is either free from pesticide residues (53.3% of the

tested samples), or contains quantities that do not exceed the permitted limits (43.9%). However, due to the lack of scientific evidence on the health impacts of pesticide "cocktails" ingested with an everyday diet, even in limited quantities, the problem of pesticide residues should not be underestimated. According to the cited EFSA report, 99.3% of the organic food samples did not contain detectable pesticide residues. This was also confirmed in the meta-analysis published by Barański et al. [16], who additionally indicated significantly lower concentration of toxic cadmium (48% less on average) in organic compared to the conventional crops. Cadmium, even in small quantities, is known to have a negative effect on the reproductive system, liver, kidneys, and was proven to be a strong carcinogen.

Due to the widespread use of antibiotics, their residues may be found in food products of animal origin. Even small amounts of these substances can cause allergic reactions and, most importantly, lead to drug resistance of microbes. Due to the limited use of antibiotics in organic farming, organic products of animal origin are free from antibiotic residues.

S9: Limited number of food additives in the organic processing

The number of food additives allowed for use in organic processing is limited compared to the conventional processing. Only natural additives are allowed. Synthetic dyes, preservatives, stabilizers, aromas and sweeteners cannot be used [2]. The lack of synthetic additives and the natural taste of organic food are acknowledged by the organic food consumers as important organic food purchase drivers.

S10: Positive health impacts of the organic foods

Many of the bioactive compounds found often in higher concentrations in organic foods have previously been linked to a reduced risk of chronic diseases, including certain cancers [23]. Negative (i.e. carcinogenic) effects of cadmium and pesticide residues found more frequently in conventional products are also well documented [24, 25, 26]. On the basis of the above statements one could expect beneficial health effects (i.e. potent anticancer properties) of organic compared to the conventional foods. Recently published results of the first big scale human cohort study to examine the association between the consumption of organic food and the risk of cancer have shown lower incidence of non-Hodgkin lymphoma in the population of organic vs. conventional food consumers [27]. Moreover, in studies on the impact of a diet based on organic products on human health, the less frequent occurrence of allergies in children and better well-being of organic food consumers has been confirmed [28]. There was also a lower risk of preeclampsia in women who regularly consumed organic vegetables [29]. It is worth mentioning that pesticides do not only pose a risk to consumers exposed to the contaminated foods. During spraying, plant protection products pose a significant danger to the farmers, their families and the overall population of the agricultural areas.

S11: Preventing antibiotic resistance of microbes

Practices applied in organic animal husbandry (using antibiotics only when necessary) prevent the spread of drug resistance among pathogenic bacteria. Miranda et al. [30] showed that *Escherichia coli* isolated from organic poultry meat was characterized by a lower level of resistance to the majority of the antimicrobials. In addition, multi-drug resistant strains were more frequently found in conventional meat. In the same study, significantly higher resistance of *Staphylococcus aureus* and *Listeria monocytogenes* to doxycycline was found in case of bacteria isolated from conventional compared to the organic poultry. Österberg et al. [31] made similar observations, showing significantly lower resistance of *E. coli* strains isolated from organic compared to the conventional pork.

The influence of animal husbandry system on drug resistance was also demonstrated by Luangtongkum et al. [32]. In organic poultry only 2% of *Campylobacter* strains were resistant to fluoroquinolones, compared to 67% in case of conventional turkeys. Also, multi-drug resistant isolates were detected mainly in turkey meat from conventional farming.

A meta-analysis published in The Lancet Planetary Health showed that limiting the use of antibiotics in animal farms reduced the prevalence of drug-resistant bacteria by about 15% and by 24-32% in case of multi-drug resistant microbes [33]. The World Health Organization recommends a restrictive use of antibiotics in animal production in order to protect their effectiveness in humans.

Weaknesses of the organic sector in the context of its impact on the natural environment and human health are presented below, together with the possibilities to reduce them.

