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Article

Bioterrorism in the agri-food sector – underestimated risk and challenges for biosecurity based on selected countries

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Abstract

The aim of this article is to describe bioterrorism threats to the agri-food sector, with particular emphasis on agroterrorism, the risk of which remains underestimated in the security policies of many countries, especially in terms of assessing its likelihood and potential consequences. Achieving this objective involves solving the research problem formulated in the form of a question: What are the bioterrorism threats to the agri-food sector? An attempt to solve this problem was made on the basis of a review of literature and legal acts, using theoretical research methods such as analysis, synthesis, abstraction and inference. Despite the recognition of the food production sector as part of critical infrastructure, there is a lack of scenarios and procedures for responding to intentional contamination. The article describes the definitions of bioterrorism, agroterrorism and agrocrime, as well as the classification of biological threats. It compares biosafety systems in selected countries, emphasises the importance of local entities in early warning systems, and points to the broader context of safety – food protection, animal and human health, which, according to the One Health concept, form an interconnected whole requiring coordinated management. The conclusions emphasise the need to develop interoperable surveillance systems, high-level biosafety

laboratories, education and digitalisation, as well as to include the agri-food sector in national and EU security strategies, thereby strengthening Europe's biological resilience to hybrid threats.

Keywords

bioterrorism, agroterrorism, food security, One Health, biological threats

Introduction

Agri-food sector constitutes an attractive target for hybridtype operations due to its large geographical extent, the complexity of associated logistical processes and a relatively low level of physical security. Biological attacks in this sector are often asymmetric – the aggressor employs cheap, unconventional and hard-to-detect methods, while the defender must incur high costs to protect against them and respond to their effects, yet these attacks remain highly effective. Their consequences may include mass culling of livestock, disruption of supply chains, rising food prices, moral panic and a loss of trust in public institutions[1]. In the face of globalisation and climate change, the risk of transboundary spread of pathogens is increasing, giving such phenomena an international dimension.

In response to these problems, the One Health concept was developed, which links human, animal and environmental health with elements of internal security and promotes an integrated, interdisciplinary approach to effectively prevent such threats. It is being developed by the World Health Organization (WHO), the World Organisation for Animal Health (WOAH) and the Food and Agriculture Organization of the United Nations (FAO).

An analysis of the security strategies of selected EU Member States shows that the risk of agroterrorism threats remains underestimated. Neither Poland nor Germany, France and Italy has developed separate response plans for attacks targeting agri-food sector. A similar gap can be observed in the United Kingdom, where, despite advanced plant biosecurity

[1] J.P. Dudley, M.H. Woodford, *Bioweapons, bioterrorism and biodiversity: potential impacts of biological weapons attacks on agricultural and biological diversity*, "Revue Scientifique et Technique" 2002, no. 21(1), pp. 125–137. http://dx.doi.org/10.20506/rst.21.1.1328.

strategies and analyses of the resilience of the food supply chain, there is no separate, comprehensive plan for responding to agroterrorism attacks.

The aim of the article was to analyse threats to the agri-food sector in selected countries. The research issues were focused around the following questions:

1. In what way does bioterrorism, and especially agroterrorism, pose a threat to agri-food sector in selected countries?
2. Why does the risk of agroterrorism remain underestimated in security policies, and how is the perception of this threat shaped by society and authorities at the local and central levels?
3. What role do farmers, veterinarians and local authorities play in local early warning and operational readiness systems?
4. What systemic actions – institutional, technological and educational – can enhance the biological resilience of the agricultural sector at both national and the EU levels?

Definitions: bioterrorism, agrocrime and agroterrorism

Bioterrorism poses a growing challenge to the internal security, public health and economic stability of states. The WHO and the WOAH define it as a deliberate use of biological agents – pathogenic microorganisms or biological toxins – against people, animals or plants in order to cause social, political or economic harm[2]. The WOAH distinguishes also the term agrocrime, referring to unlawful activities involving animals or products of animal origin that threaten public health, animal welfare or food safety. These include, among others: food product adulteration, i.e. altering their composition or quality to reduce production costs, smuggling, food fraud, i.e. misleading consumers for profit (e.g. false claims about origin or composition), as well as the deliberate release of pathogens. It is worth to emphasise that the range of agrocrime is broader than implied by the definition of the WOAH, which refers exclusively to animals and products of animal origin. These also include crimes involving plants,

[2] *Laboratory Biosafety Manual. Fourth Edition*, WHO, 21 XII 2020, https://www.who.int/publications/i/item/9789240011311 [accessed: 10 VI 2025]; *Terrestrial Animal Health Code*, https://rr-africa.woah.org/app/uploads/2023/09/en_csatvol1-2023.pdf [accessed: 14 VI 2025].

agricultural inputs, food trade, product adulteration and illegal seed trading[3].

Agroterrorism constitutes a specific form of agrocrime motivated by political and ideological factors. Its aim is destabilisation of society through the outbreak of animal or plant diseases. The difference between these categories stems from motivation. In agrocrime, the primary goal is economic, while in agroterrorism, it is political or social[4].

In its strategies, the WOAH has gradually expanded its approach to such threats. The document of 2015 focused on reducing biological risk through biosecurity and international cooperation, while the 2024 strategy formally introduced the concepts of agrocrime and agroterrorism and emphasised prevention, threat detection, and the coordination of veterinary services, law enforcement agencies and security institutions[5].

Although the food production sector has been recognised as an element of critical infrastructure in the Directive (EU) 2022/2557 of the European Parliament and of the Council (commonly referred to by the abbreviation CER Directive, from English: Critical Entities Resilience)[6] and in the plans of the North Atlantic Treaty Organization (NATO)[7], there is still a lack of response plans and consistent implementation of biosecurity principles. The Union perceives bioterrorism as the intentional use of pathogens and toxins to intimidate the population and destabilise state structures, the WOAH defines it as the deliberate introduction of infectious diseases into livestock or wildlife populations, and NATO classifies it within the framework of CBRN (chemical, biological, radiological and nuclear) threats[8]. These definitional and priority discrepancies further complicate

[3] E. Barclay, *A Review of the Literature on Agricultural Crime. Report to the Criminology Research Council,* https://criminology.fsu.edu/sites/g/files/upcbnu3076/files/2021-03/A-Review-of-the-Literature-on-Agricultural-Crime.pdf, pp. 5–18, 46–76 [accessed: 2 XII 2025].

[4] J.P. Dudley, M.H. Woodford, *Bioweapons, bioterrorism and biodiversity*…

[5] *Biological threat reduction strategy. Strengthening global biological security*, https://www.woah.org/app/uploads/2021/03/biothreat-strategy-veng-revised-1st-edition.pdf, pp. 3–12 [accessed: 14 VI 2025]; *Building resilience against agro-crime and agro-terrorism*, https://www.woah.org/app/uploads/2023/02/building-resilience-against-agro-crime-and-agro-terrorism.pdf, pp. 1–10 [accessed: 14 VI 2025].

[6] *Directive (EU) 2022/2557 of the European Parliament and of the Council of 14 December 2022 on the resilience of critical entities and repealing Council Directive 2008/114/EC*.

[7] *NATO's Chemical, Biological, Radiological and Nuclear (CBRN) Defence Policy*, NATO, 14 VII 2022, https://www.nato.int/cps/en/natohq/official_texts_197768.htm [accessed: 2 XII 2025].

[8] Ibid.

the development of coherent strategies for preventing and responding to bioterrorism incidents in the agri-food sector[9].

