Biosafety and Biosecurity in Food Production – From Ethics to Economics

A Summary

”European Agricultural Fund for Rural Development: Europe investing in rural areas”.

The project co-financed from the European Union funds under Scheme II of the Technical Assistance measure 'Polish Rural Network' of the Rural Development Programme for 2014–2020.

The Managing Authority of the Rural Development Programme for 2014–2020 – the Minister of Agriculture and Rural Development.

The content is supervised by the Foundation for the Development of Polish Agriculture.

Biosafety and Biosecurity in Food Production – From Ethics to Economics

Biosafety and Biosecurity in Food Production – From Ethics to Economics

A Summary

Authors

Brygida Adamek · Paweł K. Bereś · Konrad Dereń · Nina Dobrzyńska

Grzegorz Gorzała · Michał Grzbiela · Łukasz Kontowski

Robert Kupczyński · Łukasz Siekaniec · Justyna Zwolińska

Authors of the Appendix

Joanna Gałązka · Hanna Jarosławska · Liliana Jurczyńska

Katarzyna Niećko · Karolina Witeska-Chmielewska

Scientific editors

Robert Kupczyński · Paweł K. Bereś

Scholar Publishing House

Warsaw 2023

Authors
Brygida Adamek, *Medical University of Silesia, Katowice*
Paweł K. Bereś, *Institute of Plant Protection – National Research Institute*
Konrad Dereń, *County Veterinary Officer, Piotrków Trybunalski*
Nina Dobrzyńska, *Ministry of Agriculture and Rural Development*
Grzegorz Gorzała, *Plant Health and Seed Inspection Service*
Michał Grzbiela, *UPL Polska Sp. z o.o.*
Łukasz Kontowski, *farmer, Szałkowo*
Robert Kupczyński, *Wrocław University of Environmental and Life Sciences*
Łukasz Siekaniec, *Institute of Plant Protection – National Research Institute*
Justyna Zwolińska, *Warsaw University of Life Sciences*

Authors of the Appendix
Joanna Gałązka, *Polish Crop Protection Association*
Hanna Jarosławska, *BIO-GEN*
Liliana Jurczyńska, *Chief Sanitary Inspectorate*
Katarzyna Niećko, *Chief Sanitary Inspectorate*
Karolina Witeska-Chmielewska, *Foundation for the Development of Polish Agriculture (FDPA)*

Scientific editors
Robert Kupczyński, *Wrocław University of Environmental and Life Sciences*
Paweł K. Bereś, *Institute of Plant Protection – National Research Institute*

Reviewers
Prof. Bożena Kordan, *University of Warmia and Mazury, Olsztyn*
Prof. Dorota Witkowska, *University of Warmia and Mazury, Olsztyn*

Translation
Dorota Szmajda

Proofreading
Joanna Bilmin-Odrowąż

Cover design
Katarzyna Juras

ISBN 978-83-67450-61-4
doi 10.7366/9788367450614

The monograph titled *Biosafety and Biosecurity in Food Production – From Ethics to Economics* was prepared as part of the project: European Green Deal – Opportunities and Challenges for Polish Agriculture. "European Agricultural Fund for Rural Development: Europe investing in rural areas".The project co-financed from the European Union funds under Scheme II of the Technical Assistance measure "Polish Rural Network" of the Rural Development Programme for 2014–2020. The Managing Authority of the Rural Development Programme for 2014–2020 – the Minister of Agriculture and Rural Development. The content is supervised by the Foundation for the Development of Polish Agriculture.

Fundacja na rzecz Rozwoju Polskiego Rolnictwa

Foundation for the Development of Polish Agriculture, ul. Gombrowicza 19, 01-682 Warszawa
phone: +48 22 864 03 90; e-mail: fdpa@fdpa.org.pl; www.fdpa.org.pl

INSTYTUT ZOOTECHNIKI
PAŃSTWOWY INSTYTUT BADAWCZY

Project partner: National Research Institute of Animal Production

Krajowa Sieć Obszarów Wiejskich

Visit website at: www.ksow.pl. Become a partner of Polish Rural Network
A free copy

The publication commissioned by the FDPA and issued by Wydawnictwo Naukowe Scholar Sp. z o.o., ul. Obożna 1, 00-340 Warszawa, e-mail: info@scholar.com.pl; www.scholar.com.pl

This publication provides a synopsis of the multi-author study entitled *Biosafety and Biosecurity in Food Production – From Ethics to Economics*, published following the scientific conference organised by the Foundation for the Development of Polish Agriculture in Nowy Adamów near Aleksandrów Łódzki on 6–7 March 2023. It is the third in a series of monographs issued as part of a project titled *European Green Deal – Opportunities and Challenges for Polish Agriculture,* co-financed by the European Union under Scheme II of the Technical Assistance "National Rural Network" of the Rural Development Programme 2014–2020. The monograph has eight chapters, which are expanded versions of the papers delivered at the seminar, and an appendix with supplementary materials.

The overriding aim of the European Union's (EU) food safety policy is to protect consumers and ensure the uninterrupted operation of the single European market. Initiatives undertaken in agriculture as part of the European Green Deal (EGD) strive to create a fair, healthy, and environmentally-friendly food system. This is to be achieved primarily by the implementation of two strategies: *Farm to Fork* (F2F) and *Biodiversity 2030*. Both strategies identify specific objectives which aim to transform the EU's food system by 2030. These include reducing the use and risk of chemical pesticides by 50% and fertilisers by at least 20%; reducing the sales of antimicrobials for farmed animals and in aquaculture by 50%, and increasing the share of agricultural land under organic farming to 25%. Furthermore, the EGD addresses the major issue of protecting diversity and restoring biodiversity as a common good.