W1: Air pollution in the effect of animal manure applications and other agricultural practices

Both conventional and organic farms contribute to greenhouse gases (GHG) emission. Their main sources are: ruminants' digestion, land use conversion to produce animal feed, growing feed crops, animal excrements and agricultural soils. However, it was found that conversion to organic farming resulted in the 26% reduction in GHG emission, mainly due to non-use of mineral nitrogen fertilizers and the reduction in the number of agro-technical operations (lower fuel consumption) [34]. Promoting soil coverage in organic farming is also an important factor for the GHG balance. GHG emissions from animal agriculture can be minimized by more frequent excrements removal, the use of bedding additives (drying and limiting fermentation processes), installing specialized ventilation systems, adjusting the amount of dietary protein to the needs of animals, slurry storage in sealed chambers, use of adsorbers, installation of fertilizer cooling systems [34, 35].

W2: Increased risk of biological contamination of organic foods

Due to the limited use of antibiotics and synthetic plant protection products, as well as the increased use of natural fertilizers and animal grazing system in organic agriculture, the risk of biological contamination of organic foods could be increased. However, currently there is no such evidence. The use of natural fertilizers indeed could affect the occurrence of potentially pathogenic microorganisms in the soil (i.e. Salmonella and coliforms), as confirmed by Zielińska et al. [36]. However, in the same study, it was found that the fermentation of slurry causes a significant reduction in the number of pathogens or their complete elimination, which indicates safety of the properly processed natural fertilizers. The study of Mruczyk and Jeszka [37] showed higher content of ochratoxin A, but lower concentration of zearalenone in organic compared to the conventional cereal products. Higher concentration of Fusarium toxins in organic compared to conventional pastas was reported by Serrano et al. [38]. At the same time Solarska *et al.* [39] during their two-year observations did not find ochratoxin

A and aflatoxin in organic cereals, while the contents of deoxynivalenol and zearalenone in organic cereal samples were very low.

Also, the study of Twarużek et al. [40] did not give clear evidence for greater susceptibility of organic raw materials (grains) to mycotoxin contamination. Some researchers point to the increased prevalence of pathogens in organic foods, e.g. Oliveira et al. [41] indicate a higher frequency of *E. coli* detection in organic lettuce [, while Cui et al. [42] reported more frequent contamination of poultry with Campylobacter and Salmonella. However, in a review by Smith-Spangler et al. [43] based on the analysis of 223 studies, it was found that the risk of *E. coli* contamination did not differ between organic and conventional products. Frequent microbial contamination of pork and poultry has been observed, but it has not been associated with the animal husbandry system (organic vs conventional).

W3: Increased risk of parasitic diseases in organic animal farming

According to the scientific literature, the occurrence of parasites is more frequent in animals from organic compared to the conventional husbandry, due to access of animals to paddocks and pastures. E.g. the more frequent occurrence of liver fluke and *Toxoplasma gondii* in animals from the organic farms was reported. However, in case of proper cleaning and heat treatment of meat, occurrence of parasites isn't always associated with an actual impact on human health.

Jańczak et al. [44] detected antibodies against *T. gondii* in 10% of goats from organic husbandry, while Michalski and Platt-Samoraj [45] found *T. gondii* in 63% of organic animals. They also emphasized a risk of occurrence of live forms of *T. gondii* in goat's milk, indicating a risk of toxoplasmosis in humans as a result of the consumption of unpasteurized goat's milk.

W4: Allowing food additives with the adverse health effects

Among the additives allowed in organic processing there are some preservatives with a potentially negative impact on human health, such as e.g. sulfur dioxide, potassium pyrosulfite, potassium nitrate and sodium nitrite, which can also be used in conventional production. As consumers choose organic food mainly because of its quality and health-related properties (measured, among the others, by its composition, including lack of additives with the adverse health effects), any controversial ingredients in terms of their safety should be avoided in organic processing.