Agri-food sector as a potential target of bioterrorism attack

Agri-food sector constitutes one of the most important elements of the critical infrastructure, and at the same time one of the most vulnerable to bioterrorism activities. The complexity of the food production system – including production, transport, processing, storage and distribution – means that there are many points at which interference can occur, including contamination of raw materials, feed or water. Even incidents of a local nature may lead to a cascading effect resulting in serious health, economic and social consequences[10]. A critical element of the system remains logistics based on the *just-in-time* model. It is cost-effective but limits the ability to respond to sudden disruptions.

The COVID-19 pandemic and changes related to Brexit revealed the vulnerability of food supply chains[11]. The European Commission emphasises the need to increase the resilience of this sector through diversification of supply sources, the creation of strategic reserves, and the strengthening of early warning mechanisms[12]. The European Food Safety Authority (EFSA) studies also indicate that food security should be analysed in the context of health, logistical and political factors, considered together and requiring a collective approach to risk management[13].

[9] *Deliverable D6.5 – Guiding Document on cross-sectoral preparedness and response to biological and/or chemical terror attack. Collaboration between health, civil protection and security*, https://www.jaterror.eu/wp-content/uploads/2024/11/6.5-Guiding-Document.pdf, p. 17, 19–26, 33, 41 [accessed: 8 XII 2025].

[10] *The European Union One Health 2023 Zoonoses Report*, EFSA, 10 XII 2024, https://doi.org/10.2903/j.efsa.2024.9106.

[11] P. Garnett, B. Doherty, T. Heron, *Vulnerability of the United Kingdom's food supply chains exposed by COVID-19*, "Nature Food" 2020, no. 1, pp. 315–318. https://doi.org/10.1038/s43016-020-0097-7.

[12] *Proofing the EU food supply chains against crises: new set of recommendations published*, European Commission, 23 VII 2024, https://agriculture.ec.europa.eu/media/news/proofing-eu-food-supply-chain-against-crises-new-set-recommendations-published-2024-07-23_en [accessed: 14 VI 2025].

[13] *Food Risk Assess Europe*, EFSA, https://www.efsa.europa.eu/en/publications/food-risk-assess-europe [accessed: 13 XII 2025].

In the case of biological threats, crisis logistics is crucial for the effective isolation of infection outbreaks, efficient distribution of vaccines and maintenance of alternative supply channels[14]. Transportation disruptions – resulting from sanitary blocks or border closures – can significantly complicate intervention efforts and amplify negative economic impacts. The psychological dimension of the attacks is equally important. Bioterrorism targeting the agri-food sector can trigger social panic, leading to consumer panic, product boycotts and disinformation – often with consequences more severe than the incident involving biological agents[15].

An example of a bioterrorism attack in the food sector is the mass poisoning of food by members of the Rajneesha cult. The incident occurred in Oregon (the US) in 1984 – bacteria *Salmonella typhimurium* were released in the restaurants, causing over 750 illnesses[16]. Although such attacks are rare, they show the scale of the consequences that intentional food contamination can have.

A bioterrorism attack may also involve infecting livestock with highly contagious pathogens that cause diseases such as anthrax, foot and mouth disease (FMD) or African swine fever (ASF)[17]. This can lead to an epizootic, meaning a mass occurrence of infectious diseases among

[14] W.S. Carus, *Bioterrorism and Biocrimes: the Illicit Use of Biological Arms in the 20th Century*, August 1998, https://wmdcenter.ndu.edu/Publications/Publication-View/Article/626562/bioterrorism-and-biocrimes-the-illicit-use-of-biological-arms-in-the-20th-centu/ [accessed: 14 VI 2025].

[15] *First report on world's animal health reveals changing spread of disease impacting food security, trade and ecosystems*, WOAH, 23 V 2025, https://www.woah.org/en/first-report-on-worlds-animal-health-reveals-changing-spread-of-disease-impacting-food-security-trade-and-ecosystems/ [accessed: 15 VI 2025]; *What past disruptions can teach us about reviving supply chains after COVID-19*, World Economic Forum, 27 III 2020, https://www.weforum.org/stories/2020/03/covid-19-coronavirus-lessons-past-supply-chain-disruptions/ [accessed: 27 V 2025]; D. Ivanov, A. Dolgui, *Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak*, "International Journal of Production Research" 2020, vol. 58, no. 10, pp. 2904–2915. https://doi.org/10.1080/00207543.2020.1750727.

[16] T.J. Török et al., *A Large Community Outbreak of Salmonellosis Caused by Intentional Contamination of Restaurant Salad Bars*, "The Journal of the American Medical Association" 1997, vol. 278, no. 5, pp. 389–393. https://doi.org/10.1001/JAMA.1997.03550050051033.

[17] M. Wheelis, R. Casagrande, L.V. Madden, *Biological Attack on Agriculture: Low-Tech, High-Impact Bioterrorism: Because bioterrorist attack requires relatively little specialized expertise and technology, it is a serious threat to US agriculture and can have very large economic repercussions*, "BioScience" 2002, vol. 52, no. 7, pp. 569–576. https://doi.org/10.1641/0006-3568(2002)052[0569:BAOALT]2.0.CO;2.

animals in a specific area and time, and can result in negative economic consequences. An example is FMD epizootic that occurred in the UK in 2001. During its course, over 2000 disease outbreaks were recorded and more than 6 million farm animals were culled. The economic losses were estimated at around GBP 8 billion, including 3 billion in the agriculture sector and 5 billion in the tourism and recreation sector. This incident was not an act of bioterrorism, but it revealed the economic, social and psychological consequences of the spread of infectious animal diseases and contributed to the reform of the UK's agricultural crisis management system[18].

The deliberate introduction of pathogens into the agri-food sector could cause effects comparable to a natural epizootic. In June 2025, the US authorities accused Chinese scientists – Yunqing Jian and Zunyong Liu – of attempting to smuggle into the US a dangerous plant pathogen – the fungus *Fusarium graminearum*[19]. This species attacks wheat, barley, corn and rice, causing fusarium head blight. It can cause significant crop losses and contaminate the grain with dangerous mycotoxins – primarily deoxynivalenol, which can induce, among other things, vomiting, liver damage, immunosuppression and reproductive disorders in humans and animals. *Fusarium graminearum* is considered an organism that could be used as a weapon in bioterrorism operations due to the ease of obtaining it, its environmental resilience and its ability to spread rapidly within agricultural systems[20]. Local contamination of seeds or planting material alone is enough to introduce it into the food production chain on a regional or international scale[21]. The described incident involving Chinese scientists

[18] D. Thompson et al., *Economic costs of the foot and mouth disease outbreak in the United Kingdom in 2001*, "Revue Scientifique et Technique" 2002, no. 21(3), pp. 675–687. https://doi.org/10.20506/RST.21.3.1353.

[19] *Chinese Nationals Charged with Conspiracy and Smuggling a Dangerous Biological Pathogen into the U.S. for their Work at a University of Michigan Laboratory*, United States Attorney's Office, 3 VI 2025, https://www.justice.gov/usao-edmi/pr/chinese-nationals-charged-conspiracy-and-smuggling-dangerous-biological-pathogen-us [accessed: 20 VI 2025].

[20] E. White, *US says it broke up effort to bring toxic fungus to Michigan lab from China*, AP News, 3 VI 2025, https://apnews.com/article/chinese-scientists-charged-toxic-fungus-5ccaba9aff8e5941ebcea71b9b6690b2 [accessed: 20 VI 2025].