The F2F strategy places particular emphasis on reducing the use of pesticides. Chemical protection needs to be applied in a well-thought-out way and be replaced with non-chemical methods wherever possible. Such are the expectations of consumers who want to eat food free from pesticide residues. At the same time, food must be free from such natural threats as mycotoxins produced by certain types of pathogenic fungi. This is why, to ensure that the food is safe to eat, even certified organic farms tend to apply plant protection using dedicated preparations.

The use of antibiotics in farm animals is a complicated process affecting animals, humans, and the natural environment. Importantly, alongside the application of measures reducing the use of antibiotics in animal production, the system for monitoring antibiotic consumption needs to be strengthened. Additionally, the restrictions in the metaphylactic administration of antibiotics that are already in place need to be strictly observed.

There is a wide consensus that antimicrobial resistance has risen to alarming levels. Drug resistance poses a serious socio-economic burden, as microbes grow increasingly resistant due to

natural selection and genetic mutations. These processes are exacerbated even further by inadequate (excessive) administration of antibiotics in humans and animals, poor and inappropriate conditions in health care and animal breeding institutions or the food chain. Consequently, antimicrobial agents become progressively less effective and ultimately useless or even harmful.

Currently, high hopes are being placed on the application of phytobiotics, prebiotics, and probiotics in livestock nutrition since they are viewed as alternatives to antibiotics. In turn, microbiological criteria provide guidelines for the admissibility of foodstuffs and their production processes. Preventative measures such as the application of Good Hygiene Practices (GHP) and Good Manufacturing Practices (GMP) as well as Hazard Analysis and Critical Control Points (HACCP) help ensure food safety. The discussion of the F2F strategy also focuses on ways in which ethical values could be linked to the economy.

The Polish version of the publication is provided with photographs, diagrams, and figures not included in the English synopsis, which only contains the text version.

The first chapter, entitled "From Ethics to Economics – Bioethical Issues in Agriculture and Environmental Protection" discusses a broadly understood ethical approach to biosafety.

Nowadays, issues such as climate crisis, shrinking natural resources and dwindling biodiversity, increasing levels of environmental pollution, insufficient animal welfare, introducing genetic mutations, hunger, malnutrition, and food wastage, alongside concerns for public health and other social problems, pose systemic bioethical challenges for agriculture and environmental protection. Finding solutions that would also attempt to reconcile ethical and economic values is now among the most daunting tasks.

The F2F strategy is intended as one such solution, proposing a reform of the food system in the European Union that would modify certain aspects of agricultural production due to their adverse impact on climate, environment, animal welfare, and thereby on human life and health.

The strategy identified three systemic bioethical issues in agriculture and environmental protection: the use of chemical plant protection products (PPPs), the use of inorganic fertilisers, and a low level of farm animal welfare, which leads to an excessive, routine, and preventive administration of antimicrobials in livestock production.

The strategy addresses each of these issues in three ways. First, by calling for a reduction of chemical pesticides and antibiotics in agricultural production by 2030. Second, by identifying, as an alternative, ways to make farming independent of such external agents through agricultural production systems: agro-organic, organic, sustainable, aimed at improving animal welfare, and third, operating in a circular economy. This is how the strategy attempts to reconcile economic issues with social and environmental ones, proposing a model of synergic benefits for all food chain participants, and an optimal remedy to the bioethical challenges of the present day.

A Summary

Identifying norms, values, and sets of principles to which human actions ought to be related, and evaluating them as good or bad, proper or improper, is a quintessential part of both ethics and bioethics. This has a normative dimension, which is manifested by laws that are established and all activity that is not normalised into law but undergoes ethical evaluation by the general public. Thus, the normative dimension of bioethics becomes part of public morality, and the adoption of the F2F strategy can be viewed as its expression.

Normative public morality has at its heart the interest of the entire community and humankind. It is a public good, for which society as a whole is accountable. Observing public morality is expected to bring welfare benefits for the community as a whole and its members. As such, it goes considerably beyond mere economic interest, whether understood in a societal dimension (the wealth of a given nation, state budget revenues) or as the interest of a specific group operating in the sphere of agriculture and environmental protection.

When we look at how the approach to the role of humankind compared to other life forms on Earth is evolving, we can see a shift taking place from the anthropocentric perspective, i.e., one centred only on the interest of humans, to a biocentric approach, in which humankind is seen as an element that is inextricably linked to other forms of life and is contingent on the entire quantitative and qualitative ecosystem of our planet. Such a shift is the object of bioethics, a discipline understood more broadly than a plain set of rules intended to limit human intervention in certain procedures or operations being made on live organisms and their ecosystems.

Bioethics, as viewed by the author of the term V.R. Potter, is there to provide a "bridge to the future". Thus understood, bioethics is needed for us to develop prudent and rational operating procedures through the application of science to preserve the environment in the best condition possible, and not to generate damages or losses that could undermine the evolutionary survival of the human species. This tallies with the transformation-oriented assumptions of the F2F strategy as it clearly states that the present status quo in agriculture and environmental protection can hardly be considered a "bridge to the future". In such an ethical and economic transformation, science has a pivotal role to play, and its development towards agro-organic conceptions is needed if the ethical problems that can be encountered in these two areas are to be resolved.

Including bioethical conceptions in the discussion on farming and environmental protection is expected to provide answers to two questions: whether what is economical is also bioethical, and whether what is economical also ought to be bioethical. The answer to the latter question should be positive if we are to tackle the present problems and satisfy society's expectations regarding the need to ask questions about the morality, suitability, rationality, and desirability of specific scientific and technical arrangements adopted in agricultural production, and the entire food chain; thus, we can ensure that they do indeed represent a bridge to the future.

The chapter "Biosafety and Biosecurity of Plant Production in the Light of the European Green Deal" makes it clear that food safety and security is a complex issue that has a bearing on individuals and businesses operating in the food sector. Consumer expectations regarding food safety and concern for the natural environment are constantly growing.

On the one hand, plant production policy needs to address the issue of food security, i.e., the provision of enough food to feed the population, and on the other, it must take into account the safety of food offered to consumers. Environmental and climate issues, which are increasingly acute, are driving a search for new solutions to be found for agriculture.

