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ECONOMIC AND LEGAL ASPECTS OF PESTICIDE USE IN UKRAINE IN THE CONTEXT OF EU REQUIREMENTS

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Abstract. Current global trends towards greening agricultural production, increased attention to the implementation of eco-friendly practices, and reducing the negative impact of the agricultural sector on the environment pose new challenges for Ukraine. Along with overcoming the consequences of the war, Ukrainian farmers must respond to international requirements for environmentally friendly agricultural practices. This is, first and foremost, a prerequisite for participation in international trade in agricultural products, competitiveness on world markets, compliance with European integration requirements, and the restoration of the agricultural sector in accordance with the principles of sustainable development. Accordingly, one of the important issues is to achieve a reasonable balance between the need to reduce the use of chemicals in production processes, replace hazardous pesticides and agrochemicals with safer alternatives, and the need to reduce production costs. In view of the above, research into the economic and legal aspects of pesticide use in Ukraine in the context of EU requirements is particularly relevant, which is the purpose of this scientific article. The use of such scientific methods as philosophical (dialectical), general scientific (formal-logical and analytical) and special legal (comparative-legal and formal-legal) methods contributed to the solution of the research tasks. The statistical method of data processing and analysis was also used in the work. The study found that the absence of a ban on the use of neonicotinoid insecticides, which are particularly harmful to pollinating insects, in Ukrainian legislation is leading to an increase in their use, which is inconsistent with the position of the European Union, where such use is prohibited. At the same time, attention is focused on the economic risks for small agricultural producers in cases where a similar ban is imposed. It is noted that, given the difficult economic situation caused by the full-scale war, compliance with the requirements established by the EU in this area is practically impossible. It has been established that, despite significant risks to the environment and human health, Ukrainian legislation allows the use of pesticides by aerial spraying. The main shortcomings of the prospective legislation prohibiting this method of pesticide application and its non-compliance with EU legislation requirements have been identified (in particular, the establishment of an exhaustive list of cases for obtaining permits for aerial spraying of pesticides; reduction of the notification period for the start of such work). An economic and legal assessment of the prospects for using unmanned aerial vehicles to apply plant protection products in Ukraine and the EU has been carried out. The conclusions reached may form the basis for further economic and legal research in the field of plant protection product management.

Keywords: plant protection products, pesticides, environment, agriculture, crop yield, bee poisoning, human health, biodiversity, innovative technologies, production costs.

JEL Classification: K32, O13, Q15, Q16, Q57

1. Introduction

The widespread use of pesticides and agrochemicals, known for their ability to negatively affect human and animal health and damage the environment, has become commonplace in agricultural production. As early as the 1960s, V.L. Muntian drew attention to the need to minimise the negative effects of pesticides on animals and human health, citing an example where mineral fertilisers (superphosphate, ammonium nitrate, etc.) caused mass poisoning of grey partridges, hares,

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black grouse, moose and the death of thousands of bee colonies (Muntian, 1965). Nevertheless, chemical plant protection products continue to be actively used around the world, as they increase crop yields. In view of this, the EU's Farm to Fork Strategy establishes the need for additional measures to reduce the use of chemical pesticides by 50% and increase the use of less hazardous pesticides by 50% by 2030 (Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system). In particular, it provides for a review of the Sustainable Use of Pesticides Directive (paragraph 2.1. part 2) (Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides) (hereinafter referred to as Directive 2009/128/EC). Unfortunately, these provisions are quite difficult to implement in practice. This was clearly demonstrated by the farmers' protests that swept across Europe in early 2024 (Yuzak, 2024). As regards Ukraine, according to the Comprehensive Strategy for the Implementation of Chapter IV (Sanitary and Phytosanitary Measures) of Section IV "Trade and Trade-Related Matters" of the Association Agreement between Ukraine, on the one hand, and the European Union, the European Atomic Energy Community and their Member States, on the other hand, ratified by the Law of Ukraine of September 16, 2014, approved by the Resolution of the Cabinet of Ministers of Ukraine No. 228-p of February 24, 2016 (Association Agreement between the European Union and the European Atomic Energy Community and their Member States, of the one part, and Ukraine, of the other part.) (hereinafter referred to as the Comprehensive Implementation Strategy), a number of EU regulatory acts had to be implemented into legislation, establishing, in particular, bans on the use of neonicotinoid insecticides (clothianidin, thiamethoxam and imidacloprid) and aerial spraying of pesticides. This has not been done to date. Accordingly, the question of Ukraine's ability to achieve the EU's targets for reducing the use of chemical plant protection products in agriculture remains open. All of the above determines the relevance of the chosen topic, which is further exacerbated by the problem of taking into account the enormous scale of the negative impact of war on the environment in general and on agriculture as a sector that is objectively linked to the natural environment in particular (Ladychenko, Yara, Uliutina, Golovko, 2019).

The **purpose** of this scientific article is to examine the economic and legal aspects of pesticide use in Ukraine in the context of EU requirements. The **main** tasks of the work are: collection and summarisation of data on the use of pesticides in agriculture in Ukraine (using insecticides as an example); comparative analysis of Ukrainian and EU legislation in the field of aerial spraying of pesticides; economic and legal assessment of the prospects for the use of unmanned aerial vehicles for the application of plant protection products.