[21] A. Ramakrishnan, *What is Fusarium graminearum, the fungus US authorities say was smuggled in from China?*, AP News, 4 VI 2025, https://apnews.com/article/fusarium-graminearum-fungus-head-blight-china-8ce925ae96d9c437b987e58c336cd45f [accessed: 20 VI 2025].

confirms that concerns about biological protection measures and the use of plant pathogens as tools of agroterrorism are justified.

Typologies of biological agents that could be used as weapons against the agri-food sector

To capture the full spectrum of threats arising from the deliberate use of biological agents in the agri-food sector, it is useful to distinguish the main categories of means that may be used in agroterrorism activities.

Animal pathogens

Among the most dangerous epizootics is ASF. The virus that causes it is characterised by nearly 100% mortality in pigs and wild boars, as well as high resistance to adverse environmental conditions. Since 2014, Europe and Asia have suffered significant losses due to it[22]. Equally serious is highly pathogenic avian influenza (HPAI), particularly caused by subtypes of the influenza A virus – H5N1 and H5N8, which leads to mass culling of poultry, export bans and losses amounting to billions of dollars[23]. The effects of an extreme zoonosis were observed in 2001 during the aforementioned FMD epidemic.

Plant pathogens

A similar destabilising potential is exhibited by plant pathogens that could be used to disrupt the production of grains, fruit and vegetables. An attempt to smuggle *Fusarium graminearum* fungal spores into the US was treated as an incident with potential bioterrorism implications. Other high-risk pathogens include: bacteria *Xylella fastidiosa* infecting olive and citrus trees in Southern Europe, the Ug99 strain of wheat stem rust (caused by the fungus *Puccinia graminis forma tritici*)[24] and bacteria *Ralstonia*

[22] *African swine fever*, EFSA, 19 V 2025, https://www.efsa.europa.eu/en/topics/topic/african-swine-fever [accessed: 16 VI 2025].

[23] G. Pavade, *WOAH Updates – Global HPAI situation and current standards and recommendations regarding AI surveillance and vaccination*, https://www.izsvenezie.com/documents/reference-laboratories/avian-influenza/workshops/2022/pavade.pdf [accessed: 16 VI 2025].

[24] *USDA Coordinated Approach to Address New Virulences in Wheat and Barley Stem Rust – Pgt-Ug99*, United States Department of Agriculture, 20 IX 2017, https://www.ars.usda.gov/ug99/ [accessed: 16 VI 2025]; R.P. Singh et al., *The emergence of Ug99 races of the stem rust fungus*

solanacearum attacking potatoes and tomatoes[25]. These pathogens have been included in the national biosecurity strategies of many countries, including the US[26], Australia and Germany[27].

Vector-borne pathogens

Another category consists of vector-borne pathogens transmitted by organisms such as:

- mosquitoes (*Aedes sp., Culex sp.*), which can transmit dengue, Zika, yellow fever and West Nile viruses,
- ticks (*Ixodes spp.*), which can transmit bacteria *Borrelia burgdorferi* (causing Lyme disease), tick-borne encephalitis virus and bacteria *Anaplasma phagocytophilum* (causing anaplasmosis in animals and humans),
- midges (*Culicoides spp.*), which can transmit viruses causing diseases: Bluetongue Disease and African horse sickness[28].

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is a threat to world wheat production, "Annual Review of Phytopathology" 2011, no. 49, pp. 465–481. https://doi.org/10.1146/annurev-phyto-072910-095423.

[25] *What is EPPO Global Database?*, https://gd.eppo.int/ [accessed: 10 VI 2025].

[26] *National biodefense strategy and implementation plan for countering biological threats, enhancing pandemic preparedness, and achieving global health security*, https://bidenwhitehouse.archives.gov/wp-content/uploads/2022/10/National-Biodefense-Strategy-and-Implementation-Plan-Final.pdf [accessed: 10 VI 2025]; *National Priority Plant Pests (2024)*, Australian Government. Department of Agriculture, Fisheries and Forestry, https://www.agriculture.gov.au/biosecurity-trade/pests-diseases-weeds/plant/national-priority-plant-pests/ [accessed: 10 VI 2025].

[27] *Robust. Resilient. Sustainable. Integrated Security for Germany. National Security Strategy*, https://www.nationalesicherheitsstrategie.de/National-Security-Strategy-EN.pdf [accessed: 11 VI 2025].

[28] *Transmission of Zika Virus*, Centers for Disease Control and Prevention, 30 I 2025, https://www.cdc.gov/zika/php/transmission/index.html [accessed: 10 IX 2025]; *Dengue*, World Health Organization, 21 VIII 2025, https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue [accessed: 10 IX 2025]; *Aedes aegypti – Factsheet for experts*, European Centre for Disease Prevention and Control, 2 I 2023, https://www.ecdc.europa.eu/en/disease-vectors/facts/mosquito-factsheets/aedes-aegypti [accessed: 10 IX 2025]; *West Nile: Causes and How It Spreads*, Centers for Disease Control and Prevention, 19 VIII 2025, https://www.cdc.gov/west-nile-virus/causes/index.html [accessed: 10 IX 2025]; *Tick-Borne Encephalitis*, Centers for Disease Control and Prevention, 23 IV 2025, https://www.cdc.gov/yellow-book/hcp/travel-associated-infections-diseases/tick-borne-encephalitis.html [accessed: 10 IX 2025]; *Factsheet about tick-borne encephalitis (TBE)*, European Centre for Disease Prevention and Control, 22 I 2024, https://www.ecdc.europa.eu/en/tick-borne-encephalitis/facts/factsheet [accessed: 10 IX 2025]; *How Lyme Disease Spreads*, Centers for Disease Control and Prevention, 24 IX 2024, https://www.cdc.gov/lyme/causes/index.html

Pathogens such as bacteria: *Francisella tularensis* (causes tularemia), *Coxiella burnetii* (causes Q fever) and of the genus *Brucella spp.* (cause brucellosis) are recognised by the US Centers for Disease Control and Prevention (CDC) as potential bioterrorism agents due to the ease of their aerosolisation and difficulties in identification, which pose a challenge for surveillance and response systems[29].

Elements of the natural environment as reservoirs of pathogens

Elements of the natural environment are important, though often underestimated, reservoirs of potential biological threats that may affect the agriculture and food production sectors. Unlike classical carriers, the water-soil environment can act as a long-term reservoir for pathogens, enabling their survival and covert spread[30]. In bioterrorism scenarios, water may be deliberately contaminated, for example by introducing pathogens into water reservoirs or irrigation systems. The difficulty in detecting an infection and its delayed symptoms make such actions a particular challenge for early-warning systems, especially in the case of plant epiphytotics such as potato late blight (caused by the oomycete *Phytophthora infestans*), cereal powdery mildew (caused by the fungus *Blumeria graminis*), maize fusariosis (caused by fungi of the genus *Fusarium spp.*), or bacterial rots of fruit trees (caused by bacteria *Erwinia*

[accessed: 10 IX 2025]; *About Anaplasmosis*, Centers for Disease Control and Prevention, 4 IX 2024, https://www.cdc.gov/anaplasmosis/about/index.html [accessed: 10 IX 2025]; *Bluetongue*, World Organisation for Animal Health, https://www.woah.org/en/disease/bluetongue/ [accessed: 10 IX 2025]; *Bluetongue*, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, https://www.aphis.usda.gov/livestock-poultry-disease/cattle/bluetongue [accessed: 10 IX 2025].

