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Methodology for Formation and Inventory of Air Pollutants in Agricultural Enterprises

Development of agricultural sector increases public welfare, economic and food safety, and export capacities of a country. Yet, agricultural sector is a most risky economic sector, as its performance is affected by a wide range of nature and biological factors. Improvement of the ecological safety system, existing in Ukraine, needs to be a priority political area on the basis of system analysis and with account of current transformations in the economy and public governance.

The objective of the study is statistical analysis of methodological framework for inventory of air pollutants emissions from agricultural enterprises; analysis of the official statistical observation on air protection. It is emphasized that the official statistical observation on air protection records emissions of pollutants and greenhouse gases from production and technological processes, technological facilities (units) according to the recommendations of UN Statistical Commission on Air Emissions Inventory. Main sources and types of emissions from plant growing, agricultural soils and animal husbandry are analyzed.

It is concluded that reporting and inventories of air emissions from all the agricultural enterprises enables official statistical bodies to make statistical analysis of air emissions in plant growing and animal husbandry, to supply users with complete and reliable ecological information. Also, information of the official statistical observation on air protection is used to measure the density of emissions from stationary polluting sources per 1 km^2 and per capita, to group emissions from enterprises by sector according to the universal reporting format of UN Framework Convention on Climate Change.

Keywords: *agricultural statistics, statistical analysis, ecological statistics, emissions of pollutants, inventory of emissions, air.*

Problem setting. Agriculture is a critical sector in a national economy. Its development improves the population welfare, increases economic and food safety and export capacities of a country. Yet, agricultural sector is a most risky economic sector, as its performance is affected by a wide range of nature and biological factors. More than 20% of the Ukrainian territory has poor condition due to oversaturation of soils by various kinds of toxic compounds. The main sources of their emission are agriculture, industry and transport. Improvement of the ecological safety system, existing in Ukraine, needs to be a priority political area on the basis of system analysis and with account of current transformations in the economy and public governance. A central short-term political objective should be minimization of human impact on the environment and reliable statistical reporting of the scopes of air pollutants from stationary pollution sources in agricultural sector.

Today, with the issue of ecologically friendly agricultural production being especially urgent, quantitative and qualitative parameters and scopes of air pollution by agricultural sector need to be clearly defined. Negative performance tendencies in agricultural sector cannot be eliminated without comprehensive analytical revision of the attitude to agriculture as a sector with merely business production purposes. The global community puts the increasingly stronger emphasis on the conception of multi-purposeful nature of agriculture, which says that the agricultural activities are meant not only for production of foods or raw materials for industry, but for the production with proper quality and contribution in the public welfare. Ukraine seeks to integrate in EU, where there's clear tendency to substitution of part of chemical substances by biological means of protection, expected to be principal ones in future.

Review of latest studies and publications. Theoretical and methodological issues of environmental effects from pollution are addressed by Ukrainian researchers such as S. Doro-

huntsov, V. Tretayk, M. Khvesyk and others. Methodology, organization and practical aspects of constructing ecological statistics are studied by S. Herasymenko, V. Danylko, A. Yerina, O. Osaulenko, N. Parfentseva and others. Yet, issues related with elaboration of methodology for official statistical observations in ecology, especially ones for recording the scopes of pollution produced by agricultural enterprises, are still unsolved. Studies of methods for their solution have even greater importance for the official statistics of Ukraine today, for the development of statistical science and practice, because they largely determine the quality of information used at all the levels of public governance.

The objective of the study is statistical analysis of methodological framework for inventory of air pollutants emissions from agricultural enterprises; analysis of the official statistical observation on air protection.

Results. Official reporting on air protection in Ukraine is specified by the Decree of the Cabinet of Ministers of Ukraine [1]. The official statistical observation on air protection records emissions of pollutants and greenhouse gases from production and technological processes, technological facilities (units) according to the recommendations of UN Statistical Commission on Inventory of Air Emissions (CORINAIR 2000), which is in keeping with international requirements to statistical data on air protection.