2. Analysis of Recent Researches and Publications

An analysis of recent developments in the field of legal regulation and economic indicators of pesticide use allows the authors of the article to identify several conditional groups. The first is the work of Ukrainian legal scholars and economists. First and foremost, these are works that outline the key principles of legal regulation of pesticide use. In particular, Sakadji K.B. analysed the state of legal regulation of the use of plant protection products at the dissertation research level, including the issue of the negative impact of the use of chemical plant protection products (Sakadji, 2011). The legal basis for the protection of bees in the process of cultivating agricultural land with plant protection products in Ukraine was examined in a scientific study by Hafurova and Kukhar. In particular, the authors addressed the issue of liability for violations of beekeeping legislation when using insecticides. They paid particular attention to researching issues related to the adaptation of Ukrainian legislation in this area to EU requirements (Hafurova, Kukhar, 2020). Public law aspects of handling pesticides and agrochemicals were highlighted (Branitskyi, 2023), as were issues of legal liability for violations in the use of plant protection products (including pesticides) (Malchyk, 2024). Among the works directly devoted to the legal issues of protecting bees as part of the ecosystem from the negative impact of chemicalisation in agricultural production, this authors would like to highlight the work by Godovanyuk (2023), in which these aspects are discussed in the context of adapting Ukrainian legislation to EU requirements and best environmental practices. The work of scientists on current issues of harmonising Ukraine's environmental legislation with the requirements and principles of EU environmental policy is also important (Ladychenko, Golovko, 2017). The complexity of the problem of pesticide use – finding a balance between environmental and economic interests – necessitates its study in the economic sphere as well. It is worth noting the research devoted to the interaction of economic and environmental factors in the development of the agricultural sector of Ukraine's national economy, which concludes that adaptive, comprehensive and cross-sectoral approaches to agricultural development based on economic and environmental synergy are important (Lehkyi, 2025). An examination of the potential for the expansion of the plant protection

products market, alongside the anticipated level of pesticide utilisation in the medium term (Vdovenko et al., 2022). The second is the work of foreign scientists. It is evident that the subject matter has been developed to a greater extent, and the research is more comprehensive. In particular, there are works devoted to the analysis of approaches to regulating the risks of pesticide use for plant pollinators in the United States, the EU and Asian countries, comparing the relevant legal mechanisms with an emphasis on preventive protection of pollinators and integrated risk assessment of chemical use (Phan et al., 2023); studying European Union legislation in the field of legal regulation of pesticide use in the context of its impact on biodiversity, analysing legal mechanisms, and identifying opportunities for legislative reform (Musselli, I., Ituarte-Lima, 2026); assessing the extent to which EU legislation takes into account the risks of pesticide use and their impact on bees through nectar and pollen (Kaila et al., 2022). Recently, a large body of scientific work has begun to emerge on innovative technologies for the application of plant protection products, namely the use of unmanned aerial vehicles (drones). For example, Ukrainian scientists have studied the dynamics of the range of pesticides approved for use in Ukraine that can be applied using agricultural drones, identified the risks of this method of applying chemicals to the environment, and emphasised the need to register chemical plant protection products for use with UAVs (Borysenko et al., 2023). They also examined the economic efficiency of using drones in agriculture as part of the concept of precision farming (Ponomarenko et al., 2021). The achievements of foreign scientists cannot be ignored. The main focus is on the economic and environmental benefits of introducing digital technologies into agricultural production (in particular, precision farming tools, including agricultural drones) (Papadopoulos et al., 2024). There is also work on the regulatory framework for plant treatment using UAVs in Switzerland (Anken et al., 2025), on the potential of drone-related agricultural technologies in the Western Balkans, and on the legal restrictions on the use of UAVs (Ivezić et al., 2023). To summarise the conclusions reached by the authors, it is evident that the primary issue hindering the prospective widespread utilisation of UAVs in agricultural production pertains to the compatibility of the technical capabilities of drones with the provisions of current legislation. This concern is not exclusive to Ukraine but is also relevant for other countries, particularly those within the European Union. Currently, UAVs remain outside the scope of direct legal regulation, which creates legal risks primarily for users. Thus, there is a pressing need to continue comprehensive research in the field of legal regulation of pesticide use in the context of their impact on biodiversity in combination with the latest technologies, environmental practices and standards. From a practical point of view, it remains important to determine the economic effect of applying plant protection products from the air using drones.

3. Methodology

A wide range of scientific methods were used in the research process, including philosophical (dialectical), general scientific (formal logical and analytical methods, statistical methods of data processing and analysis) and special scientific (formal legal and comparative legal) methods. Thanks to the dialectical method, it was possible to identify the economic and legal basis for the use of chemical plant protection products in Ukraine and the EU, taking into account their impact on the environment and human and animal health (in particular bees). The formal-logical method allowed us to formulate conclusions and trace trends in the development of legislation in this area. The analysis method was used in the process of reviewing scientific sources, as well as to identify a number of contradictions in the legislation, which made it possible to make proposals for its improvement. The formal legal method was used to reveal the content of legal norms that establish requirements for the use of insecticides and the implementation of activities related to the aerial application of pesticides. A comparison of Ukrainian legislation with EU legislation in the field under study was made possible by applying a comparative legal method. The statistical method of data processing and analysis made it possible to track the dynamics of insecticide use in terms of quantitative and qualitative (active ingredient) parameters.

4. Results and Discussions

4.1 Current State and Economic Implications of Limited Insecticide Use in Agriculture

As mentioned above, Ukraine continues to use neonicotinoid insecticides, which pose a particular danger to bees because they disrupt their nervous system and negatively affect their memory, navigation, and reproductive capacity even in low doses, leading to mass poisoning and death.