[29] *CDC Bioterrorism Agents*, https://biosecurity.fas.org/resource/documents/CDC_Bioterrorism_Agents.pdf [accessed: 10 VI 2025]; *Emergency preparedness, resilience and response concept of operations*, UK Health Security Agency, 15 I 2025, https://www.gov.uk/government/publications/emergency-preparedness-resilience-and-response-concept-of-operations/emergency-preparedness-resilience-and-response-concept-of-operations [accessed: 10 VI 2025]; D.T. Dennis et al., *Tularemia as a biological weapon: medical and public health management*, "The Journal of the American Medical Association" 2001, vol. 285, no. 21, pp. 2763–2773. https://doi.org/10.1001/JAMA.285.21.2763; *Bluetongue*, World Organisation for Animal Health...

[30] *Guidelines for drinking-water quality: fourth edition incorporating the first addendum*, Geneva 2017.

amylovora) – diseases that spread massively within crop plant populations and are difficult to detect in the early warning phase[31]. Water used for irrigation, watering livestock or washing crops, can become a source of contamination with zoonotic and foodborne pathogens such as bacteria: *Escherichia coli*, *Listeria monocytogenes*, of the genus *Salmonella spp.* or noroviruses[32]. The greatest risk concerns products consumed raw, such as leafy vegetables and berries. Sources of contamination may include animal feces, farm runoff and wastewater from treatment plants, but they may also result from bioterrorism activities.

Soil, dust and aerosols can carry bacterial spores such as *Bacillus anthracis*, which remain viable for decades and can cause secondary outbreaks of infection[33]. The negative consequences – both epidemiological and economic – are exacerbated by the spores' ability to survive in the environment[34] for long periods and their potential to trigger sudden, difficult-to-control epidemics[35]. This burdens healthcare systems, destabilises agricultural production and generates significant financial losses[36].

'One Health' concept – integrated framework for protection against bioterrorism threats

In the past decade, there has been a marked shift in the perception of biological threats in Europe. Even before 2020, risk factors associated with biological sabotage were largely underestimated. The public

[31] *Terrorist Threats to Food: Guidance for Establishing and Strengthening Prevention and Response Systems*, Geneva 2002.

[32] *Foodborne Disease Outbreaks: Guidelines for Investigation and Control*, Geneva 2008.

[33] J.P. Wood et al., *Environmental Persistence of Bacillus anthracis and Bacillus subtilis Spores*, "PLoS ONE" 2015. https://doi.org/10.1371/journal.pone.0138083.

[34] R. Sinclair et al., *Persistence of Category A Select Agents in the Environment*, "Applied and Environmental Microbiology" 2008, no. 74(3), pp. 555–563. https://doi.org/10.1128/AEM.02167-07.

[35] S. Shadomy et al., *Anthrax Outbreaks: a warning for improved prevention, control and heightened awareness*, "Food and Agriculture Organization of the United Nations" 2016, vol. 37, https://openknowledge.fao.org/server/api/core/bitstreams/59269d58-654e-4790-ac60-a9ea7edd3a99/content [accessed: 16 IV 2025].

[36] S.A. Sarker et al., *An integrated model for anthrax-free zone development*, "Journal of Infection and Public Health" 2023, vol. 16, pp. 141–152. https://doi.org/10.1016/j.jiph.2023.10.024.

debate was dominated by issues related to climate changes, chemical or cybersecurity changes. The COVID-19 pandemic revealed that the consequences of biological threats can be just as far-reaching as economic or climate crises, potentially leading to disruptions in supply chains, destabilisation of healthcare systems and significant social losses[37]. In Europe, attention has also been drawn to the risks associated with zoonotic disease outbreaks, such as SARS-CoV-2 on mink farms in Denmark and the Netherlands, as well as the spread of ASF, which has necessitated the implementation of stricter biosecurity measures in agriculture[38]. An event in 2018, classified as a CBRN threat, was also significant. In Cologne, man suspected of producing biological weapons based on highly toxic ricin was apprehended[39]. The problem lies in the sporadic inclusion of issues related to agroterrorism or crimes involving biological agents in documents concerning the security of EU countries, including Poland, even though international organisations (WHO, WOAH, Interpol) recommend preparing response plans for attacks targeting supply systems for food[40].

The response for the shortcomings was the One Health concept, that links human, animal and environmental health with internal security elements and promotes close cooperation between human, animal and environmental health sectors[41]. Complementing this approach are

[37] *Lessons from the COVID-19 pandemic*, https://www.ecdc.europa.eu/sites/default/files/documents/COVID-19-lessons-learned-may-2023.pdf [accessed: 16 IV 2025].

[38] C. Adlhoch et al., *Avian influenza overview February – May 2021*, "EFSA Journal" 2021, vol. 19, no. 12. https://doi.org/10.2903/j.efsa.2021.6951; J.V. Baños et al., *Epidemiological analyses of African swine fever in the European Union*, "EFSA Journal" 2022, vol. 20, no. 5. https://doi.org/10.2903/j.efsa.2022.7290.

[39] *Update: Cologne couple in court over 'biological bomb plot'*, The Local Germany, 7 VI 2019, https://www.thelocal.de/20190607/tunisian-german-couple-in-court-over-ricin-attack-plot [accessed: 16 IV 2025].

[40] *Animal agrocrime and agroterrorism*, Interpol, https://www.interpol.int/Crimes/Terrorism/Bioterrorism/Animal-agrocrime-and-agroterrorism [accessed: 10 VI 2025]; A. Elbers, R. Knutsson, *Agroterrorism Targeting Livestock: A Review with a Focus on Early Detection Systems*, "Biosecurity and Bioterrorism: Biodefense Strategy, Practise, and Science" 2013. https://doi.org/10.1089/bsp.2012.0068; C. Gyles, *Agroterrorism*, https://pmc.ncbi.nlm.nih.gov/articles/PMC2839819/pdf/cvj_04_347.pdf [accessed: 10 VI 2025].

[41] *One health joint plan of action 2022–2026: working together for the health of humans, animals, plants and the environment*, World Health Organization, https://www.who.int/publications/i/item/9789240059139 [accessed: 10 VI 2025].

regulations: the International Plant Protection Convention (IPPC)[42], the Terrestrial Animal Health Code[43] and the Biological Weapons Convention (BWC)[44]. Furthermore, the EU operates early warning systems, such as the Rapid Alert System for Food and Feed (RASFF), the Early Warning and Response System (EWRS) and the Animal Disease Notification System (ADNS), which support biological incident response[45]. At the global level, the Quadripartite One Health Joint Plan of Action 2022–2026 was adopted, outlining, among other things, a common framework for oversight, preparedness and response. Within the EU, the EU4Health programme (2021–2027) formally incorporated the One Health into health action frameworks and funding mechanisms[46]. Legally, a milestone was the *Regulation (EU) 2022/2371 of the European Parliament and of the Council of 23 November 2022 on serious cross-border threats to health and repealing Decision No 1082/2013/EU*, which strengthened threat monitoring, early warning and the coordination of reference laboratory activities at the EU level.

In Poland, implementation of the One Health faces barriers such as the lack of a comprehensive legislative and institutional strategy, fragmented databases, limited interoperability and differences in competencies between sectors. These challenges translate into difficulties in integrating passive and active surveillance (the Sentinel Network, i.e. network of veterinarians monitoring field conditions and reporting information to central institutions), which involves farmers, veterinarians, reference laboratories and biological security services. It is recommended to establish central coordination structures that would enable effective

[42] *International Plant Protection Convention (1997)*, Rome 2024, https://openknowledge.fao.org/server/api/core/bitstreams/30cc2e83-a6fd-4e2c-a5ee-312093d5a307/content [accessed: 10 VI 2025].