W5: Allowing crop protection treatments with a strong toxicity for humans and other organisms

Among substances raising concerns, and allowed for use in organic farming, there are i.e. preparations containing copper compounds. They are used as plant protection products with fungicidal activity. Copper can be accumulated in soils and cause changes in the composition of soil microflora, which leads to deterioration of soil properties. High copper concentrations may reduce the abundance of nitrogen-fixing bacteria, actinomycetes and fungi, leading to the reduction in soil fertility [46]. As confirmed in the study of Bielicki et al. [46], spraying plants with a copper-based preparation resulted in a reduction in the population of soil microflora. In addition, almost 60 times higher copper concentrations were detected in the leaves of these plants compared to the leaves of plants from the control plots. It has been confirmed that copper-based fungicides pose risk to the aquatic organisms, bees, birds and mammals, and for workers performing spraying [47].

W6: Difficulties in the effectiveness of the control and certification system in organic farming

In comparison with conventional food production, organic farming is subject to the specific control in at least annual manner, as well as additional random controls. None of those can review, however, a day by day compliance of the farmers with the organic production regulations, for example the use of certified cleaning substances or animal access to the pastures. The solution for this would be an increased farmers' education, pointing out an importance of organic rules for natural environment and human health.

W7-8: High prices and limited availability of organic products & Limited consumers trust in the sector

According to the IMAS International report [48], high prices and lack of trust are two the most important barriers against organic food purchase by the Polish consumers. While about 64% of consumers, especially from rural areas, consider organic food as too expensive and not worth the price, another 25% of the consumers have no confidence in its environmental friendliness, and 15% do not trust in organic certification process. This situation might be a result of unfair or dishonest practices of some organic farmers and processors, such as the use of prohibited chemicals, unauthorised use of organic labelling, or misleading labels on conventional products with words 'natural' or 'biological' causing confusion in uneducated customers. The decreased confidence in organic sector is also caused by strong media attention in cases of organic food contamination and recalls.

All the above slow down organic sector development, and thus beneficial effect of the organic farming on the natural environment and human health. The rise of organic food sale would also increase the conversion rate of farms to organic management and farmers' income, which could lead to investments in farm innovations (solar panels for heat or electricity generation, wind turbines, better animal housing, closed slurry tanks, etc.). On the other hand, this could also lead to the increase in financial support for organic sector, including research aiming at organic agriculture development.

The list of actions that could decrease the negative effect of organic farming on the environment and increase its positive impact on human health, is presented below:

O1: Farmers' education

Organic farmers' education in form of lectures, workshops, and materials such as leaflets, short publications and guides accompanied by the development of education centres could minimise weak spots of organic agriculture.

As reported by Drygas et al. [49], 42% of organic farmers in Poland consider consulting as an important tool in knowledge transfer. The 13% of them pointed inconsistency and ambiguity of the national regulations as main cause stopping organic sector development, and at the same time 90% of farmers admitted that they use help of advisors when preparing applications for subsidies [. According to Kondratowicz-Pozorska [50] underfunding and the lack of expert advisory centres are the main barriers in technical development of organic farms in Poland.

Educational programs on organic farming practices, current legal regulations and good agricultural practice (e.g. principles of application and storage of organic fertilisers or using innovative solutions), could help to reduce the negative impact of organic farming on the environment. Also,

dissemination of knowledge about the beneficial effects of organic agronomic practices on natural environment and human health could be considered as an encouragement for farmers to convert their farms to organic and increase organic sector development.

O2: Research into the possibilities of replacing some substances used in organic crop protection and food processing with safer ones

To date, no substitute has been found for Cu-fungicides, and more research is needed to develop natural agents that could efficiently fight fungal diseases on crops without the risk of negative impact on the natural environment.

In the organic food processing the use of sulphur dioxide and potassium metabisulphite as food additives has recently been limited to mead only. While both nitrates and nitrites have not been replaced by safer preservatives, the ongoing research in this area is indicating such possibility. Results of Wójciak et al. [51] suggest that the addition of a probiotic bacteria strain and acid whey enables the production of organic raw-ripening sausage without the addition of sodium nitrate (III) and (V), while maintaining the appropriate colour and shelf-life of the product.