The situation regarding the use of pesticides in Ukraine (in particular insecticides, as chemicals that have the most detrimental effect on biodiversity and directly on bees as part of the latter) can be illustrated by the data presented in Tables 1-4. They are based on official information from the State Statistics Service of Ukraine and contain data on the volumes of the fifteen most popular types of insecticides used in the cultivation of sunflowers, soybeans, rapeseed, fruits and berries, nuts, grapes, hops and other perennial crops

Table 1

Amounts of pesticides applied in sunflower cultivation throughout Ukraine (kilograms of active ingredient)

No.	Type of substance	Hazard class for bees	2019	2020	2021	2022	2023	2024
1	Chlorpyrifos	1	78591.21	74040.28	53058.13	52,299.66	33,179.35	49,073.58
2	Imidacloprid	1	42849.47	50092.62	53766.3	55266.49	43,783.15	45,263.95
3	Lambda-cyhalothrin	1 or 2	15041.13	14066.98	19363.52	14240.19	17681.1	16,192.63
4	Alpha-cypermethrin	1 or 2	10421.38	13135.68	53,802.54	18057.02	16,151.55	13,228.13
5	Thiamethoxam	1	17517.55	12060.52	16118.31	10361.42	13,215.25	12,868.31
6	Acetamiprid	1	3011.67	6550.41	9977.7	9165.12	8465.7	8894.73
7	Clothianidin	1	3534.33	6330.33	10868.43	10030.89	6132.5	7501.55
8	Dimethoate	1	8022.06	5761.63	3796.92	4857.55	3227.79	6057.95
9	Malathion	1 or 3	1984.69	1101.53	984.96	2298.73	2090.66	5693.47
10	Cypermethrin	1 or 2	6538.68	6415.02	4485.21	4862.2	3161.46	4114.62
11	Thiacloprid	3	1601.24	806.48	1266.98	737.08	450.05	1552.61
12	Aluminum phosphide	1	8470.48	2093.25	2155.85	1192.07	1635.13	1239.41
13	Bifenthrin	1	931.16	853.16	1508.33	446.97	386.95	1196.56
14	Chlorantraniliprole	3	2218.99	1787.45	1799.34	1810.92	529.87	876.36
15	Clopentazepine	3	223.71	222.55	46	39.5	42.5	866.25

Source: compiled by the authors based on data from the State Statistics Service of Ukraine. Available at: https://stat.gov.ua/uk/search?f%5B0%5D=content_type%3Adataset&f%5B1%5D=topics%3A178&query=%D0%BF%D0%B5%D1%81%D1%82%D0%B8%D1%86%D0%B8%D0%B4

throughout Ukraine over the last 5 years. The choice of these particular crops is due, firstly, to the fact that they are all pollinated by bees and, secondly, to the fact that sunflower, soybean and rapeseed are among the leaders in the structure of domestic crop production in terms of both volume and area.

Analysis of these data shows different dynamics in the use of certain types of insecticides over the years. An examination of the statistics on the total volumes of all insecticides applied in the cultivation of these crops (see Table 5) reveals a decline in 2022, which can be attributed to the onset of the full-scale Russian invasion of Ukraine. However, in subsequent years, there is a tendency towards an increase in the use of these chemicals. For example, for rapeseed, this indicator for 2024 already exceeds the 2018 indicator. In other words, in today's reality, the use of chemicals in agricultural production is not decreasing, which is inconsistent with the general vector of development of the agricultural sector based on environmental principles, as declared by the European community. Thus, back in 2013, EU legislation introduced a temporary ban (Commission Implementing Regulation (EU) № 485/2013 of 24 May 2013 amending Implementing Regulation (EU) No 540/2011, as regards the conditions of approval of the active substances clothianidin, thiamethoxam and imidacloprid, and prohibiting the use and sale of seeds treated with plant protection products containing those active substances) on the use of insecticides such as imidacloprid, clothianidin and thiamethoxam, which became permanent in 2018 (Commission Implementing Regulation (EU) 2018/783 of 29 May 2018 amending Implementing Regulation (EU) № 540/2011 as regards the conditions of approval of the active substance imidacloprid), (Commission Implementing Regulation (EU) 2018/784 of 29 May 2018 amending Implementing Regulation (EU) № 540/2011 as regards the conditions of approval of the active substance clothianidin), Commission Implementing Regulation (EU) 2018/785 of 29 May 2018 amending Implementing Regulation (EU) № 540/2011 as regards the conditions of approval of the active substance thiamethoxam). However, according to 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, (hereinafter referred to as Regulation (EC) No 1107/2009), in emergency situations, a Member State may grant authorisation for a period not exceeding 120 days for the placing on the market of plant protection products under conditions of restricted and controlled use, if, in view of the threat that cannot be contained by any other reasonable means, such a measure is considered necessary (Article 53(1)). This provision created conditions for the continued use of the aforementioned pesticides. Only in 2023 did the European Court of Justice clarify that Article 53 (1) of Regulation (EC) No 1107/2009 should be interpreted as prohibiting Member States from granting authorisations for the placing on the market of plant protection products for seed treatment or for the placing on the market and use of seeds treated with such products, if such actions are expressly prohibited by the relevant implementing Regulations (Commission Implementing Regulations (EU) 2018/783, 2018/784,