[43] *Terrestrial Animal Health Code*...

[44] *Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction*.

[45] *Commission publishes 2023 Annual Report on food safety alerts and agri-food fraud investigations*, European Commission, 16 IX 2024, https://ec.europa.eu/newsroom/sante/items/847722/en [accessed: 14 VI 2025].

[46] *One health joint plan of action (2022–2026): working together for the health of humans, animals, plants and the environment*, Rome 2022; *Regulation (EU) 2021/522 of the European Parliament and of the Council of 24 March 2021 establishing a Programme for the Union's action in the field of health ('EU4Health Programme') for the period 2021-2027, and repealing Regulation (EU) No 282/2014*.

implementation of the integrated approach and the development of modern early warning systems and biomonitoring.

Biosafety systems in Poland and selected countries

Biosafety systems allow for the identification of the key factors influencing the effectiveness of biological threat prevention in the agri-food sector, as well as the detection of and response to such threats.

Poland

In Poland, several key institutions are responsible for carrying out tasks related to biosafety, including the protection of human, animal and plant health, food safety and biological threat prevention, including bioterrorism. These are:

- the State Sanitary Inspection, operating under the Ministry of Health based on the *Act of 14 March 1985 on the State Sanitary Inspection*. Its tasks include, among others, supervision of public health, environmental hygiene, public facilities, water and the safety of non-animal-derived food;
- the Veterinary Inspection operating on the basis of the *Act of 29 January 2004 on the Veterinary Inspection*. It is responsible for animal health protection, oversight of products of animal origin, combating infectious diseases and border control related to the movement of animals and products;
- the State Plant Health and Seed Inspection Service whose tasks arise from the *Act of 18 December 2003 on plant protection* and the *Act of 13 February 2020 on Plant Health and Seed Inspection Service*. It is responsible for the monitoring of plant health, the prevention of the spread of pests and the quality control of seed material;
- the Commercial Quality Inspection of Agricultural and Food Products operating on the basis of the *Act of 21 December 2000 on commercial quality of agri-food products*. It oversees commercial quality, labelling and the compliance of agri-food products with legal requirements;
- the European Food Safety Authority, whose tasks in Poland are carried out by the national contact point in accordance with *Regulation (EC) No 178/2002 of the European Parliament and*

of the Council of 28 January 2002 laying down the general principles and requirements of food law.

The cooperation of these institutions forms the foundation of the national biosafety system, which encompasses the monitoring and detection of biological threats and the response to them, including deliberate contamination of the food chain and epidemics of infectious diseases in humans, animals and plants. This also applies to phenomena of a transboundary nature. Their activities are integrated within national and European information-exchange and early-warning systems, such as the RASFF, the ADNS or the Trade Control and Expert System (TRACES), which enables a rapid and coordinated response to crisis situations[47].

Biosafety supervision in Poland is carried out through cooperation between the Main Sanitary Inspectorate, the Main Veterinary Inspectorate, the State Plant Health and Seed Inspection Service, the Commercial Quality Inspection of Agricultural and Food Products and other institutions of public administration whose competences include the protection of human, animal and environment health. Despite existing legal regulations, such as the *Act of 11 March 2004 on protection of animal health and combating contagious animal diseases* together with executive acts and the *Act of 25 August 2006 on food and nutrition safety*, Poland still lacks – as already mentioned – an integrated strategy covering the coordination of activities in the areas of human and animal health and food safety in accordance with the One Health concept[48].

Laboratories specialising in pathogen diagnostics and threat monitoring play an important role in the biological protection system. In Poland, there are several biosafety level-3 (BSL-3) laboratories[49] operating, among others, in the National Veterinary Institute – the National Research Institute in Puławy. It serves as the national reference laboratory for animal

[47] *Rapid Alert System for Food and Feed (RASFF)*, European Commission, https://food.ec.europa.eu/food-safety/rasff_en [accessed: 10 X 2025].

[48] K.M. Mełgieś, *The Evolution of One Health concept – a European perspective*, "Review of European and Comparative Law" 2024, vol. 57, no. 2. https://doi.org/10.31743/recl.17467; P. Kaczmarek et al., *The One Health Concept: A Holistic Approach to Protect Human and Environmental Health*, "Medycyna Pracy. Workers' Health and Safety" 2024, no. 5, pp. 433–444. https://medpr.imp.lodz.pl/pdf-192557-116180.

[49] K. Chomiczewski, M. Bartoszcze, A. Michalski, *Budowanie nowoczesnego systemu obrony przed bronią biologiczną Sił Zbrojnych RP zgodnego z wymaganiami NATO* (Eng. Building a modern biological weapons defence system for the Polish Armed Forces in line with NATO requirements), "Lekarz Wojskowy" 2019, no. 1, pp. 56–64.

diseases of epizootic and zoonotic importance[50]. Most BSL-3 laboratories, including in the National Institute of Public Health – the National Institute of Hygiene – the National Research Institute and in academic institutions (the University of Gdańsk and the Medical University of Gdańsk) focus on diagnosing human diseases and therefore only contribute indirectly to food safety. At the same time, there is a network of military laboratories, including the Military Institute of Hygiene and Epidemiology, which has BSL-3 laboratories at its disposal[51]. The Military Institute of Hygiene and Epidemiology has the Centre for Diagnosis and Control of Biological Hazards located in Puławy[52], among other places. Military laboratories diagnose biological agents with epidemic and bioterrorism potential as well as support crisis response and international cooperation[53]. BSL-3 laboratories are an essential element of the national biological protection system – they enable early detection and analysis of threats as well as strengthen the state's ability to respond to bioterrorism attacks.

Despite the existence of the above structures and mechanisms, there is still a gap in the ability to quickly detect and respond to intentional contamination of food or feed, both in plant and animal production. There is also a lack of BSL-4 laboratories that enable safe research on the most dangerous pathogens. This limits the state's preparedness for the most serious biological threats, including potential bioterrorism attacks[54].

Germany

Germany has an advanced biosafety infrastructure, coordinated by the Federal Ministry of Agriculture, Food and Regional Identity (Bundesministerium für Landwirtschaft, Ernährung und Heimat). Entities

[50] *Krajowe Laboratoria Referencyjne* (Eng. National reference laboratories), Państwowy Instytut Weterynaryjny – Państwowy Instytut Badawczy, https://www.piwet.pulawy.pl/krajowe-laboratoria-referencyjne/ [accessed: 29 VII 2025].

[51] *Wojskowy Instytut Higieny i Epidemiologii im. Generała Karola Kaczkowskiego*, https://wihe.pl/wihe/o-nas [accessed: 29 VII 2025].

[52] *Ośrodek Diagnostyki i Zwalczania Zagrożeń Biologicznych* (Eng. Centre for Diagnosis and Control of Biological Hazards), Wojskowy Instytut Higieny i Epidemiologii, https://wihe.pl/zaklady/odizzb/organizacja [accessed: 29 VII 2025].

[53] *Zadania badawczo-rozwojowe* (Eng. Research and development tasks), Wojskowy Instytut Higieny i Epidemiologii, https://wihe.pl/wihe/zadania [accessed: 29 VII 2025].

