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MANAGEMENT AND MONITORING OF PLANT PROTECTION PRODUCTS IN AGRICULTURE WITH REGARD TO HUMAN AND ANIMAL HEALTH

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Abstract. The management and monitoring of plant protection products in agriculture involve the proper application of these products in appropriate doses and timings, monitoring their effectiveness, and minimizing their negative impact on the environment. Human health and environmental safety depend on the decisions made by farmers who use plant protection products in their production. In Poland, chemical agents are the most used tools for crop protection in the field. The European Union has very strict regulations and legal frameworks aimed at safeguarding human and animal health as well as the environment. There are specific regulations concerning the registration, application, sale, and monitoring of plant protection products under the EU's policy. Relevant regulations and legal acts govern the permissible levels of plant protection product residues in food. Proper management of these products at the legislative level and during their application will contribute to reducing their adverse effects on human and animal health.

Key words: plant protection products, management, monitoring, risk, environment, laws, human health, animal health.

INTRODUCTION

Management and monitoring of plant protection products in agriculture are essential elements of caring for the health of animals, humans, and the natural environment. It involves the proper application of plant protection products in appropriate doses and timings, monitoring their effectiveness, and minimizing their negative impact on the environment.

Plant protection products are widely used worldwide to increase crop productivity. They should only be used when absolutely necessary. Reports of residues of plant protection products in food and water have raised public awareness about potential hazards to humans. Human health and environmental safety depend on the decisions made by farmers who use plant protection products in their production. In Poland, chemical agents are the most commonly used tools for field crop protection. Currently, there are 2,558 different registered plant protection products in Poland (MRiRW 2020). In recent years, the European Union has been striving to reduce the quantity of used plant protection products and promote the use of alternative methods in plant production. One of these actions is the implementation of good plant protection practices, where treatments with plant protection products used for specific plants are selected,

dosed, and planned to ensure acceptable efficacy with the minimum necessary amount, taking into consideration local conditions and the potential of using mechanical and biological control methods.

The key elements of managing and monitoring plant protection products in agriculture are plant protection planning, proper selection of plant protection products, application of plant protection products according to the label, monitoring the effectiveness of actions, and minimizing environmental impact. The European Union has strict regulations and legal frameworks aimed at protecting human and animal health as well as the environment. There are specific regulations concerning the registration, application, sale, and monitoring of plant protection products under the European Union's policy.

Proper management of plant protection products can contribute to reducing the risks to human health, animals, and the environment. The aim of this work is to present the ways of managing and monitoring plant protection products in agriculture with respect to human and animal health in Poland (Gajdzik 2006).

CONCEPT OF PLANT PROTECTION PRODUCTS AND THEIR CLASSIFICATION BASED ON THEIR PERSISTENCE IN THE ENVIRONMENT

The legal concept of plant protection products is regulated in Article 2(1) of Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21st October 2009 concerning the placing of plant protection products on the market. Plant protection products are substances with strong toxic effects intentionally introduced into the environment under human control. The United States Environmental Protection Agency (EPA) defines pesticides as substances or mixtures of substances that have the ability to repel, inhibit the growth of pests, or destroy them (Baæmaga et al. 2007). Plant protection products include insecticides, fungicides and herbicides.

Plant protection products can be classified based on their application, formulation, mode of penetration into the pest's organism, toxicity, persistence in the environment, physicochemical properties, and chemical structure.

Plant protection products can be classified based on their persistence in the environment as follows (Wierzbicki 2004; Wrzosek et al. 2009):

- non-persistent – degrading within 12 weeks,
- moderately persistent – degrading within 1–18 months,
- persistent – degrading within 2–3 years in 75–100%.

ENVIRONMENTAL RISK ARISING FROM THE USE OF PLANT PROTECTION PRODUCTS

The use of plant protection products entails certain risks to the natural environment. The toxicity of plant protection products results from the presence of biologically active ingredients, emulsifiers, adjuvants, and fillers that may adversely affect the environmental biocenosis (Nowak et al. 2015). Plant protection products sprayed on fields can penetrate the soil and nearby water bodies. They can have negative impacts on fauna and flora, leading to a loss of biodiversity and insect mortality (Geiger et al. 2010). When assessing the risk of using plant protection products for the environment, parameters such as the application of optimal doses and proper disposal of expired products and packaging from used preparations should be taken into account (Nowak et al. 2015).