Table 2
Amounts of pesticides used in soybean cultivation throughout Ukraine (kilograms of active ingredient)

No	Type of substance	Hazard class for bees	2019	2020	2021	2022	2023	2024
1	Imidacloprid	1	26871.47	28403.01	18791.5	21382.24	28,774.17	31,224.42
2	Chlorpyrifos	1	101010.3	23851.76	21210.65	17490.58	8572.08	19,890.79
3	Lambda-cyhalothrin	1 or 2	8158.29	4632.33	4948.14	5642.28	7648.15	8169.33
4	Thiamethoxam	1	1598.73	1234.84	2491.38	3048.44	2771.54	5677.62
5	Alpha-cypermethrin	1 or 2	4899.63	3531.32	4887.37	3926.19	3566.99	5110.11
6	Dimethoate	1	8718.84	2955.91	2811.72	2879.95	1495.09	4399.32
7	Aluminum phosphide	1	6666.97	4509.08	1179.93	1454.71	2797.39	2681.64
8	Acetamiprid	1	959.7	1185.59	1477.41	2170.97	1333.87	2366.24
9	Chlorantraniliprole	3	1735.91	1030.31	1504.77	570.88	812.6	1588.05
10	Cypermethrin	3	8420.1	1862.35	1661.69	1573.88	623.59	1538.42
11	Clothianidin	1	1533.41	819.21	1919.67	1596.73	1610.7	1524.08
12	Fipronil	1 or 3	682.91	1168.83	948.32	936.31	919.45	1184.33
13	Pyrimiphos-methyl	1	2330.56	1026.15	467.47	1005.53	2535.97	1163.53
14	Bifenthrin	1	1873.9	864.63	1014.74	727.6	482.37	1123.22
15	Malathion	1 or 3	1137.72	1378.26	853.49	163.59	99.87	551.43

Source: compiled by the authors based on data from the State Statistics Service of Ukraine. Available at: https://stat.gov.ua/uk/search?f%5B0%5D=content_type%3Adataset&f%5B1%5D=topics%3A178&query=%D0%BF%D0%B5%D1%81%D1%82%D0%B8%D1%86%D0%B8%D0%B4

Table 3
Amounts of pesticides applied in rapeseed cultivation throughout Ukraine (kilograms of active ingredient)

№	Type of substance	Hazard class for bees	2019	2020	2021	2022	2023
1	Chlorpyrifos	1	281,477.2	167,746.7	108,352.7	124,465.3	157,514.5
2	Imidacloprid	1	43403.71	40022.1	45595.5	48132.14	56,422.04
3	Thiacloprid	3	43244.58	30792.37	27,740.07	29,508.04	34,870.27
4	Dimethoate	1	22,135.52	18,951.95	28,191.68	24,221.54	34,681.39
5	Lambda-cyhalothrin	1 or 2	13737.35	10297.62	12181.07	13,470.29	19,170.19
6	Acetamiprid	1	9201.09	12365.94	12,274.41	9996.6	16,886.21
7	Malathion	1 or 3	8502.46	3481.29	2340.42	5461.27	16,130.04
8	Alpha-cypermethrin	1 or 2	14654.97	12,903.39	11,907.62	11618.93	13546.5
9	Cypermethrin	1 or 2	24087.5	14338.44	9682.29	10,627.99	12,156.87
10	Clothianidin	1	2840.48	3739.8	4007.9	4855.02	10154.28
11	Tau-fluvalinate	3	5660.42	4674.26	4378.79	6008.68	5723.19
12	Thiamethoxam	1	2952.4	4001.47	4267.39	3944.64	4548.33
13	Bifenthrin	1	1632.24	1156.68	779.61	1203.12	1994
14	Pyrimiphos-methyl	1	1496.01	842.4	1917.61	334.35	1806.86
15	Piridaben	3	122.97	132.68	228.2	127.75	955.92

Source: compiled by the authors based on data from the State Statistics Service of Ukraine. Available at: https://stat.gov.ua/uk/search?f%5B0%5D=content_type%3Adataset&f%5B1%5D=topics%3A178&query=%D0%BF%D0%B5%D1%81%D1%82%D0%B8%D1%86%D0%B8%D0%B4

2018/785 – authors' note) (Judgment of the Court (First Chamber) of 19 January 2023. Pesticide Action Network Europe ASBL and Others v État belge). Thus, a definitive ban on the use of the aforementioned neonicotinoids has been introduced.

In Ukraine, however, imidacloprid is the second most widely used insecticide in sunflower cultivation (Table 1) and rapeseed cultivation (Table 3), the first in soybean cultivation (Table 2) and the third in perennial crops (Table 4). Concurrently, there has been a consistent increase in the utilisation of imidacloprid. Furthermore, the active ingredients clothianidin and thiamethoxam are currently being utilised in Ukraine (Tables 1-4).