[54] K. Goniewicz et al., *Bioterrorism Preparedness and Response in Poland: Prevention, Surveillance and Mitigation Planning*, "Disaster Medicine and Public Health Preparedness" 2021, no. 15(6), pp. 697–702.

such as the Friedrich Loeffler Institute (Friedrich Loeffler Institut, FLI) and the Robert Koch Institute (Robert Koch Institute, RKI) play an important role in the surveillance, investigation and diagnosis of infectious diseases in animals and humans, respectively. The Robert Koch Institute runs the RefBio project at a global level. In this way, it supports an international network of laboratories within the framework of the United Nations Secretary-General's Mechanism to Investigate Suspected Use of Biological Weapons (UNSGM) and organise exercises, workshops and ensures knowledge transfer[55]. The Germans also have laboratories with the highest, biosafety level-4 rating – BSL-4 (including in Berlin)[56]. The crisis management system is based on a federal organisation model, with strong coordination of activities between the federal states. The state's operational readiness is significantly enhanced by regular simulation exercises codenamed LÜKEX. During these exercises, various crisis management scenarios are tested, such as pandemic variants or energy crises and early warning systems[57]. By comparison, in Poland such exercises are conducted less frequently and with a limited agro-bio component. This reinforces the call for a separate agricultural module to be included in them.

France

France integrates sanitary, veterinary and environmental activities through the French Agency for Food, Environmental and Occupational Health & Safety (Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail, ANSES). There is a reference biosafety

[55] *RefBio – German Contribution to Strengthen the Reference Laboratories Bio in the UNSGM*, Robert Koch Institut, 10 V 2019, https://www.rki.de/EN/Institute/International-activities/Biosecurity-Programme/RefBio.html [accessed: 16 VI 2025].

[56] *The Biosafety Level-4 Laboratoty at RKI*, Robet Koch Institut, 31 I 2024, https://www.rki.de/EN/Topics/Research-and-data/Specialised-laboratories/BSL-4-laboratory/bsl-4-laboratory-at-the-robert-koch-institute-node.html [accessed: 16 VI 2025]; *FLI tests mobile One Health laboratory for diagnosing highly pathogenic pathogens*, Friedrich Loeffler Institut, 13 VI 2025, https://www.fli.de/en/press/press-releases/press-singleview/fli-tests-mobile-one-health-laboratory-for-diagnosing-highly-pathogenic-pathogens/ [accessed: 20 VI 2025].

[57] *Germany*, European Commission, https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/national-disaster-management-system/germany_en?utm [accessed: 15 XII 2025]; *Historie der LÜKEX Krisenmanagementübungen*, Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, https://www.bbk.bund.de/DE/Themen/Krisenmanagement/LUEKEX/Historie/historie_node.html [accessed: 15 XII 2025].

level-4 (BSL-4) laboratory – Laboratoire P4 Inserm Jean Mérieux in Lyon[58]. Despite the existence of a strong institutional base, the reports point to difficulties in cooperation between civil and military services as well as the need for better integration of cross-sectoral data[59].

Italy

In Italy, the biosecurity system is coordinated by the Ministry of Health and regional veterinary services. The network of Zooprophylactic Institutes (Istituti Zooprofilattici Sperimentali) acts as reference laboratories for animal diseases. In Rome, a BSL-4 laboratory operates within the National Institute for Infectious Diseases (Istituto Nazionale per le Malattie Infettive)[60]. Challenges in responding to biological threats include the lack of a central platform for data integration and differences between regions in their ability to respond to these threats[61].

Great Britain

The 2001 FMD epidemic marked a turning point in the UK biosafety policy. After the crisis, a comprehensive biological risk management system was introduced, covering prevention and rapid response. The leading institution is the Animal and Plant Health Agency, which is responsible for surveillance and diagnostics (both routine and in crisis situations), as well as for coordinating actions in the events of threats[62]. The agency cooperates with the Pirbright Institute, which conducts research on viruses that cause diseases in animals[63] and has SAPO-4 laboratory (Specified Animal

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58 *ANSES Laboratories*, ANSES, 15 II 2013, https://www.anses.fr/en/content/anses-laboratories [accessed: 20 VI 2025].

59 T. Lefrançois et al., *One Health approach at the heart of the French Committee for monitoring and anticipating health risks*, "Natura Communication" 2023, no. 14, p. 9. https://doi.org/10.1038/s41467-023-43089-2.

60 *INMI Lazzaro Spallanzani IRCCS, Istituto Nazionale Malettie Infettive*, https://www.inmi.it/ [accessed: 20 VI 2025].

61 A. Perella, M. Bisogno, *The strength and resilience of Italy's health data system*, "The Lancet Regional Health" 2025, vol. 51. https://doi.org/10.1016/j.lanepe.2025.101255.

62 *Animal and Plant Health Agency framework document*, Department for Environment, Food & Rural Affairs, 7 III 2024, https://www.gov.uk/government/publications/animal-and-plant-health-agency-framework-document/animal-and-plant-health-agency-framework-document [accessed: 20 VI 2025].

63 *Our science*, The Pirbright Institute, https://www.pirbright.ac.uk/our-science [accessed: 20 VI 2025].

Pathogens Order class 4), serving as a reference for the FAO, the WOAH and the EU[64]. The institute conducts research, provides training and develops vaccines.

The government Department for Environment, Food and Rural Affairs (DEFRA) and the UK Health Security Agency (UKHSA) have developed integrated plans for managing zoonotic and phytopathological risks within the framework of the One Health approach[65]. They form the basis of the national preparedness plans in case of outbreaks of non-endemic diseases[66]. After 2001, cooperation between administration, veterinary services, reference laboratories and international partners was developed. Simulation exercises and reports, prepared by the Anderson Report[67] and the National Audit Office[68], among others, have contributed to strengthening analytical and early warning systems. The 2023 biosecurity strategy sets out a framework for protection against natural, accidental and deliberate threats, including bioterrorism threats[69]. It is based on four pillars: understanding, prevention, detection and response, supported by state authorities, scientific and technological development and international cooperation. This strategy aims to be fully operational by 2030 and to establish the National Biosecurity Centre, with a budget of approx. GBP 1 billion. It is expected to reach full operational capacity between 2033 and 2034[70].

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[64] *Reference Laboratories*, The Pirbright Institute, https://www.pirbright.ac.uk/facilities-and-resources/reference-laboratories [accessed: 17 VI 2025].

[65] *UKHSA Strategic Plan 2023 to 2026*, https://assets.publishing.service.gov.uk/media/650d530e52e73c00139426c1/UKHSA_3_year_strategy.pdf [accessed: 18 VI 2025].

[66] *Contingency plan for exotic notifiable diseases of animals in England*, https://assets.publishing.service.gov.uk/media/691c80cd84a267da57d706da/Defra-contingency-plan-exotic-notifiable-diseases-animals-England.pdf [accessed: 18 VI 2025].

[67] I. Anderson, *Foot and Mouth Disease 2001: Lessons to be Learned Inquiry Report*, London 2002.

[68] *The 2001 Outbreak of Foot and Mouth Disease*, London 2023.

[69] *UK Biological Security Strategy*, Cabinet Office, 12 VI 2023, https://www.gov.uk/government/publications/uk-biological-security-strategy/uk-biological-security-strategy-html [accessed: 10 VI 2025].