The widespread use of plant protection products in agriculture, as well as rainfall and atmospheric dust containing pesticide residues, are the main sources of soil pollution. Plant protection products can reach groundwater during the period of water runoff from snowmelt. They

can also reach groundwater through leaching from the soil due to agrochemical treatments (Pérez-Lucas et al. 2018). Chemical industries producing plant protection products are also sources of water pollution (Aktar et al. 2009).

Some chemical substances present in plant protection products can affect the soil. Prolonged and excessively intensive use of these substances can lead to a loss of soil fertility, disruption of microbial balance, and other soil components. The persistence of pesticides in the soil is one of the aspects that should be considered (Kookana et al. 2007).

HEALTH RISKS ARISING FROM THE USE OF PLANT PROTECTION PRODUCTS

The use of plant protection products carries certain health risks, both for those directly involved in their application and for food consumers. Possible hazards associated with the use of plant protection products are to some extent accepted due to the benefits they provide (Van Bol et al. 2008).

Chemical substances contained in plant protection products come into contact with both rural and urban residents, and the routes of their penetration into the body are highly diverse. Residues of these products are found in plant-origin food, meat, fish, eggs, honey, milk, and drinking water (Bennett et al. 1999). Their sources can be plant protection products used, contaminated green or industrial feed used for feeding animals, and polluted water (Biziuk et al. 2001). Pesticides enter the animal body through the digestive system, skin, or respiratory tract (Kowalska and Kowalski 2019). The improper use of plant protection products or failure to observe the pre-harvest withholding periods is the cause of their residues in food. If the level of these residues exceeds the allowable threshold, there is a health risk for consumers.

The most exposed to plant protection products are farmers and agricultural workers who carry out plant spraying treatments. For individuals performing agrochemical work (spraying), an acceptable operator exposure level (AOEL) is determined. To assess the risk, the values of AD (the amount of plant protection products absorbed by the human body) and the value of the risk quotient IR, allowing the determination of risk acceptability, are also determined (Nowak et al. 2015).

In the human body, plant protection products cause mutagenic, teratogenic, and carcinogenic changes, disrupt hormonal and enzymatic regulation. They are often the cause of respiratory, digestive, circulatory, and skin diseases. They can also impair reproduction and fetal development. People allergic to chemical substances present in plant protection products may experience allergic reactions such as skin rashes, itching, swelling, or breathing difficulties. Some pesticides exhibit neurotoxic effects and may affect the nervous system, causing dizziness, headaches, motor coordination problems, seizures, or mood disorders (Bondesson et al. 1989; Alavanja et al. 2013; Giulivo et al. 2016; Debnath and Khan 2017; Grotowska et al. 2018; Kowalska and Kowalski 2019).

Farmers can minimize health risks associated with the use of plant protection products by complying with legal regulations and recommendations for their use. The use of appropriate protective clothing during preparation for spraying and during spraying significantly reduces this risk.

MANAGEMENT AT THE LEVEL OF LEGAL REGULATIONS RELATED TO THE USE AND STORAGE OF PLANT PROTECTION PRODUCTS

The Regulation of the Minister of Agriculture and Rural Development dated May 22, 2013, on the methods of using and storing plant protection products, defines detailed procedures for the use and storage of plant protection products, including:

1. Method of:

- a) storing plant protection products;

- b) preparing plant protection products for application;
 - c) handling residues of the spraying solution after the treatment with plant protection products;
 - d) procedures during the cleaning of equipment intended for the application of plant protection products.
2. **Requirements** that places or facilities where plant protection products are stored should meet, taking into account the minimum distances from specified locations or objects, after considering which these products can be stored.
 3. **Method of warning** about the intention to conduct a treatment with plant protection products, posing a particular risk to the health of humans or animals or to the environment, for people who may come into contact with these products or are owners of farm animals that may come into contact with these products.