Table 4

Amounts of pesticides used in the cultivation of fruit and berry crops, nuts, grapes, hops, and other perennial crops throughout Ukraine (kilograms of active ingredient)

№	Type of substance	Hazard class for bees	2019	2020	2021	2022	2023	2024
1	Chlorpyrifos	1	17489.04	21973.6	11531.26	6427.61	6828.42	9084.73
2	Dimethoate	1	2856.54	1071.56	830.58	800.76	2377.82	1449.6
3	Imidacloprid	1	1291.1	1284.07	1896.42	1231.37	1504.56	1403.75
4	Lambda-cyhalothrin	1 or 2	687.87	1075.49	893.79	578.05	727.84	1028.13
5	Thiamethoxam	1	721.48	976.23	1120.35	660.89	993.8	1001.54
6	Acetamiprid	1	891.68	1151.53	705.46	570.04	582.02	774.65
7	Cypermethrin	1 or 2	1009.36	1452.88	792.93	330.18	400.8	613.3
8	Pyrimiphos-methyl	1	2430.99	2451.09	1694.31	1061.61	604.73	592.17
9	Bifenthrin	1	526.63	570	414.17	443.68	538.32	558.7
10	Chlorantraniliprole	3	558.37	1137.79	735.05	271.57	363.42	417.4
11	Thiacloprid	3	1031.3	1034.74	757.3	453.3	433	394.55
12	Alpha-cypermethrin	1 or 2	232	375.96	209.76	172.83	209.5	383.37
13	Propargite	3	2071.7	1043.03	1347.51	523.37	1016.31	365.94
14	Malathion	1 or 3	2189.09	2296.3	2376.67	967.63	514.72	344.68

Source: compiled by the authors based on data from the State Statistics Service of Ukraine. Available at: https://stat.gov.ua/uk/search?f%5B0%5D=content_type%3Adataset&f%5B1%5D=topics%3A178&query=%D0%BF%D0%B5%D1%81%D1%82%D0%B8%D1%86%D0%B8%D0%B4

Table 5

Amounts of pesticides applied in crop cultivation throughout Ukraine (kilograms of active ingredient)

Type of agricultural crop	2018	2019	2020	20	2022	2023	2024
Sunflower	204,187	197,376	202132	241333	194,107	157,750	178,352
Soy	162,485	186,847	84,898	71609	70474	67,667	91678
Perennial crops (fruit and berry crops, nuts, grapes, hops, and other perennial crops)	55175	41554	45837	30869	17,468	19621	20812
Winter rapeseed and colza (spring rapeseed)	356006	482215	336660	279,762	303991	393,451	410683

Source: compiled by the authors based on data from the State Statistics Service of Ukraine. Available at: https://stat.gov.ua/uk/search?f%5B0%5D=content_type%3Adataset&f%5B1%5D=topics%3A178&query=%D0%BF%D0%B5%D1%81%D1%82%D0%B8%D1%86%D0%B8%D0%B4

The following should be noted: According to the ecotoxicological assessment, all pesticides are categorised by hazard class (see Table 6), each of which has corresponding environmental regulations for use.

Tables 1-4 show that the vast majority of the most popular insecticides in Ukraine are highly dangerous to bees.

Scientific literature has already drawn attention to the need to establish a legislative ban on the use of neonicotinoid insecticides (Hafurova, Kukhar, 2020). However, according to experts, this will have negative consequences for the country's agriculture, which will consist not only in a decrease in crop yields, but also in an increase in production costs; a reduction in acreage due to the inability to control pests; and a deterioration in product quality (Expert identifies problems for the agricultural sector in the event of a significant reduction in insecticide use, 2023). According to available data, one third of agricultural production worldwide is currently produced thanks to the use of plant protection products (Liu et al., 2002). According to research by the National Academy of Agrarian Sciences, in connection with the possible ban on certain active ingredients in plant protection products on the Ukrainian market, the total losses to the agricultural sector due to crop shortfalls, lower product quality,

Table 6

Hazard classes of pesticides for bees

Hazard class	Degree of danger	Bee mortality rate	Border protection zone for bees	Restrictions on bee flight
1	highly hazardous	more than 20%	at least 4 km	4-5 days
2	moderately hazardous	from 5 to 20%	at least 3-4 km	2-3 days
3	low- hazardous	from 1 to 5%	2-3 km	1-2 days
4	practically safe	-	at least 1-2 km	6-12 hours

and additional costs for insecticide substitutes could increase by 36.8–74.9 billion hryvnia, which is equivalent to 1.3–2.7 billion USD (At a meeting of the Presidium of the National Academy of Agrarian Sciences, issues relating to the plant protection products market in Ukraine were discussed). According to published data, annual crop losses in Ukraine could reach 14 million tonnes, economic losses could amount to 4.3 billion USD, and gross harvests could fall by 20%. The expected reduction in exports is 34% for wheat, 34% for sunflower oil, and 22% for rapeseed (Tkachenko, Kozachenko, & Rodak, 2025). Given the need to comply with environmental restrictions, primarily as a condition for competitiveness in international markets, the transformation of the business model of agricultural enterprises into more innovative and technology-oriented ones is inevitable. According to research, farms that switch to environmentally friendly technologies see their operating costs increase by 12-25% in the first 2-3 years, but starting from the fourth year, these costs decrease thanks to savings on fertilisers, fuel and chemicals (Lehkyi 2025). However, while farms receive significant financial support under the EU's common agricultural policy, in the context of the ongoing war in Ukraine, it is practically impossible to provide a similar or even comparable level of support to agricultural producers from the state budget.