The sustainable development strategies and programmes that have long been in place and driven desirable changes in agriculture are nevertheless insufficient to meet the ever-increasing needs. To address this situation, the European Union originated new measures, such as the EGD. Its ambitious goals call for a multifaceted approach to agricultural policy and a modification of farmers' attitudes, while its overarching objective is to make Europe the first climate-neutral continent by 2050. The resultant new requirements will affect all sectors associated with agriculture production, including livestock breeders, manufacturers of fertilisers, and PPPs, research institutions, advisory firms, and farmers themselves.

In 2019, the European Commission published the main assumptions of the EGD, and in 2020, two major strategies were announced: *Farm to Fork* and *Biodiversity*. At the EU level, these strategies define some ambitious environmental goals, such as reducing nutrient losses by at least 50% while ensuring no deterioration in soil fertility; reducing the use of fertilisers by at least 20%, or increasing the share of agricultural land under organic farming to 25% by 2030. Other aims of these strategies include reducing the sales of antimicrobials for farmed animals and in aquaculture by 50%, and extending protected areas to 30% of Europe's land by 2030.

The European Commission resolved to incorporate the EGD goals into the Strategic Plans of the Common Agricultural Policy (CAP). Each of the Member States prepared its own CAP Strategic Plan based on the Commission's recommendations. The key issues as regards plant production include reducing fertilisation and use of PPPs, increasing the acreage of arable land, and improving the popularity of organic farming.

Fertilisation, in particular, mineral fertilisation can be limited through the popularisation of precision farming which enables more efficient use of fertilisers without adversely affecting the volume of crops. The relevant investment support is provided to farmers in Poland both under the CAP Strategic Plan as well as the National Recovery and Resilience Plan. The Strategic Plan also introduces eco-schemes that involve more advanced agro-engineering, performing soil analyses, fertilisation plans, and liming. In addition to the above, advisors are expected to play a significant role. Other important measures include the application of options other than inorganic fertilisers such as microbial fertilisers, simplified procedures for their market admission, and appropriate tax measures.

A Summary

The application of PPPs needs to be restricted rationally to safeguard crop and consumer safety. All protection methods are preferred, including the use of biological agents. To encourage farmers to try out such solutions, support in the form of eco-schemes has been offered: integrated production and biological plant protection. Additionally, other measures, including training and information initiatives, are being undertaken; they are outlined in the present issue of the National Action Plan on Sustainable Use of Plant Protection Products.

Organic farming in Poland has a huge potential, further reinforced by the assistance provided under the CAP Strategic Plan, as well as awareness-raising, promotional, and information activities. That notwithstanding, attaining a level of 25% organic farming in Poland does not seem feasible in the next financial perspective.

Currently, there is a heated EU-wide debate with the active participation of Poland concerning the draft Resolution on reducing the use of PPPs. The European Commission has proposed extremely strict solutions in that regard, without attempting an appropriate evaluation of their impact on agriculture. Such an evaluation, though, has been requested by Member States, which will mean that this issue will be further addressed.

In Poland, as regards compliance with the principles of the EGD with respect to plant production, the Plant Health and Seed Inspection Service (Pol. Państwowa Inspekcja Ochrony Roślin i Nasiennictwa) has a significant role to play. The chapter entitled "The Role and Responsibilities of the Plant Health and Seed Inspection Service in Ensuring Food Security and Safety" points out that the Inspectorate discharges its tasks related to food safety and security through its control as well as inspection activities; raising awareness of both agricultural producers and food consumers. The institution's scope of activity in that regard encompasses trade in, and the application of, PPPs, trade in fertilisers, and plant biostimulants as well as making available on the market CE-marked fertilisers (Pol. NAWÓZ WE) and EU fertilising products.

Under the Act of 8 March 2013 on Plant Protection Products, the Minister for Agriculture and Rural Development is the competent authority for the admission of PPPs to be traded and used in the market. The list of products permitted to trade (by authorisation or a parallel trade permit) can be found in the register available on the Ministry's website. The use of chemical PPPs in crops is interlinked with the possibility for their residues to be present in harvested agricultural products.

Improper use of pesticides frequently results in exceeding maximum residue levels. The Inspectorate carries out official inspections of PPP residue in plant products originating directly from primary agricultural production. Laboratory tests also help detect irregularities and the application of illegal PPPs. The test findings are assessed based on the list of maximum residue levels of pesticides provided in Regulation (EC) No. 396/2005 of the European Parliament and of the Council.

In Poland and other EU Member States, the application of PPPs must conform with the principles of integrated plant protection, which can be developed into integrated plant production. Integrated plant production is a voluntary system for the certification of food quality in Poland. Only suitably qualified or trained persons can purchase and use PPPs intended for professional users.

Practices with the use of PPPs employ equipment intended for PPP applications, which, if used according to its function and being technically fit, and calibrated, poses no danger to human or animal health or the environment. It means that equipment owners for the PPP application are obliged to perform calibration and conduct periodic tests to confirm its technical fitness.

Under the regulations in force, every single use of a PPP must be registered. Professional users are obliged to maintain and keep for three years the documentation listing the name of a given PPP, the time of its application and dosage applied, the area or acreage or the unit of grain and crop weight, or the facilities where the PPP was distributed. The law also requires documentation to evidence how the requirements of integrated plant protection have been met, by stating as a minimum the reason why a given PPP was used.

As part of its oversight duties, the Plant Health and Seeds Inspection Service conducts an annual audit of the whole PPP supply chain, PPP laboratory tests, and PPP application; collects samples of plant material for testing PPP residue, the whole supply chain of "fertilising products" as well as their laboratory tests for nutrients, and chemical or biological contaminants. If any irregularities are detected within the area of supervision, the Inspection Service will impose penalties.