Pesticides shall be stored:

1. In their original packaging and in a manner that prevents contact of these substances with food, beverages, or feed.
2. In a way that ensures:
 - a) they will not be accidentally ingested or used for feeding animals;
 - b) they are inaccessible to children;
 - c) there is no risk of:
 - contaminating surface and groundwater within the meaning of the provisions of the Water Law,
 - contaminating soil due to leakage or seepage of pesticides into the soil profile,
 - entering sewage systems, with the exception of separate non-drainage sewage systems equipped with a sealed wastewater tank or devices for their neutralization.

Preparation of plant protection products for application by preparing the working solution is carried out:

1. In a way that limits the risk of contamination:
 - a) of surface and groundwater within the meaning of the provisions of the Water Law;
 - b) of soil, including due to leakage or seepage of plant protection products into the soil profile.
2. At a distance of not less than 20 meters from wells, water intakes, as well as water reservoirs and watercourses – in the case of preparing the working solution using plant protection products intended for professional users.

Residues of the working solution after the treatment with plant protection products should be handled in a way that limits the risk of contamination of surface and groundwater within the meaning of the provisions of the Water Law, as well as soil. For residues of the working solution after the treatment with plant protection products intended for professional users, the following measures should be taken:

1. Use them after prior dilution on the surface where the treatment was carried out, in the area where the plant protection product was applied in a smaller quantity, if possible, or
2. Dispose of them using technical solutions ensuring the biological degradation of the active substances of the plant protection products, or
3. Dispose of them in a manner other than indicated in point 2, if it is in accordance with waste regulations.

Plant protection products help farmers combat pests in crops. However, if they are improperly used, they can be harmful to animals and humans.

Cleaning equipment intended for the application of plant protection products shall be carried out:

1. In a way that limits the risk of contamination:
 - a) of surface and groundwater within the meaning of the provisions of the Water Law;
 - b) of soil, including due to leakage or seepage of plant protection products into the soil profile.
2. At a distance of not less than 30 meters from wells, water intakes, as well as water reservoirs and watercourses – in the case of cleaning equipment intended for the application of plant protection products intended for professional users.

The use of plant protection products in open areas using (Regulation of the Minister of Agriculture and Rural Development of March 31, 2014, on the conditions of using plant protection products – Journal of Laws of 2014, item 516):

- ground-based equipment at a distance of at least 20 meters from apiaries,
- tractor-mounted and self-propelled sprayers used in field or orchard areas at a distance of at least 3 meters from the edge of public roadways, excluding public roads classified as municipal or county roads,
- tractor-mounted and self-propelled sprayers used in orchard areas at a distance of at least 3 meters from water reservoirs, watercourses, and non-agricultural unused areas not intended for the treatment with plant protection products,
- tractor-mounted and self-propelled sprayers used in field areas at a distance of at least 1 meter from water reservoirs, watercourses, and non-agricultural unused areas not intended for the treatment with plant protection products,
- plant protection products may be applied in open areas only when the wind speed does not exceed 4 m/s.

Certificate of completion of plant protection products application training

The Act of March 8, 2013, on Plant Protection Products, Article 25 and Article 64, stipulates that individuals applying plant protection products must have appropriate training, confirmed by a valid certificate of completion of training in the scope of using plant protection products, plant protection advisory, integrated plant production, or any other document confirming the authorization to use pesticides during the period of performing treatments. After 5 years, a refresher training must be undertaken.

According to Regulation (EC) No. 1107/2009 of the European Parliament and of the Council dated October 21, 2009, documentation regarding the application of plant protection products should be kept for a minimum period of 3 years from the date of carrying out the plant protection treatment.

Agricultural producers who receive environmental payments should retain the following documents for a period of 5 years from the completion of the agri-environmental program:

- a) evidence of purchasing fertilizers and plant protection products;
- b) certification for tractor-mounted sprayers and documents confirming:
 - completion of training in the use of plant protection products for ground-based equipment, excluding equipment mounted on rail vehicles and other equipment used in railways,
 - documentation related to the application of plant protection products.

MANAGEMENT AND MONITORING OF PLANT PROTECTION PRODUCT RESIDUES IN FOOD

The management and monitoring of plant protection product residues in food are crucial elements in protecting consumers' health. In the European Union, there are very strict regulations aimed at controlling and limiting the residues of plant protection products in food.