[70] *UK pledges 1 billion pounds to build new biosecurity centre*, Reuters, 24 VI 2025, https://www.reuters.com/business/healthcare-pharmaceuticals/uk-pledges-1-billion-pounds-build-new-biosecurity-centre-2025-06-23 [accessed: 8 VIII 2025]; *Dowden: world-class crisis capabilities deployed to defeat biological threats of tomorrow*, 12 VI 2023, https://www.gov.uk/government/news/dowden-world-class-crisis-capabilities-deployed-to-defeat-biological-threats-of-tomorrow [accessed: 8 VIII 2025].

Research institutions and information tools in the EU

The EU states use shared surveillance networks, such as the RASFF, the TRACES and the EWRS, which support information exchange and coordination of activities[71]. Germany and France have efficient institutional structures in place, including the FLI and the ANSES[72]. In Poland and Italy, there is no unified coordination system linking the veterinary, phytosanitary and public health sectors. Poland has the National Crisis Management Plan, and its framework nature does not ensure operational cross-sector integration. A significant limitation remains the lack of BSL-4 laboratories, which are available in Germany, France, the US and Great Britain[73]. Great Britain has seen effective cooperation between the agriculture, public health, defence and environmental sectors, supported by strategic legal regulations[74].

Despite the existence of community tools, the implementation of the One Health approach within the EU is uneven[75]. The analysis presented in the publication *Countering Agricultural Bioterrorism* emphasises that bioterrorism threats continue to be underestimated in the security policies of the EU states[76]. There is a lack of comprehensive response scenarios, especially regarding responses to acts of agroterrorism, despite the recognition of the food sector as an element of critical infrastructure.

The role of key stakeholders in the early warning system: farmers, veterinarians and local authorities

Effective strengthening of the biosecurity system in the agri-food sector is not possible without the active involvement of farmers, veterinarians and local authorities. These groups are the first line of detection alarming

[71] *One Health: a joint framework for action published by five EU agencies*, European Centre for Disease Prevention and Control, 7 V 2024, https://www.ecdc.europa.eu/en/news-events/one-health-joint-framework-action-published-five-eu-agencies [accessed: 10 VI 2025].

[72] *FLI tests mobile One Health laboratory…*; *ANSES Laboratories…*

[73] *Laboratory Biosafety Manual…*

[74] *UK Biological Security Strategy…*

[75] *One Health: a joint framework for action published…*

[76] *Countering Agricultural Bioterrorism*, Washington 2022. https://doi.org/10.17226/10505.

symptoms and play a decisive role in responding early to biological incidents.

Farmers are the first link in the early notification and warning system. Their daily contact with animals and plants allows them to quickly detect symptoms of ASF, FMD or plant infection caused by bacteria *Xylella fastidiosa*[77]. It is important that farmers know the symptoms and reporting procedures, and that they have confidence in state institutions. This helps to reduce response times. Unfortunately, low awareness, limited access to up-to-date information and fear of administrative consequences often cause delays in implementing procedures[78]. There is also a lack of formal mechanisms to encourage rapid reporting, such as financial support or legal protection for reporting persons.

Veterinarians are a connecting element between local farming communities and the system for monitoring and diagnosing zoonotic threats. Their tasks include not only recognising epizootics, but also educating farmers, providing early warnings and transmitting data to the veterinary services and reference laboratories[79]. Sentinel surveillance operates in many EU states[80].

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[77] C. Guinat et al., *English Pig Farmers' Knowledge and Behaviour towards African Swine Fever Suspicion and Reporting*, "PLoS ONE" 2016, no. 9. https://doi.org/10.1371/JOURNAL.PONE.0161431; S. Costard et al., *Epidemiology of African swine fever virus*, "Virus Research" 2013, vol. 173, no. 1, pp. 191–197. https://doi.org/10.1016/J.VIRUSRES.2012.10.030.

[78] M.C. Gates, L. Earl, G. Enticott, *Factors influencing the performance of voluntary farmer disease reporting in passive surveillance systems: A scoping review*, "Preventive Veterinary Medicine" 2021, vol. 196, pp. 1–2, 5–7. https://doi.org/10.1016/j.prevetmed.2021.105487; G. Enticott, L. Earl, M.C. Gates, *A systematic review of social research data collection methods used to investigate voluntary animal disease reporting behaviour*, "Transboundary and Emerging Diseases" 2021, no. 5, pp. 2573–2587. https://doi.org/10.1111/tbed.14407; J.C. Mariner et al., *Rift Valley fever action framework*, Italy 2022. https://doi.org/10.4060/cb8653en.

[79] O.A. Hassan, K. de Balogh, A.S. Winkler, *One Health early warning and response system for zoonotic diseases outbreaks: Emphasis on the involvement of grassroots actors*, "Veterinary Medicine and Science" 2023, no. 4, vol. 9, pp. 1881–1889. https://doi.org/10.1002/vms3.1135.

[80] C. Saegerman et al., *Clinical Sentinel Surveillance of Equine West Nile Fever, Spain*, "Transboundary and Emerging Diseases" 2014, vol. 63, no. 2, pp. 161–164. https://doi.org/10.1111/tbed.12243; C. Plaza-Rodriguez et al., *Wildlife as Sentinels of Antimicrobial Resistance in Germany?*, "Frontiers in Veterinary Science" 2021, vol. 7, pp. 1–11. https://doi.org/10.3389/fvets.2020.627821; R. Özçelik et al., *Evaluating 5.5 Years of Equinella: A Veterinary-Based Voluntary Infectious Disease Surveillance System of Equines in Switzerland*, "Frontiers in Veterinary Science" 2020, vol. 7, pp. 1–4. https://doi.org/10.3389/fvets.2020.00327.

In Poland, similar solutions are still developing and are mainly implemented within the National Veterinary Inspection, which coordinates the monitoring of infectious animal diseases on the basis of national and EU surveillance programmes. Digitalisation and integration of systems such as the IRZplus (Identification and Registration of Animals), the TRACES and national databases on animal diseases play an important role. Data exchange and reporting platforms to the Chief Veterinary Officer and European institutions, including the EFSA and the RASFF system, are also becoming increasingly important. However, there are still limitations in terms of full system interoperability and the inclusion of private practitioners in the rapid alert network, which limits the effectiveness of sentinel surveillance compared to solutions used in e.g. Germany or France[81].

Local authorities – provincial, district and municipal – play the most important role in the practical implementation if biosafety principles and biological threat response systems, cooperating with central administration and critical infrastructure operators. Despite the availability of analytical tools such as risk matrices, vulnerability models and predictive scenarios, their effectiveness in practice remains limited due to low awareness and a lack of consistent implementation among the responsible entities.

In Poland, the National Crisis Management Plan and the National System of Contamination Detection and Alarm formally provide for mechanisms for assessing and monitoring threats, including biological ones, but their effectiveness depends not only on the availability of tools, but also on their proper interpretation and use by the administration and critical infrastructure operators.

The role of local institutions should be strengthened through regular training, trust building and ensuring access to digital tools (e.g. e-learning platforms, applications that support monitoring and reporting). Permanent educational programmes, run in cooperation with agricultural chambers, veterinary services and research institutes, should

[81] *Zwalczanie i monitoring wybranych chorób zakaźnych zwierząt* (Eng. Combating and monitoring of selected infectious animal diseases), Główny Inspektorat Weterynarii, https://www.wetgiw.gov.pl/nadzor-weterynaryjny/programy-zwalczaniamonitorowania-chorob-zakaznych-zwierzat [accessed: 1 IX 2025]; *European Commission*, https://ec.europa.eu [accessed: 1 IX 2025]; *Aplikacja IRZplus* (Eng. The IRZplus app), Główny Inspektorat Weterynarii, https://www.wetgiw.gov.pl/systemy-informatyczne/cbd-irzgo [accessed: 1 IX 2025]; *EFSA*, https://www.efsa.europa.eu [accessed: 1 IX 2025]; *Rapid Alert System for Food and Feed (RASFF)*...

cover not only the recognition of symptoms of infectious diseases, but also response procedures and inter-institutional cooperation. The educational programmes implemented in Germany and the Netherlands, in which local food producers participate in simulations of crisis situations are a good example[82].