O3-7: Consumers' education about the advantages related to the organic food production and consumption; Trend to 'healthy eating', increased consumer interest in natural and regional food with special health-related values; Diversification of the products assortment and the development of new and existing distribution channels; Increasing consumers' wealth; Permanent subsidising of the organic sector

The dynamic development of Polish organic sector could be assured by the increase of producers and consumers interest in organic food, being a result of, among others, fashion, increased awareness and wealth of consumers, as well as better selection and availability of organic products. Stable funding of organic sector could provide help for organic farmers, encourage them to convert from conventional practices to environmentally friendly ones, and enable farm modernisation.

The development of the organic sector could be also supported by the increased financing of the research and development in the area of i.e. organic food safety, use of natural resources or new technologies in agronomy and food processing. As a result, this would indirectly contribute to the sector improvement in terms of its impact on the natural environment and human health.

The external threats that could cause the reduction of the positive impact of the organic agriculture on the natural environment and human health are listed below:

T1: Lack of complete isolation from the external contaminations

Despite strict rules of organic agriculture, organic crops are not free from contamination, such as toxic metals or pesticide residues. The presence of these contaminants is mostly caused, however, by environmental pollution or cross-contamination from conventionally managed fields. An appropriate distance from conventional farms, physical barriers in the form of tall trees or other plants, wide field margins, or drainage ditches are considered as an effective protection from cross-contamination [52]. However, it is very difficult to ensure a complete separation from all pollutants.

Pesticides used in conventional farms, due to their volatility, travel long distances from place of application, causing contamination of the soil, plants and water. As shown by Kubiak et al. [53], 60% of the pesticides volume is lost to the atmosphere during application, by evaporation or wind erosion from soil surface, and by post-application emission from plant surface (it accounts for 3-90% losses, depending on pesticide used).

The environment is considered the main source of toxic metals found in organic crops. Thus, the levels of metals in organic crops grown on the open field are usually higher in comparison with crops from greenhouse cultivation [54]. At the same time higher concentration of toxic metals was found in plant leaves than in fruits and roots. The level of contamination of crops was also correlated with the levels detected in the air and linked with absorption of metals from the soil.

T2-4: Reduction of subsidies for organic farmers; Frequent changes of legal regulations and the possibility of their misinterpretation; Competition with the imported foods

According to the study by Drygas et al. [49] the majority of farmers surveyed (52.4%) admitted that without subsidies for organic production, they could not bear expenses on the current level, which could lead to their conversion back to conventional agriculture. This would reduce the area cultivated according to the environmentally friendly rules, lower the organic food supply, increase prices, and consequently slow down the organic food sector development in Poland.

Competition between the local and the imported products (i.e. low prices and high quality of the imported foods) as well as inconsistency and ambiguity of the current legal regulations, are important factors limiting the organic sector development, thus, indirectly, reducing the positive impact of the overall agricultural production on the environment and human health [49].

4. Summary and conclusions

Organic farming methods protect the soil from erosion and degradation, and build its fertility. They protect ground and surface waters from pollution and eutrophication. Lack of intensive agricultural practices, lack of chemical fertilizers and low animal density in organic farms are only few reasons for a lower carbon footprint and climate change impact of organic agriculture. Organic farmers protect natural biodiversity, promote local species and breeds, respect animal welfare. Organic foods are usually characterized by higher quality, measured by i.e. higher concentrations of natural antioxidants, lower and less frequent contamination with pesticide residues and cadmium. Organic food consumers show less skin allergies, lower risk of some cancers (non-Hodgkin lymphoma) and preeclampsia. Moreover, they evaluate their health status better than conventional food consumers. Organic farming has a positive impact on human health not only by providing high quality produce, but also by protecting the environment, which translates into the health of the population.

The weaknesses of the organic sector identified in the undertaken SWOT analysis consist of i.e. increased risk of parasites, biological contamination, allowing food additives and crop protection treatments with potential adverse health effects, difficulties in the effectiveness of the control and certification system, high prices and limited produce availability, limited consumers trust. Most of them could be re-

duced by i.e. appropriate education of producers, processors and consumers, and by providing stronger support for the research on organic farming.

On the basis of the undertaken analysis, it can be concluded that organic agriculture has more strengths than weaknesses, and that taking advantage of the identified opportunities and minimizing existing threats would affect its further development, with benefits to the environment and humans.

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