Since 1997, residue monitoring of plant protection products in food has been conducted in EU countries. Germany and the Netherlands are among the countries with the highest number of tested plant protection products in food. According to Dobosz and Jaskólecki (2007), 399 pesticides were analyzed in Germany, while 332 in the Netherlands. The European Union recommends the analysis of all major chemical groups of plant protection products that may occur in plant-origin food (over 4,505 compounds). Maximum Residue Limits (MRLs) for each plant protection product in various food products are established in the European Union. Before registering a plant protection product, a risk assessment related to its residues in food is conducted. The assessment includes dosing and frequency of application of the product, as well as its toxicity.

Due to the emergence of new preparations with harmful effects, there is a need for constant increase in the number of analyzed plant protection product residues in food (Struciński et al. 2006).

Regulation (EC) No. 882/2004 of the European Parliament and of the Council of 29 April 2004 on official controls performed to ensure the verification of compliance with feed and food law regulates the safety control of food. According to the provisions of this regulation, Member States are obliged to check whether the requirements concerning food safety are met by economic operators at all stages of production, processing, and distribution. Therefore, they must organize and regularly carry out official control and monitoring programs. Such control programs should consist of two parts: a coordinated community control program and a national control program. The regulations of the European Union precisely determine which pesticides and food products should be subject to control tests. They also specify the minimum number of samples of each food product that should be tested in each Member State (Góralczyk et al. 2009). Customs controls are conducted at the EU borders, including examinations and analyses of plant protection product residues in imported food.

The introduction of plant protection products into circulation in the EU is regulated by Regulation (EC) No. 1107/2009 of the European Parliament and of the Council of 21 October 2009. The Pesticides Unit at the European Food Safety Authority (EFSA) is responsible for risk assessment of active substances used in the EU. In the European Union, all plant protection products must undergo a two-step procedure for authorization to be placed on the market. Firstly, the Commission approves the active substances, and then the Member States may grant authorization for specific commercial forms of plant protection products containing approved active substances.

Proper and reliable determination of plant protection product residues in food products is defined by standards that contain guidelines for the applicable testing procedures.

The annual EFSA report on pesticide residues in food includes over 88,000 food samples collected in the European Union in 2020. The conducted research showed that 94.9% of the tested samples were within legally allowed levels (EFSA 2020).

CONCLUSION

Plant protection products, due to their toxicity to living organisms and long-term effects, are considered to be the most hazardous chemical compounds. For this reason, they are subject to strict control, especially their residues in food. Appropriate regulations and legal acts govern the permissible levels of plant protection product residues in food. Proper management of plant protection products at the legislative level and during their application will contribute to reducing their adverse effects on human and animal health.