The Inspection Service is also engaged in the dissemination of knowledge about PPPs, particularly integrated plant protection and safe PPP use; it also controls the placement of "fertilising products" on the market.

The chapter entitled "Non-Chemical Plant Protection Methods – the Example of Maize" presents some non-chemical plant protection solutions implemented in the practices of maize cultivation in Poland.

Maize (*Zea mays*) is the second most important agricultural crop in Poland, with a cropped area totalling over 1.8 million ha in 2022. In contrast, sweet corn (*Zea mays* convar. *saccharata* var. r*ugosa*), which is classified as a vegetable, has only about 13,000 ha of cropped area, and interest in its cultivation is constantly growing in Poland. The recommendations concerning integrated maize and sweet corn protection allow for the use of alternative methods to chemical plant protection with the aim of reducing the number and harmfulness of pests.

Agro-engineering methods include among others, crop rotation, timely sowing, spatial isolation, balanced fertilisation, weeding, timely harvesting, shredding of crop residues, and performing required tillage operations. Resistance breeding is a method of sowing plant varieties that are less affected by certain pests or diseases, while biological protection involves the use of biopesticides

containing micro- or macro-organisms. In Poland, biopesticides containing microorganisms such as fungi or bacteria must be registered as PPPs.

However, not every species that is harmful to maize can be effectively controlled by non-chemical methods, which means that chemical protection will still be used, but on a lesser scale. Wherever effective organic alternatives are available, farmers should use them first. Some incentives have the form of eco-schemes included in the CAP Strategic Plan. Two eco-schemes are of major significance in reducing pesticide use: "integrated plant production", of which integrated plant protection is a part, and "biological crop protection".

To limit the presence of weeds in maize crops, mechanical methods (e.g., use of in-row weeders) are recommended to be used first. Maize can be weeded using machines, but limited use of chemical plant protection is also possible. The mechanical-chemical method aims to eliminate weeds from inter-rows using mechanical tools and spraying only plant rows with herbicides. This helps reduce the volume of pesticides used for weeding. Farmers can also apply herbicides using the lowest doses recommended on the product labels.

Other pests for maize and sweet corn cultivation include those which cause diseases, of which pathogenic fungi are the most common. To contain the risk posed by them, extensive prevention is recommended, with such measures as agricultural engineering methods, sowing varieties less prone to certain diseases, primarily Fusarium wilt of maize cob and maize Ustilago being used. Other important measures include crop rotation, well-planned fertilisation, and timely harvesting. A biopesticide with the fungus *Trichoderma asperellum,* which contains plant diseases caused by Fusarium fungi, can also be used while sowing the grain.

Maize pests are increasingly becoming a serious problem in Poland. Non-chemical methods are the measures of first choice in controlling their populations. These include agro-engineering methods and selecting varieties that are less prone to infestation, mainly caused by the European corn borer (*Ostrinia nubilalis*). Other, equally important measures include crop rotation, shredding of crop residues, optimal fertilisation, and timely harvesting. The pests' incidence can also be monitored with Barber traps. Biopesticides with live *Trichogramma brassicae* (Hymonoptera) can be applied in the cultivation of common maize and sweet corn to control the eggs of European corn borers, the most dangerous pest to maize cultivation in Poland. Biopesticides with *Trichogramma* ssp. are applied more and more frequently from the air, by drones and gyroplanes.

In sowing maize and sweet corn, farmers can use a biopesticide containing beneficial nematodes (*Heterorhabditis bacteriophora*) to control the population of the larvae of western corn rootworm (*Diabrotica* v. *virgifera*) in monoculture plantations. In good soil moisture conditions, these nematodes will seek and parasitise on the pest's larvae, thus helping to reduce its population.

Other microbial biopesticides registered for sweet corn cultivation include those containing insecticidal bacteria *Bacillus thuringiensis* ssp. *kurstaki* to reduce the population of European corn borer caterpillars and other caterpillars that damage the leaves while feeding. Biopesticides with insecticidal bacteria are applied to sweet corn plants by spraying. Such agents affect only the surfaces of the plant.

The recommendations for integrated sweet corn protection also propose a biopesticide with insecticidal *Beauveria bassiana* fungus. Such bioinsecticides can be used to control, e.g., the populations of wireworms in the soil and those of leaf pests such as spider mites.

Maize can serve as a good illustration of how biological plant protection that can reduce the use of certain chemical pesticides in its cultivation is developing in Poland. However, biopesticides are not available for all crops. Their most widespread use is noted in horticultural crops grown in greenhouses.

The chapter "Risks to the Safety of Foods from Animal Production" points out that the responsibility for food safety rests with everybody, from the farmer to the consumer. Ensuring food safety is the top priority for public health; it encompasses a whole range of actions and calls for cooperation between the legislators, producers, and inspection authorities. Production of safe foods requires a comprehensive approach whereby food is protected against contamination during its production, processing, and distribution. Contaminants can render the food inedible or harmful to human health. Furthermore, the raw materials, ingredients, and ready-to-eat products which induce the growth of dangerous microorganisms must be stored at safe temperatures.

Food contaminants are classified based on the type of factors causing them, i.e., chemical, physical, microbiological, and radiological. Microbiological contaminants can pose some risks to food safety. The most common ones include Salmonella, *Listeria monocytogenes*, *Escherichia coli*, and botulism caused by *Clostridium botulinum*. According to the data of the National Institute of Public Health – National Institute of Hygiene (Pol. Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny), in Poland these microorganisms account for the bulk of infectious diseases and food poisoning cases caused by contaminated food. To ensure food safety, checks are carried out to detect harmful microorganisms in animals and foodstuffs. Also importantly, food fraud and fraudulent practices need to be prevented through an adequate formulation, adoption, and enforcement of food-related regulations.