4.2 Features of Legal Support for the Use of Pesticides by Aerial Spraying

Work involving the **aerial spraying of pesticides** is particularly dangerous for bees. After all, insects usually end up in the spray zone. Currently, such activities are regulated by the State Sanitary Rules (SSR 8.8.1.2.001-98) "Transportation, Storage and Use of Pesticides in the National Economy", approved by order of the Ministry of Health of Ukraine on August 3, 1998. No. 1 (hereinafter referred to as SSR 8.8.1.2.001-98) (The Order of the Ministry of Health of Ukraine "On approval of the State Sanitary Rules 'Transportation, Storage, and Use of Pesticides in the National Economy'"). Incidentally, this document contains references to a number of regulatory acts that are no longer in force (The Resolution of the Cabinet of Ministers of Ukraine "On Repealing Certain Orders of Ministries and Other Central Executive Bodies"), in particular, the State Sanitary Rules for the Aerial Application of Pesticides and Agrochemicals in the National Economy of Ukraine (SSR 382-96), approved by the Ministry of Health of Ukraine on 18 December 1996 (hereinafter referred to as SSR 382-96) (The Order of the Ministry of Health of Ukraine "On Approval of State Sanitary Rules for the Aerial Application of Pesticides and Agrochemicals in the National Economy of Ukraine"). It stipulates that three days prior to the commencement of aerial spraying, the customer must take preventive measures in accordance with the requirements of SSR 382-96 (paragraph 6.2.12, part 6.2). These requirements included: a) informing the population of this territory (via radio, television, and the press) about the location, dates, and times of the spraying; a ban on other agricultural work and grazing livestock within 1 km of the site of aerial spraying, and the need to move apiaries to another honey-gathering site more than 5 km away from the site of aerial spraying for a period of up to 5 days; b) putting up special warning signs, showing the end of the waiting period, 300 m away from the treated areas, as well as on roads that go through these fields and on roads leading to the agricultural aerodrome (helicopter landing site) (paragraph 5.2 of part 5 of SSR 382-96). SSR 8.8.1.2.001-98 also stipulates that when applying pesticides by aircraft, it is necessary to strictly observe the sanitary protection zones specified in SSR 382-96 from areas of aerial chemical treatment to other objects (populated areas, livestock and poultry farms, water sources, etc.) (paragraph 6.2.13). Accordingly, compliance with these provisions becomes optional, which may adversely affect human and animal health. Only issues related to the use of plant protection products for treating honey plants remain properly regulated. The law establishes the obligation to warn beekeepers whose apiaries are located within 10 km of the treated areas through the media no later than three days before the start of treatment (Article 37) (The Law of Ukraine "On Beekeeping"). In addition, SSR 8.8.1.2.001-98 requires that certified aviation chemical equipment be used on aircraft and establishes requirements for carrying out such work (to be carried out in the morning and evening hours, at an air speed not exceeding 3 m/s (fine spray) and 4 m/s (coarse spray), at an air temperature not exceeding +22 degrees Celsius , and a working height above the treatment object of at least 3 m) (paragraphs 6.2.14- 6.2.15).

It should be noted that in order to minimise the impact of pesticides on the environment, Directive 2009/128/EC requires Member States **to prohibit aerial spraying of pesticides**, i.e., their application from aircraft (airplanes or helicopters) (Article 9). These measures were taken by France in 2014. Spain, which banned aerial spraying of pesticides in 2012, allowed exceptions, particularly in cases where it is impossible to do so by ground means or for the control of pests of particular importance (France bans aerial spraying of pesticides, 2026).

It should be noted that EU legislation provides for exceptions only in special cases where pesticides cannot be applied by any other means for technical or economic reasons. Moreover, Member States must designate authorities competent to establish such reasons, examine requests for aerial spraying of pesticides and publish information on crops, areas,

circumstances and specific requirements for their use, including weather conditions when aerial spraying may be permitted (Hafurova, Kukhar, 2020). The latter may only be carried out if a number of conditions are met: 1) there are no alternative options for their application or there are clear advantages in terms of reducing the impact on human health and the environment compared to ground application of pesticides; 2) the pesticides used must be approved specifically for aerial spraying by the Member State; 3) the operator performing aerial spraying must have the appropriate certificate; 4) the enterprise responsible for submitting applications for aerial spraying must be certified by the competent authority for the approval of equipment and aircraft; 5) measures must be taken in the area to be sprayed to ensure that there are no harmful effects on human health. Such areas should not be located in close proximity to residential areas; 6) since 2013, aircraft must be equipped with special equipment that reduces the spray radius (Article 9). Despite the fact that EU legislation sets out clear conditions for the use of aerial spraying of pesticides, violations are quite common. For example, in Spain, over the past five years, 234,000 hectares of rice fields have been sprayed with pesticides, sometimes unauthorised ones (The 9 aerial sprayings of pesticides carried out on rice fields in Spain in the last 7 years are illegal, 2024).

The above-mentioned Directive, as well as Regulation (EU) No. 1107/2009, should have been implemented into Ukrainian legislation back in 2018 (clause 67 of the Comprehensive Implementation Strategy). Despite this, their implementation will begin almost 10 years after the set date, with the entry into force on 17 January 2028 of the Law of Ukraine of December 17, 2024, "On State Regulation of Plant Protection" (The Law of Ukraine "On State Regulation of Plant Protection").

A subsequent analysis will consider how the requirements set out in Directive 2009/128/EC are reflected in the aforementioned Law. Primarily, it should be noted that the legislation prohibits the application of plant protection products from the air (clause 1 of Article 47). The conditions under which pesticides may be applied using a piloted aircraft are virtually identical (Article 47(2)). However, it should be noted that the aerial application of plant protection products is additionally permitted in the event of a state of emergency or the introduction of a special plant protection regime (Article 47(11)). This cannot be considered a positive innovation against the backdrop of the general European trend towards restricting such cases. In addition, the above-mentioned regulatory act provides for the possibility of using pesticides from the air in other cases specified by law (Article 47(11)), which indicates the creation of so-called "loopholes" in the legislation in order to ensure the continued use of aircraft for treating fields with pesticides.