REFERENCES

- Aktar M.W., Sengupta D., Chowdhury A.** 2009. Impact of pesticides use in agriculture: Their benefits and hazards. *Interdisc. Toxicol.* 2(1), 1–12. DOI: 10.2478/v10102-009-0001-7.
- Alavanja M.C., Ross M.K., Bonner M.R.** 2013. Increased cancer burden among pesticide applicators and others due to pesticide exposure. *Cancer J. Clin.* 63, 120–142. DOI: 10.3322/caac.21170.
- Baëmaga M., Kucharski J., Wyszowska J.** 2007. Impact of crop protection chemicals on plants and animals. *J. Elementol.* 12(2), 135–148.
- Bennett D.H., Kastenber W.E., McKone T.E.** 1999. A multimedia, multiple pathway risk assessment of atrazine: The impact of age differentiated exposure including joint uncertainty and variability. *Reliab. Eng. Syst. Saf.* 63, 185–198. DOI: 10.1016/S0951-8320(98)00046-5.
- Biziuk M., Żelechowska A., Wiergowski M., Tyszkiewicz H.** 2001. Występowanie pestycydów w środowisku, in: *Pestycydy – występowanie, oznaczanie i unieszkodliwianie*. Eds. M. Biziuk. WNT, Warszawa, 42–62 [in Polish].
- Bol V. van, Ruelle P., Fontier H.** 2008. Environmental risks due to pesticide use at a national scale: indicators calculation on the Belgian pesticide sales database, ENDURE International Conference 2008 Diversifying Crop Protection, 12–15 October, La Grande-Motte, France.
- Bondesson I., Ekwall B., Hellberg S., Romert L., Stenber K., Walum E.** 1989. MEIC – A new international multicenter project to evaluate the relevance to human toxicity of in vitro cy-toxicity tests. *Cell Biol. Toxicol.* 5, 331–347. DOI: 10.1007/BF01795360.
- Debnath M., Khan M.S.** 2017. Health concerns of pesticides, in: *Pesticide residue in foods. sources, management, and control*. Eds. M. Samad Khan, M. Shafiur Rahman. Cham, Springer, 103–118.
- Dobosz B., Jaskólecki H.** 2007. Pozostałości pestycydów w żywności pochodzenia roślinnego. *Probl. Ecol.* 11(43), 187–190.
- EFSA.** 2020. The 2020 European Union report on pesticide residues in food, <https://multimedia.efs.europa.eu/pesticides-report-2020/>, access: 5.05.2023.
- Gajdzik B.** 2006. Zarządzanie przedsiębiorstwem a ochrona środowiska [Enterprise management vs. environment protection]. *Ekon. Org. Przeds.* 10, 49–56 [in Polish].
- Geiger F., Bengtsson J., Berendse F., Weisser W., Emmerson M., Morales M.B., Ceryngier P., Liira J., Tschardt T., Winqvist C., Eggers S., Bommarco R., Pärt T., Bretagnolle V., Plantegenest M., Clement L.W., Dennis C., Palmer C., Oñate J., Guerrero I., Hawro V., Aavik T., Thies C., Flohre A., Hänke S., Fischer C., Goedhart P.W., Inchausti P.** 2010. Persistent negative effects of pesticides on biodiversity and biological control potential on European farmland. *Basic Appl. Ecol.* 11(2), 97–105. DOI: 10.1016/j.baae.2009.12.001.
- Giulivo M., López de Alda M., Capri E., Barceló D.** 2016. Human exposure to endocrine disrupting compounds: Their role in reproductive systems, metabolic syndrome and breast cancer. *Environ. Res.* 151, 251–264. DOI: 10.1016/j.envres.2016.07.011.
- Góralczyk K., Struciński P., Korcz W., Czaja K., Hernik A., Snopczyński T., Ludwicki J.K.** 2009. Badania pozostałości pestycydów w żywności pochodzenia roślinnego w Polsce w latach 2004–2007 [Studies of pesticide residues in food of plant origin in Poland in the years 2004–2007]. *Rocz. PZH* 2009, 60(2), 113–119 [in Polish].
- Grotowska M., Janda K., Jakubczyk K.** 2018. Wpływ pestycydów na zdrowie człowieka [The impact of pesticides on human health]. *Pomeranian J. Life Sci.* 64(2), 42–50 [in Polish].
- Kookana R.S., Kumar A., Oliver D.P., Correll R.L.** 2007. Pesticide risk indicators: Their role in minimizing off-site impacts of pesticides on water quality, in: *Rational environmental management of agrochemicals*. Eds. I.R. Kennedy, K.R. Solomon, S.J. Gee, A.N. Cros-