To guarantee high food quality and safety, screening systems need to be put in place to allow the full identification of foods, from raw materials to the final products. A holistic approach to the entire food chain is necessary, starting with crops that need to be high-grade. The quality of food products is managed through adequate screening systems that ensure full identification in the fodder and food chain, and safeguard food standards and safety. This gives consumers certainty that they eat high-quality products, free from harmful substances that have sufficient

nutritional value. The Hazard Analysis and Critical Control Points (HACCP) system offers the best approach for counteracting these risks and ensuring food safety: it can help prevent food infections and poisoning in the entire food chain. The implementation of a systematic and effective system for screening risks to food safety makes it possible for us to provide high-quality and healthy foods.

When a threat related to food, feed or product/material having contact with food is identified, the Single Contact Point of the relevant member of the Rapid Alert System for Food and Feed (RASFF) network is obliged to immediately notify the European Commission's Contact Point, using a dedicated notification form via the iRASFF online platform. The system serves to communicate information on direct or indirect risks to food quality, with the European Commission being tasked with notifying the other Member States.

The food safety system operating in Poland is an example of a multi-institutional arrangement. According to the legislation on food safety, the relevant state authorities for food inspections include the offices of the State Sanitary Inspectorate (Pol. Państwowa Inspekcja Sanitarna) and Veterinary Inspectorate (Pol. Inspekcja Weterynaryjna) as well as other authorities within their remit. Food safety checks take the form of regular inspections in the facilities of food producers and distributors as well as through a scheduled sampling of foods for checking. These measures are aimed at ensuring official monitoring and oversight of food. Importantly, the checks are conducted to maintain food and feed safety standards through such measures as identifying cases of using forbidden substances in food production; exceeding permissible levels of medicinal products' residues, and other contaminants, or checking the maximum pesticide levels.

Parasites still pose a serious threat to human health, despite the developments in science, control methods, and sanitary conditions. New parasites and infections appear concurrently with civilisational and tourism changes. This is compounded by the increasing incidence of drug-resistant parasites. In Poland, zoonotic parasites such as *Toxoplasma gondii*, *Alaria alata*, *Anisakis* spp., and *Trichinella* spp., and plant parasites present in food and water, such as *Cryptosporidium* spp., *Giardia intestinalis*, and *Echinococcus* spp., are those which pose the gravest risk to food safety.

One single major threat to human life and health is trichinosis. It is a dangerous disease that sometimes ends in death and is caused by humans and many other mammal species being infected with larvae of roundworms of the *Trichinella* type. Trichinosis can be prevented by removing roundworm-infected animals from the food chain. In Poland, pork, wild boar, horse, and nutria meat is tested for trichinosis, as well as the meat of other species prone to roundworm infection. Infected carcasses are confiscated and disposed of.

The food industry is constantly evolving and improving its quality as well as safety standards through effective food control systems. Such systems enable the supervision of the production, storage, processing, and distribution of food to ensure that it is free from risks. Certain chemical

substances in the environment can contaminate food, and therefore, maintaining their content at the lowest possible level is of cardinal importance. To protect public health, maximum permissible levels have been adopted for some contaminants, such as mycotoxins, dioxins, heavy metals, and nitrates.

The chapter "Antimicrobial Substitutes in the Protection of Farm Animals" discusses the issue of antimicrobial resistance, which poses one of the key health risks to humans and animals across the globe. Drug resistance imposes a serious burden to society and the economy, and it is estimated that by 2050 resistance to antimicrobials may lead to more deaths than cancer. The increase in antimicrobial resistance is a consequence of natural selection and genetic mutations and is a natural process that occurs over time.

Furthermore, these processes are exacerbated by excessive and unjustified use of antibiotics in humans and animals; bad and inappropriate practices in healthcare and animal breeding institutions or the food chain. In effect, antimicrobials gradually become inefficacious, in a process that ultimately renders them useless or even detrimental. In Poland, the sale of antibiotics for pet animals per active substance totalled a staggering 778.7 tons in 2021. This has been a growing trend since 2011 and requires decisive actions aimed at reducing the use of antibiotics in farm animals. Bacterial infections are extremely widespread in animal breeding and farming.

Antibiotics are used as a medically justified treatment procedure while allowing for a withdrawal period for the tissues. Regulation (EU) of the European Parliament and of the Council 2011/6 of 11 December 2018 lays down new rules for the use of antimicrobials (antibiotics) in veterinary medicine, and therefore, affects the use of medicinal products in animals to prevent the growth of resistant bacteria. Prevention of infections, vaccinations, biosecurity, and improvement of the living conditions and nutrition of animals (including targeted supplementation) are all of cardinal significance in the controlling of all infectious microorganisms because they curb the need for antibiotics, and thereby limit the opportunities for the emergence of resistant microorganisms. Appropriate and prudent use of antimicrobials can play a major role in reducing antimicrobial resistance in animal husbandry.

The new restrictions on the metaphylactic use of antibiotics must be strictly observed. The application of antibiotics in farm animals is a complex issue that affects not only animals but also humans and the natural environment in a variety of ways. A strengthened system for the monitoring of antibiotic use will make it possible to evaluate risks to eliminate the danger posed by increased antimicrobial resistance. Currently, work is underway to implement an electronic animal treatment book as of 2024. In addition to putting in place measures to curb the use of antibiotics, technological progress is anticipated not only to enhance the efficacy of the already existing antibiotics but also, potentially, to help find new alternatives for certain types of antibiotic treatment.

A Summary

Currently, high hopes are being placed on the use of phytobiotics, prebiotics, and probiotics in the nutrition of farm animals as an alternative to antibiotics. The use of probiotics has an impact on the microbiota in the alimentary tract. This helps maintain the system's homeostasis, modify its immunological processes, and reduce the risk of diseases, mainly of the alimentary tract. If probiotics are administered, the population of pathogenic bacteria is crippled through a dynamic increase in the number of beneficial bacteria, and, thanks to the similar adhesion properties to those of the pathogens, they can fight harmful bacteria once the intestinal lumen is colonised. In their composition, probiotics can contain a specially selected single bacterial strain or a microbial cocktail with their metabolites. As a result, the global market for this type of feed additive for farm animals is booming.