It should also be noted that, on the one hand, the above-mentioned Law clearly spells out the procedure for notifying the use of plant protection products by submitting advance notice (Article 44), which is undoubtedly a positive development. On the other hand, it is established that it must be submitted at least 48 hours before the start of the relevant work. In cases where there is a risk of mass development and spread of harmful organisms, the deadline for submitting such a notification may be shortened, but it cannot be less than 12 hours before the start of the use of plant protection products (Article 44(2)). Thus, the Law reduces the notification period from three days, as provided for by current legislation, in particular SSR 8.8.1.2.001-98. Moreover, as mentioned above, the Law of Ukraine "On Beekeeping" also establishes a three-day notification period for beekeepers. Accordingly, the Law of Ukraine "On State Regulation of Plant Protection" does not take into account the provisions of special legislation in this part. This is particularly important because, as the legislator itself acknowledges, the poisoning of bees with plant protection products may also be caused by the failure to notify or untimely notification of apiary owners about the time, place and nature of their future use (para. 3 of the Instructions on the prevention and establishment of the fact of bee poisoning by plant protection products, approved by Order of the Ministry of Economic Development, Trade and Agriculture of Ukraine No. 338 of February 19, 2021) (The Order of the Ministry of Economic Development, Trade, and Agriculture of Ukraine "On Certain Issues in the Field of Beekeeping"). Furthermore, in the opinion of the authors of the article, in this case, the right of citizens to environmental information, established by the Law of Ukraine of June 25, 1991, "On Environmental Protection" (Article 25) (The Law of Ukraine "On Environmental Protection"), the right to an environment that is safe for life and health; accurate and timely information about their health and the health of the population, including existing or potential risk factors and their severity, as enshrined in the Laws of Ukraine of November 19, 1992, "Fundamentals of the Legislation of Ukraine on Healthcare" (Art. 6) (The Law of Ukraine "Fundamentals of the Legislation of Ukraine on Healthcare"), as well as the principle of safety for human health during their use (Article 3 of the Law of Ukraine "On Pesticides and Agrochemicals" dated March 2, 1995). Incidentally, it should be noted that among the basic principles for handling plant protection products contained in the Law of Ukraine "On State Regulation of Plant Protection", the principle of pesticide safety for human health during their use is absent. In accordance with the aforementioned, it is considered appropriate to set out subparagraphs 4) of Article 40 of the Law of Ukraine "On State Regulation of Plant Protection" as follows: "4) ensuring human health safety, preventing

damage to natural biodiversity, protected species and natural ecosystems".

4.3 Economic and Legal Aspects of Using Drones for Applying Plant Protection Products

Separately, it is necessary to dwell on the assessment provided for in the Law of Ukraine "On State Regulation of Plant Protection" of the possibility of applying plant protection products using unmanned aerial vehicles (Article 47(1)). The topic of the use of drones in agricultural production and the economic risks and benefits of introducing such innovations is currently gaining considerable popularity in scientific circles and is positioned as promising in practical terms. The following observations are derived from an examination of the extant research on the potential utilisation of drones for the application of pesticides and other plant protection products. The undeniable advantage of precision spraying systems installed on drones is the targeted, ultra-precise application of pesticides and other plant protection products. First and foremost, this allows for a reduction in the amount of chemicals used compared to traditional application methods. According to various estimates, this reduction ranges from 45% (Guebsi, Mami, & Chokmani, 2024). Such optimisation of direct production costs is a significant factor both in terms of reducing harmful environmental impact and in the long term, with the transition of agricultural production to more expensive biological products. Also, compared to traditional crop treatment technologies, the use of drones reduces the consumption of other resources (water, fuel and lubricants, agricultural machinery). Experts also point to an increase in crop yields due to the efficient use of drones and an increase in agricultural producers' income by 1.05% (Ponomarenko et al., 2021). In general, factors such as direct resource savings, environmental benefits, increased yields, and increased revenues allow us to conclude that the economic profile of intensifying the use of drones in precision farming systems is favourable (Talaeizadeh, et al., 2025).

As regards the legal component, such use is currently an exception to the general ban on aerial application of plant protection products. The following additional requirements apply to this activity: 1) carried out exclusively by a professional user (a market operator who uses plant protection products in the course of their professional activities, including an unmanned aircraft operator, an operator of equipment for the application of plant protection products, an employer and a self-employed person (para. 74) of Article 1(1)); 2) notification of the competent authority at least 24 hours before the planned period of application of plant protection products is mandatory; 3) plant protection products used must be registered in accordance with the Law of Ukraine "On Pesticides and Agrochemicals" and intended for aerial application; 4) requirements for unmanned aerial vehicles (must be registered in accordance with the aviation rules of Ukraine or registered in accordance with the Air Code of Ukraine; operation must be carried out in accordance with the manufacturer's recommendations; a technical inspection of the equipment used to apply plant protection products must be carried out). It should be noted that this issue is particularly relevant for Ukraine, where interest in the active use of drones for agricultural work was already noted in 2021 (Ukraine's once pioneering agriculture drone industry is hoping to return to the skies, 2025). In the context of military operations, Ukraine has gained extensive experience in their production and use. Therefore, it is expected that after the war, part of the production capacity for military drones will be reoriented towards purely agricultural purposes, which should lead to lower prices and wider availability (Post-war use of crop-protection drones will boost Ukraine's agricultural output, 2026).