CORINAIR 2000 is the program for coordination of information on environmental performance, designed for making inventory of air pollutants emissions. Emissions refer to discharge of pollutants or their mixtures into the air. Air is a vitally important component of the environment, which is a natural mixture of gases out of dwelling buildings, industrial buildings (areas) or other indoor areas. Air protection refers to the set of measures related with protection, improvement or rehabilitation of the air condition, with prevention or reduction of its pollution and the impact on it from chemical compounds, physical or biological factors [2; 3]. Quality of statistical data collected in the official statistical observation on air protection can be improved by adopting stricter requirements to administrative statistical information on issuance of permits to agricultural enterprises for emission of pollutants, and to the nomenclature of agricultural enterprises covered by official registration.

According to the EMEP/EEA guidebook on inventory, there are four main sources of emissions in agriculture:

- ✓ use of pus;
- ✓ plant growing and agricultural soils;
- ✓ other types of agricultural practices, including use of pesticides;
- ✓ burning of agricultural wastes on fields.

European Environment Agency (EAA) is an EU agency responsible for providing complete and independent data on the environment, i. e. the data required for elaboration, adaptation, implementation and assessment of environmental policies. According to EMEP/EEA method, plant growing and agricultural soils account for nearly 10% of the total emission sources by the European indicator of ammonia (NH3) emissions. Emissions of various types of gaseous nitrogen in plant growing and agricultural soils tend to correlate with the quantities of used nitrogen fertilizers. Emissions of ammonia cause oxidation of nature ecosystems. Also, ammonia may be a component of solid particles. Nitrogen oxide (NO) and non-methane flying organic compounds (NMFOC) may be components of ozone, affecting human health and growing of plants on the Earth surface. Solid particles (SP) discharged to the air are specified by size or range zone. In various agreements particles are broken into categories: from dust ones to ultra-small ones. Emissions of particles may affect human health. There are four main sources of emissions from plant growing and agricultural soils:

- ✓ use of fertilizers (NH3);
- ✓ microbe activity in the soil (NO);
- ✓ processes of development of a culture (NH3 and NMFOC);
- ✓ soil treatment and harvesting (SP).

As regards animal husbandry, the sources of NH_3, NO and NMFOC emissions are physical discharges of agricultural animals inside or around buildings, accumulated in form of solid or liquid pus, stall pus. The sources of these emissions are buildings accommodating cattle, repositories of pus, spreading of pus over fields and keeping of cattle on pastures. PS emissions usually originate from feeding, from livestock bedding, from animal skin or feather; they amass on the area of buildings accommodating livestock. Another type of emissions is NO.

Discharges of livestock account for more than 80% of emissions in the European agriculture. However, emissions vary by animal category: cattle, sheep, pigs or poultry. The variations are caused by varying scopes of discharges and oxygen emissions depending on animal type, by different agricultural practices (including maintenance of cattle or use of pus), or by differences in climate conditions. Currently, it is believed that discharges of livestock and pus account for approximately 2% of the total NO and NMFOC emission. Emissions from pigsties and poultry processing enterprises account for nearly 30% and 55% of the total agricultural SP emission; the main source for the rest of emission is arable farming. There are five main sources of emission, caused by operation of livestock farms and use of pus:

- ✓ feeding of livestock (SP);
- ✓ livestock farms and zones of livestock maintenance (NH3, SP, NMFOC);
- ✓ storage of pus (NH3, NO, NMFOC);
- ✓ pus spread over fields (NH3, NO, NMFOC);
- ✓ pus accumulated on pastures (NH3, NO, NMFOC).

The source of NH3 emissions resulting from use of pus is nitrogen discharged by farm animals. Usually, more than half of nitrogen discharged by cattle is contained in urine; from 65 to 85% of nitrogen contained in urine is discharged in form of urea and other compounds that are quickly mineralized. Ammonia is discharged whenever pus is exposed to environmental effects: in cattle maintenance areas, in storage of pus, after spreading of pus over fields and from discharges left by cattle on pastures. Differences in agricultural practices, such as maintenance of cattle or use of pus, and differences in climate conditions have strong implications for the scopes of emissions. In animal husbandry NO is produced from nitrification in surface layers of stored pus. Emissions of nitrogen from soil are usually regarded as a result of nitrification. The increased nitrification is expected after spreading of pus over fields and accumulation of discharges from cattle kept on pastures. NMFOC from animal husbandry farms is emitted from forage, especially silage. Therefore, everything that intensifies feeding or use of pus (use of silage for feeding of animals, use of silage in animal accommodation areas, use of straw in pus and duration of its storage, or methods for use of pus) have effects for NMFOC emissions. The areas of more intensive emission are animal stalls, pus warehouses, fields where pus is removed, and fields used as animal pastures. The main source for SP emissions is buildings for animal accommodation, although outdoor areas also can be sources for large scopes of emissions. Most part of these emissions results from feeding accounting for 80 to 90% of the total SP emissions. Materials used for animal bedding, such as straw or wood chips, or poultry and pig farms are another potential source of SP emissions. Emissions from poultry enterprises result from feathers or manure, whereas emissions from pig farms result from small parts of skin, feces and animal bedding [4, p. 9–15].