Similarly, herbs and phytogenic additives which are categorised as feed additives having an immunomodulating effect provide a valuable supplement to compound feeds. Bioactive components in herbs can make feeds more appetising and increase their nutritional value, but can also affect other physiological functions to help maintain animal health and welfare at a satisfactory level. Due to their biological effects, flavonoids, essential oils, and other compounds of plant origin have been proposed as feed additives with anti-inflammatory, antioxidant, immunostimulating, and antibacterial effects. As a consequence, they help improve health and production indicators, enhancing the profitability of breeding.

The use of phytobiotics can also have a beneficial effect on the environment by reducing emissions, e.g., methane from ruminants. A significant factor in their production is the standardisation of the content of biologically active substances. While devising the composition of herbal mixtures, such factors as the properties of the plant's active substances, the physiological needs of animals, and consumer expectations about the quality of milk or meat must be taken into account.

The chapter "Multidrug-Resistant Bacteria – a Challenge for Human Health and the Environment" discusses one major issue associated with bacteria resistance. Bacteria are common one-cell organisms co-existing with other microorganisms (such as microbiota), as well as human, plant, and animal systems. They exist side by side in various parts of the system (skin, alimentary tract, respiratory tract) without causing any pathological symptoms. Moreover, they can even be beneficial to the organism they live in. However, if they find their way into inner tissues and organs, they can lead to diseases of various degrees of severity. The activity of factors that can damage bacteria releases mechanisms allowing them to survive despite adverse conditions. The bacterial life cycle lasts 20 to 30 minutes on average; after this time, two daughter cells are formed from one parent cell. Changes in the genetic materials can occur as early as in the process of daughter cell formation if this could help the bacteria survive despite adverse factors.

The use of antibiotics is one of the factors vital for human health that drives changes in how bacteria operate. Their discovery and introduction into medical practice was a huge success in medicine. Consequently, antibiotics found their applications in agriculture, animal breeding,

and food production. Antibiotics were originally effective against G(+), and then G(-) bacteria. By the end of the 20th century, they had found their way into numerous areas of human activity. However, as more and more groups of compounds were introduced into the array of antibiotics in use, individual bacterial strains became increasingly insensitive to them. The phenomenon of bacterial survival and proliferation despite the presence of antibiotics in the system/micro-environment is known as antibiotic resistance.

This seemed initially to be merely a medical problem, to be resolved by the introduction of antibiotics that could actively fight a growing range of infectious microbes. The strategy led to what is called "selective pressure": the use of antibiotics with an increasingly wider scope of bactericidal activity was expected to eliminate strains of susceptible bacteria while stimulating other strains to develop resistance mechanisms.

Bacteria that were able to develop an effective mechanism allowing them to survive in the antibiotic's presence and replace less resistant bacteria in a given area manifested new survival strategies. One such strategy involved the "replacement" of parts of genetic information, which had coded a compound structure allowing for the antibiotic to be neutralised, between different, even unrelated strains. In effect, the resistance mechanisms to individual groups of antibiotics soon began to spread at a fast rate. Another important phenomenon was the accumulation of genetic information determining the resistance to several antibiotics within one strain.

The mechanism in question led to the selection of what is called multidrug-resistant bacteria: they display resistance mechanisms to all or most of the known antibiotics. The World Health Organisation (WHO) indicated how many such strains have become a global hazard due to their resistance to many or nearly all antibiotics available today. The WHO's appeal for whole-hearted efforts in the search for effective drugs has not as yet brought about any breakthrough.

Monitoring the proliferation of multidrug-resistant bacteria is a major aspect of controlling hospital-acquired infections. The reported data are filed in the records of the State Sanitary Inspection, and eight selected bacteria species that are most robustly evolving their resistance mechanisms are monitored at the European level, under the supervision of the European Centre for Disease Prevention and Control (ECDC). Monitoring alone is only an attempt at assessing the extent of the problem. Isolates from clinical material, i.e., blood and/or cerebrospinal fluid are analysed, which means the examination of those microbial properties that have caused serious, life-threatening conditions. Although the medical problem is limited to those who are severely ill, bacterial multidrug resistance has also an epidemiological dimension.

The data for 2019 from 204 countries and territories, compiled by Antimicrobial Resistance Collaborators, informed the analysis of 471 million patients in whom 23 different pathogens were identified: it was estimated that there were nearly 5 million deaths in this group associated with infections caused by multidrug-resistant bacteria, and 1.27 million deaths attributable to such pathogens. The global COVID-19 pandemic experience did little to improve this situation.

A Summary

Many patients with the most acute symptoms were treated with broad-spectrum antibiotics to control or prevent secondary bacterial infections. The pandemic's summary for European countries noted that the consumption of antibiotics fell overall, but their use in hospital conditions was on the increase. This was followed by an observably increased frequency of isolates from strains showing compounded resistance mechanisms. The absence of effective treatment of bacterial infections in humans as a consequence of multilevel interactions is bound to result in the lack of effective antimicrobial protection for food and farmed animals.

Mechanisms of antibiotic resistance are also developed by bacteria found in human physiological microbiota. Hospital stays or out-of-hospital contacts with those who have suffered such colonisation do not cause the infection but can play a significant role in spreading antibiotic-resistant strains outside hospitals. Another mechanism that fosters the emergence of antimicrobial resistance is associated with the lack of consistency in the use of antibiotics in outpatient medicine: when the antibiotic is not administered as prescribed; in the case of viral infections; for too short a period; in inappropriate doses or without observing the time regime; all these factors tend to drive antimicrobial resistance.

Antibiotic resistance of strains colonising the alimentary tract is strongly induced by the presence of antibiotics and their metabolites in food products. They can be found in foods if they were earlier present in animals – sources of food, or were introduced into the final product as a protective measure.