As for EU legislation, it does not yet provide for the use of drones for agricultural work. On December 16, 2025, the European Commission adopted a Working Document with proposals for a number of EU regulations, including Directive 2009/128/EC. It aims to reduce regulatory interference in this area while maintaining high standards of food and feed safety and protecting human, animal and environmental health (Simplification Omnibus Package Proposal for a Directive of the European Parliament and of the Council amending Council Directive 98/58/EC and Directive 2009/128/EC of the European Parliament and of the Council as regards the simplification and strengthening of food and feed safety requirements, and repealing Council Directives 82/711/EEC and 85/572/EEC). The document states that drones have the potential to apply pesticides more accurately and, in some cases, may pose less risk to the operator and the environment than ground-based treatment technologies. However, they are subject to a general ban on aerial spraying under Directive 2009/128/EC, and the granting and obtaining of individual authorisations for their use creates a significant administrative burden for professional users and the competent authorities of Member States. This hinders the development and implementation of this innovative technology. Accordingly, it is proposed to make the necessary amendments to the above-mentioned Directive and allow aerial spraying of pesticides for certain types of drones specified by the European Commission. In order to ensure proper regulation of these relations, the European Food Safety Authority (EFSA) should develop an appropriate guidance document on the use of pesticides by drones. According to the authors of this article, this approach by lawmakers indicates, to

a certain extent, a departure from the strict policy of restricting the use of aerial pesticides.

At the same time, a number of EU countries have already started using drones for such work. As a rule, they are used in exceptional cases when there is no other alternative, and applying pesticides by other means is ineffective or difficult and dangerous for humans. In Germany, for example, they are permitted to be used for spraying fungicides on vineyards with steep slopes. The flight altitude and speed of drones are strictly limited. They are also equipped with special spray nozzles to minimise potential drift (Europe crop protection regulatory update / Precision farming: Status on the use of drones in agriculture, 2025). On April 23, 2025, France adopted Law No. 2025-365, aimed at improving the treatment of diseases affecting crops using remotely piloted aircraft (LOI n° 2025-365 du 23 avril 2025 visant à améliorer le traitement des maladies affectant les cultures végétales à l'aide d'aéronefs télépilotés, 2025). According to it, a separate procedure has been established for obtaining a temporary permit (for up to 3 years) to carry out the relevant treatments. The use of drones is only possible if their obvious advantages for human health and the environment compared to ground spraying of pesticides are proven. In particular, for the treatment of agricultural land located on slopes with a gradient of more than 20%, as well as banana plantations. At the same time, pesticides must be classified as low-risk plant protection products within the meaning of Article 47 of Regulation (EC) No 1107/2009 of the European Parliament and of the Council of October 21, 2009 (Regulation (EC) № 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). In view of the above, Ukrainian legislation should establish clear requirements for conducting the above activities by adopting an appropriate subordinate regulatory act.

5. Conclusions

As a result of collecting and summarising data on the use of chemical plant protection products in Ukraine, it has been established that Ukrainian farmers are increasing their use, including the most dangerous for biodiversity (in particular for pollinating insects) insecticides of the neonicotinoid group, which is not in line with the EU's policy of reducing and optimising the use of chemicals in agricultural production. However, refusing to use them could be critical for small agricultural producers. As the risks of reduced crop yields increase, production costs will also rise due to the use of more expensive substitutes. This is confirmed by the example of EU countries. Despite several attempts to abandon the use of insecticides such as imidacloprid, clothianidin and thiamethoxam, they continued to be used in agriculture on the basis of Article 53 of Regulation (EC) No. 1107/2009. Only the decision of the European Court of Justice on January 19, 2023 contributed to the introduction of a final ban on this. This indicates a rather long and complex process of transition to the use of biological products, even with a high level of financial support for economic entities. Unfortunately, given the difficult economic situation caused by the full-scale war in Ukraine, compliance with the requirements established by the EU in this area is practically impossible.

Unlike the EU, where aerial spraying of pesticides is prohibited (only temporary permits may be obtained), agricultural land in Ukraine continues to be treated in this manner. The introduction of a corresponding ban is to take place with the entry into force of the Law of Ukraine "On State Regulation of Plant Protection". It should be noted that this regulatory act has a number of shortcomings. For example, the list of cases in which a temporary permit can be obtained is not exhaustive. This does not comply with the requirements set out in Directive 2009/128/EC. In addition, reducing the notification period for the use of plant protection products from three days to 48 hours, as provided for by the Law, increases the risk of bee poisoning by pesticides, "narrows" citizens' right to access environmental information and violates the principle of safety for human health during their use. It is important to acknowledge the expansion in the scope for the utilisation of plant protection products from the air by means of drones, which is a favourable development that should be given due consideration. It is evident that the utilisation of precision pesticide application technology will ensure the efficiency of agricultural production. Furthermore, it has been demonstrated that this technology will reduce the negative environmental impact of chemicals. In order to regulate these relations in a clearer manner, it is necessary to develop and adopt an appropriate subordinate regulatory act at the level of a resolution of the Cabinet of Ministers of Ukraine.

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