In the context of Poland, the measures described are recommendations rather than binding programmes at national or provincial level. Their aim would be to adapt good practices from the EU level, e.g. initiatives of the EFSA and the European Centre for Disease Prevention and Control (ECDC), in the field of food safety and public health, including educational mechanisms such as the Better Training for Safer Food[83]. The recommended solutions should be implemented within national and regional structures by provincial and district crisis management teams, veterinary services as well as agricultural chambers and closely integrated with local response plans[84]. Such integrated measures should be supplemented by regular simulation exercises[85], which allow for practical verification of the effectiveness of the procedures implemented, and cross-sectoral coordination.

A well-developed logistics infrastructure is crucial for responding to biological threats, however in many countries it remains inadequate. France has advanced cold chains and vaccine reserves, which shortens

[82] *Chemical and biological deliberate events,* World Health Organization, https://openwho.org/emergencymgmt/501116/Chemical+and+biological+deliberate+events [accessed: 1 IX 2025].

[83] *Empowering food safety through enhanced training,* European Commission, 9 IX 2024, https://ec.europa.eu/newsroom/btsf/items/846699/en [accessed: 1 IX 2025].

[84] Ibid.; *Breaking language barriers: translation of training materials on food safety regulations now available,* European Commission, 25 III 2025, https://hadea.ec.europa.eu/news/breaking-language-barriers-translation-training-materials-food-safety-regulations-now-available-2025-03-25_en [accessed: 1 IX 2025]; *HaDEA launches third call for tenders under BTSF,* European Commission, 5 VIII 2022, https://hadea.ec.europa.eu/news/hadea-launches-third-call-tenders-under-btsf-2022-08-05_en?utm [accessed: 1 IX 2025]; *Digitalising the EU agricultural sector,* European Commission, https://digital-strategy.ec.europa.eu/en/policies/digitalisation-agriculture [accessed: 1 IX 2025]; *Transparency solutions for transforming the food system*, EU CAP Network, https://eu-cap-network.ec.europa.eu/projects/transparency-solutions-transforming-food-system_en [accessed: 1 IX 2025].

[85] *Field simulation trainings to support emergency preparedness,* World Organisation for Animal Health, 13 IV 2023, https://www.woah.org/en/article/field-simulation-trainings-to-support-emergency-preparedness/ [accessed: 10 VI 2025].

response times[86]. Poland has modern logistics centres, such as NewCold's warehouses, and systemic reserves of vaccines and diagnostic products maintained by the Government Strategic Reserves Agency[87], however their scope and availability – especially at regional level – are limited. Despite the resilience of the cold chain sector during crises, further investment in digitalisation, interoperability and strategic reserves is necessary[88].

Summary and conclusions

For many years, the security policies of the countries in question reflected a belief that the likelihood of serious biological incidents occurring was low. This assumption led to underestimating risks, limiting investments in preventive measures and a lack of response procedures – particularly in agri-food sector, which resulted in the lowering of the operational readiness. The lack of systemic training, low spending on prevention and neglect of bioterrorism scenarios in local crisis management plans widened the gap between the strategy's provisions and the institutions' actual capacity to act effectively[89].

Over the last decade, there has been a significant change in the perception of biological threats. The COVID-19 pandemic has demonstrated that biological crises can generate effects comparable to economic or climate crises, leading to serious disruptions in supply chains, burdens on health systems and social losses[90]. More attention has also been paid to threats related to zoonotic diseases, such as ASF, SARS-CoV-2, and

[86] Y. He, M. Liu, *Research on sustainable development of agricultural product cold chain logistics under public safety emergencies*, "Frontiers in Sustainable Food Systems" 2023, vol. 7. https://doi.org/10.3389/fsufs.2023.1174221; A. Spitalleri et al., *BioTrak: A Blockchain-based Platform for Food Chain Logistics Traceability*, International Conference on Intelligent Computing, Communication, Networking and Services (ICCNS), Valencia 2023, pp. 105–110. https://doi.org/10.1109/ICCNS58795.2023.10193341.

[87] *Rezerwy medyczne* (Eng. Medical reserves), Rządowa Agencja Rezerw Strategicznych, https://www.gov.pl/web/rars/rezerwy-medyczne [accessed: 30 IX 2025].

[88] *Poland Cold Chain Logistics et 2025–2034 – Size, Share, Trends, Analysis & Forecast 2025–2034*, MarkWide Research, https://markwideresearch.com/poland-cold-chain-logistics-market/ [accessed: 18 VI 2025].

[89] *Deliberate events*, World Health Organization, 2 IV 2024, https://www.who.int/news-room/fact-sheets/detail/deliberate-events [accessed: 18 VI 2025].

[90] *Lessons from the COVID-19 pandemic*...

incidents classified as CBRN threats[91]. Despite the existence of NewCold's WHO, NewCold's WOAH and Interpol recommendations concerning the need to prepare response plans for intentional contamination of food systems, issues related to agroterrorism continue to be treated marginally in national strategic documents of the EU states, including in Poland[92]. The One Health approach aims to fill this gap by integrating human, animal and environmental health into a single coherent biological threats management system. However, the implementation of this concept is not uniform and faces significant barriers. This hinders the integration of passive and active surveillance and the inclusion of farmers, veterinarians, laboratories and local authorities into the early warning network. The examples from Germany and the Netherlands show that effective One Health implementation requires not only legal tools, but also systemic training, trust building as well as regular simulation exercises, which include local food producers[93]. At the same time, it is necessary to strengthen logistics infrastructure, including cold chains, vaccine reserves, diagnostic materials, and to continue investing in interoperability, digitalisation and the management of strategic reserves.

Given the growing complexity of threats, it is reasonable to consider establishing a specialised EU agrobiosecurity institution, similar to the ECDC[94], but focused on threats for the agri-food sector. Such an institution could conduct strategic research, risk analyses, develop early warning systems and coordinate the activities of food safety, veterinary and sanitary services, reference laboratories and scientific centres. Close cooperation with the Directorate-General for Health & Food Safety[95], the EFSA and the RASFF system would be important in this context. It is also crucial to conduct qualitative and quantitative research among

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stakeholders – farmers, veterinarians, laboratories, sanitary services and administration – to identify real operational barriers to the implementation of biosafety procedures and assess readiness for inter-institutional cooperation. At the same time, systemic analyses should be conducted, including mapping of decision-making and communication processes, to detect gaps in coordination and interoperability. The research material gathered would form the basis for the creation of an organisationally and socially effective institution that responds to the real needs of frontline actors and strengthens the ability of the EU and its Member States to respond effectively to biological threats.

In summary, strengthening resilience to bioterrorism attacks requires:

- full integration of activities in the One Health model,
- development of interoperable surveillance systems and laboratories,
- systematic organising trainings and exercises,
- involvement of local actors in sentinel surveillance,
- building efficient logistics in crisis situations,
- taking into account the agri-food sector in national and European security plans.

Implementing these proposals would increase the effectiveness of responses to biological threats – both natural and intentional – and strengthen countries' resilience to hybrid threats.

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