The current indicators showing the incidence of multidrug resistance strains are consequences of all those aspects being compounded. They illustrate a situation where many bacteria can survive despite the antibiotic's presence, and those very bacteria can cause the most severe diseases and deaths. Nonetheless, our efforts have failed so far to produce effective treatment methods or strategies reducing the use of antibiotics now available on the market. The far-reaching consequences of such a situation are at present the objects of a debate and give rise to pessimistic hypotheses. The growing resistance to antibiotics is becoming a clear danger to public health globally.

The chapter "Foodborne Zoonotic Diseases" looks at human diseases caused by pathogens transmitted from animals to humans. Their role in public health has been highlighted by such institutions as the European Food Safety Authority (EFSA) and the European Centre for Disease Prevention and Control (ECDC). The report jointly published by the two institutions, *The European Union One Health 2019 Zoonoses Report*, emphasises that plant, human and environmental health as well as welfare are interlinked with human health and well-being.

Zoonotic pathogens can be transmitted via several ways, notably the gastrointestinal route. Pathogens can find their way into food if they were earlier present in meat, plants, or fluids. Another route of transmission is their introduction into foods through the preparation of meals and food products without observing the rules of hygiene (what is called secondary

microbiological food contamination). The list of infectious agents transmitted via those two routes largely overlaps.

The EFSA/ECDC report, presenting the number of cases recorded in 2020 in 27 countries, found that the first most reported zoonosis in humans was campylobacteriosis (120,946), followed by salmonellosis (52,702), yersiniosis (5,668), toxin-producing *Escherichia coli* strains – VTEC (4,446), listeriosis (876), tularemia (641), Q fever (523), brucellosis (128), and tuberculosis (88). In the same year in Poland, campylobacteriosis was diagnosed in 418 cases, and in 2021 – in 631 cases. There were 5,302 and 8,014 cases of salmonellosis caused by foodborne infections, respectively.

The number of yersiniosis cases diagnosed in 2021 also increased. Although the illness is defined and has a name, its set of syndromes can be induced by different bacteria from the same family. However, the common feature of its clinical picture is the varying severity of functional gastrointestinal disorders, which predominantly include diarrhoea, spasmodic abdominal pain, and fever. These symptoms can be accompanied by vomiting and diarrhoeal stools with traces of blood. In all cases, a more severe form of the illness was reported to affect babies and young children as well as elderly and immunocompromised patients.

Each of the above diseases may present with few symptoms; such cases may not be successfully diagnosed, and therefore, will not be put on record by the State Sanitary Inspectorate. For this reason, the data quoted above ought to be regarded as underestimates rather than an accurate reflection of the actual number of cases.

The definition of zoonosis implies that animals are the sources of the infection, and the range of animals which can induce contagion caused by specific pathogens is quite broad, with sheep, pigs, dogs, cattle, poultry, or even free-living animals. Zoonotic pathogens can be introduced into the human body in a variety of ways: through the consumption of infected/contaminated food, undercooked meat, raw milk, or water from natural reservoirs (contaminated with animal faeces).

Given the above considerations, it is vital to maintain adequate sanitary conditions at every stage of food production and processing. Observing these requirements is particularly important in the prevention of listeriosis since *Listeria* is a bacteria resistant to a broad range of changes taking place in its environment. If such a microorganism finds its way into a ready-to-eat food product, due to its resistance to gastric juice it will end up in the intestines, causing a disease process. Listeriosis is the disease with the highest mortality rate, reaching up to 30%. Although each of these diseases can pose significant risks to pregnant women, listeriosis is considered particularly dangerous as it can penetrate the placenta and cause congenital infections.

Another aspect of paramount epidemiological significance is the incidence of asymptomatic infections in both humans and animals. Pathogenic microorganisms present in the

gastrointestinal tract, and in effect, on the skin, have the potential to proliferate in the environment. This phenomenon, which is hard to evaluate or monitor, is yet another argument in favour of hygiene standards being observed in broadly understood food production and processing.

Among the zoonoses caused by parasites, toxoplasmosis occupies a special place. The invasion of the protozoan *Toxoplasma gondii* can occur both as a result of eating meat with its cysts or pseudocysts as well as through introducing invasive oocysts excreted with cat faeces and present in the environment. In individuals with a well-functioning immune system, the invasion can present non-characteristic symptoms, is not always diagnosed, and will remain in a latent form later in life. It can be reactivated if the immune system is significantly weakened. *Toxoplasma gondii* is yet another pathogen that can cause congenital malformation syndrome if the infection takes place during pregnancy. In 2019, congenital toxoplasmosis was diagnosed in 176 children.

Yet another parasite, the nematode *Trichinella*, can cause symptoms in the alimentary tract, internal organs, and skeletal muscles. Trichinae can have a wide range of hosts, of which pigs and wild boars play a major epidemiological role: the larvae that grow in their muscles, once eaten by humans, will continue their development cycle in the human body. It takes several months for the larvae in the muscles to encyst, and they remain viable for a long time. The latter feature is of paramount importance in the inspection and supervision of food of animal origin. The reported cases of human infections are relatively rare, but because trichinosis can also have atypical symptoms and remain undiagnosed, our vigilance should never waver.

The *Echinococcus* tapeworms also have a broad range of hosts. In their mature form, they reside in the alimentary tract of canids, especially foxes. In their faeces, eggs are excreted which are highly resistant to external conditions, and can end up in the alimentary tract of humans and animals (cattle, pigs, sheep, hares, deer, wild boars). In the new host's body, the eggs evolve into slowly growing larval forms which may invade nearly all organs, usually the liver, and slowly damage them. If a fragment of tissue with larvae is eaten by a dog or fox, a mature tapeworm form will evolve in their bodies and, if eaten by a representative of another species, larval development will continue. Dog tapeworms (*Echinococcus granulosus*) will form cyst-shaped larvae, while the larvae of fox tapeworms (*Echinococcus multilocularis*) will form infiltrates that are similar to neoplastic ones. As in the case of bacterial zoonoses, the prevention of foodborne parasitic diseases requires a consistent application of all the rules of proper handling at all stages of the production process and meal preparation.