- san, S. Wang, F. Sánchez-Bayo. Washington, American Chemical Society, 37–52. DOI: 10.1021/bk-2007-0966.ch003.
- Kowalska G., Kowalski R.** 2019. Pestycydy – zakres i ryzyko stosowania, korzyści i zagrożenia [Pesticides – scope and risks of use, benefits and risks]. *Ann. Hortic.* 2, 1–21 [in Polish].
- MRiRW.** 2020. Rejestr Środków Ochrony Roślin, <https://www.gov.pl/web/rolnictwo/rejestr-rodkow-ochrony-roslin>, access: 2.04.2023.
- Nowak R. Włodarczyk-Makuła M., Mamzer E.** 2015. Ryzyko środowiskowe i zdrowotne wynikające ze stosowania środków ochrony roślin [Risk assessment of exposure to pesticide residues in food of plant origin at the registration stage of a plant protection product]. *Zesz. Nauk. WSZOP* 1(11), 51–63 [in Polish].
- Pérez-Lucas G., Vela N., Aatik A.E., Navarro S.** 2018. Environmental risk of groundwater pollution by pesticide leaching through the soil profile, in: *Pesticides – use and misuse and their impact in the environment*. Eds. M. Larramendy, S. Soloneski. London, Intech-Open, 1–27.
- Regulation (EC) No 882/2004 of the European Parliament and of the Council of 29th April 2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health, and animal welfare rules.** *Off. J. Eur. Union* L 191/1.
- Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC.** *Off. J. Eur. Union* 50, 1–50.
- Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 18 kwietnia 2013 r. w sprawie wymagań integrowanej ochrony roślin** [Regulation of the Minister of Agriculture and Rural Development of 18th April 2013 on the requirements of integrated plant protection]. *DzU* 2013 poz. 505 [in Polish].
- Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 22 maja 2013 r. w sprawie sposobu postępowania przy stosowaniu i przechowywaniu środków ochrony roślin** [Regulation of the Minister of Agriculture and Rural Development of 22nd May 2013 on the procedures for the application and storage of plant protection products]. *DzU* 2013 poz. 455, poz. 625 [in Polish].
- Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 31 marca 2014 roku w sprawie warunków stosowania środków ochrony roślin** [Regulation of the Minister of Agriculture and Rural Development of 31st March 2014 on the conditions for the use of plant protection products]. *DzU* 2014 poz. 516 [in Polish].
- Struciński P., Góralczyk K., Czaja K., Hernik A., Korcz W., Ludwicki J.K.** 2006. Ocena ryzyka związana z narażeniem na pozostałości pestycydów w żywności pochodzenia roślinnego na etapie rejestracji środka ochrony roślin [Risk assessment of exposure to pesticide residues in food of plant origin at the registration stage of a plant protection product]. *Rocz. PZH* 57, 303–315 [in Polish].
- Ustawa z dnia 8 marca 2013 r. o środkach ochrony roślin** [The Act of 8th March 2013 on Plant Protection Products]. *DzU* 2013 poz. 2097 [in Polish].
- Wierzbicki T.L.** 2004. Wpływ środków ochrony roślin na środowisko człowieka. Mikrozanieczyszczenia w środowisku człowieka. Częstochowa, Wydaw. Politechniki Częstochowskiej, 261–269 [in Polish].
- Wrzosek J., Gworek B., Maciszek D.** 2009. Środki ochrony roślin w aspekcie ochrony środowiska [Plant protection products in the aspect of environmental protection]. *Ochr. Śr. Zasobów Nat.* 39, 75–88 [in Polish].

ZARZĄDZANIE I MONITOROWANIE ŚRODKAMI OCHRONY ROŚLIN W ROLNICTWIE W ASPEKcie ZDROWIA LUDZI I ZWIERZĄT

Streszczenie. Zarządzanie i monitorowanie środkami ochrony roślin w rolnictwie obejmuje stosowanie ich w odpowiednich dawkach i terminach, monitorowanie skuteczności działania oraz minimalizację negatywnego wpływu na środowisko. Zdrowie człowieka oraz bezpieczeństwo środowiska zależą od decyzji rolników oraz farmerów, którzy podejmują działania z wykorzystaniem środków ochrony roślin w swojej produkcji. W Polsce środki chemiczne są najczęściej stosowanym sposobem ochrony upraw polowych. Unia Europejska ma bardzo surowe przepisy i uregulowania prawne, które mają na celu ochronę zdrowia ludzi i zwierząt oraz ochronę środowiska. Istnieją specjalne regulacje dotyczące rejestracji, stosowania, sprzedaży i monitorowania środków ochrony roślin w ramach polityki Unii Europejskiej. Odpowiednie rozporządzenia i akty prawne regulują dopuszczalne poziomy zawartości środków ochrony roślin w żywności. Właściwe zarządzanie środkami ochrony roślin na poziomie ustaw oraz podczas ich stosowania przyczyni się do ograniczenia ich niekorzystnego wpływu na zdrowie ludzi i zwierząt.

Słowa kluczowe: środki ochrony roślin, zarządzanie, monitoring, ryzyko, środowisko, przepisy prawa, zdrowie ludzi, zdrowie zwierząt.