The monograph's appendix offers four more papers that complete the overall picture. The first paper presents the conclusions and recommendations from the paper session and the study visit accompanying the seminar *Biosafety and Biosecurity in Food Production – From Ethics to Economics*.

The paper entitled "The Role of the European Food Safety Authority (EFSA) in the Implementation of the EU's *Farm to Fork* Strategy" discusses in detail the mission and tasks of the EFSA, the

role of the Focal Points, and the assumptions underpinning the EC's F2F strategy, exemplified by researchers' opinions published by the EFSA, e.g., as part of the F2F strategy.

The paper "Biotechnology as a Response to the European Green Deal?" explains the role of biotechnology in agricultural development. It discusses such issues as biological atmospheric nitrogen fixation, revitalisation of the soil environment, phosphorus solubilisation, and biostimulation of cultivated crops.

The fourth paper, entitled "Pesticide Residues and Food Quality and Safety", discusses the role of PPPs in food production, supervision of pesticide use, PPPs residues, and monitoring of their effects, e.g., in agricultural produce.

The Foundation for the Development of Polish Agriculture (FDPA) is a nongovernmental organisation with traditions dating back 35 years. Our mission is to support the sustainable development of rural areas, in particular, enterprise and the creation of jobs outside agriculture, and to ensure equal opportunities for women, the unemployed, and young people. To this end, as one of the most active and largest loan funds in Poland, we engage in loan activities and services fostering the development of small rural enterprises.

We take part in local development programmes, community initiatives, information, and education schemes. We also publish respected studies and specialist reports such as the biannual report on the state of Poland's rural areas (latest edition: *Polska wieś 2022. Raport o stanie wsi*) and numerous publications to promote the sustainable development of rural areas that deal with issues such as adaptation to climate change and effective resource management.

Since 2009, we have regularly organised a competition entitled Rural Poland – the Legacy and the Future for scientific and popular-science works on agriculture and rural areas and those that promote their history and cultural heritage. We initiated debates held as part of the cyclical event entitled Rural Poland in the 21st Century. We have also organised many international, domestic and local projects addressed to rural residents, farmers, local governments, agricultural advisory centres, public institutions as well as small and medium-sized enterprises.

Foundation for the Development of Polish Agriculture
www.fdpa.org.pl
www.facebook.com/Fundacja.FDPA

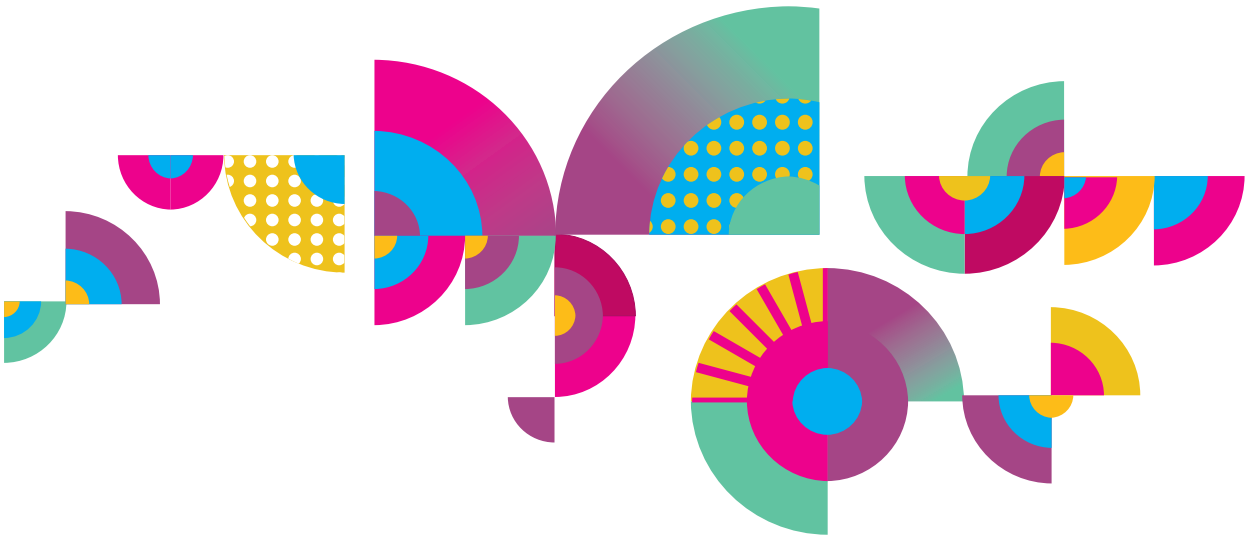
"This monograph makes a valuable contribution to the public debate on the assumptions underpinning the European Green Deal in general, and in particular, its *Farm to Fork* strategy, which aims – among others – to make food systems fair, healthy and environmentally friendly. It offers a multifaceted consideration of the major risks to human and animal health and the environment posed by animal and plant production. A unique aspect of the publication lies in the inclusion in its deliberations of bioethical dilemmas of current agricultural and food production processes".

Prof. Bożena Kordan

"The monograph offers a topical study of biosafety and biosecurity issues in primary food production. In light of the measures undertaken in farming as part of the European Green Deal, the issues it tackles will certainly be of interest to a wider public, and a source of valuable information to agricultural producers".

Prof. Dorota Witkowska

The monograph is the third of five volumes compiled as part of a project titled *European Green Deal – Opportunities and Challenges for Polish Agriculture*, administered by the Foundation for the Development of Polish Agriculture (FDPA). The papers included here were originally presented at seminars focused on formulating guidelines for the implementation of the EU's new scheme, European Green Deal (EGD), through farming practices aiming to enhance opportunities for the development of Polish agriculture.



ISBN 978-83-67450-61-4