An observation unit for the official statistical observation on air protection is specified considering that the observation covers the entities with official registration by scopes of potential emissions of pollutants and greenhouse gases in the air according to the Procedure for Official Registration for Air Protection Purposes, approved by the Decree of the Cabinet of Ministers of Ukraine from 13.12.2001 No 1655 [1]; enterprises, establishments and organizations in all the economics activities, using energy materials or oil refinery products for operative purposes. According to the guidelines for making up documents justifying the scopes of emissions to obtain a permit for air emissions of pollutants from stationary sources, made up in keeping with the "Procedure for Issuance of Permits for Air Emissions of Pollutants from Stationary Sources, Registration of Enterprises, Establishments and Individual Entrepreneurs Obtaining These Permits", approved by the Decree of the Cabinet of Ministers of Ukraine from 13.03.2002 No 302, the documents justifying the emission scopes are valid for ten years. The composition of documents justifying the emission scopes, required for registration of an enterprise, is conditional on the scopes of its effects for air pollution [4; 5].

Assessment of air pollution effects from air emissions of pollutants is made by data on scattering of pollutants in the air and data obtained by instrumental methods of analysis by accredited laboratories in a manner determined by law. According to Article 11 of the Law of Ukraine "On Air Protection", pollutants can be emitted in the air from stationary sources given the permit issued to a business entity whose business facilities are classified in the

firsts group, to a business entity whose business facilities are located on the territory of an exclusion zone or a zone of unconditional (obligatory) removal of population, which is affected by radioactive pollution resulting from Chernobyl catastrophe; the permit is issued by the central executive power body charged with implementation of environmental policy, with the agreement of the central executive power body charged with the policy of sanitary and epidemiological safety of population [6; 7]. The first group covers registered business entities with production and technological facilities, which must introduce ecologically safe technologies and management methods. The second group covers registered business entities without production and technological facilities, which must introduce ecologically safe technologies and management methods. The third group covers business entities not included to either the first or the second group. A permit issued for a business entity of the first group is valid for seven years, for a business entity of the second group – for ten years; a permit issued for a business entity of the thirds group has no limitations on validity.

The nomenclature of enterprises, establishments and organizations entitled for making up documents justifying the scopes of emissions is specified by the central executive power body charged with implementation of environmental policy.

Conclusions and prospects of future studies. Once official statistics offices have reports and inventories of air emissions from all the agricultural enterprises, they will be capable to make comprehensive statistical analysis of air emissions in plant growing and animal husbandry, and provide users with complete and reliable ecological information. Also, information of the official statistical observation on air protection is used to measure the density of emissions from stationary polluting sources per 1 km^2 and per capita, to group emissions from enterprises by sector according to the universal reporting format of UN Framework Convention on Climate Change.

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Методологія формування та інвентаризації викидів забруднюючих речовин у атмосферне повітря сільськогосподарськими підприємствами

Розвиток сільськогосподарської галузі сприяє підвищенню матеріального добробуту населення, зміцненню економічної та продовольчої безпеки країни, зростанню її експортного потенціалу. Водночас сільськогосподарське виробництво є одним з найбільш ризикових секторів економіки, оскільки на його розвиток впливає цілий спектр природних та біологічних факторів. Удосконалення нині чинної системи забезпечення екологічної безпеки в Україні має стати одним із пріоритетних напрямів державної політики на основі системного аналізу та врахування процесів трансформації в економіці та державному управлінні.

Метою дослідження є: статистичний аналіз методологічних основ інвентаризації викидів в атмосферне повітря від сільськогосподарської діяльності, аналіз державного статистичного спостереження щодо охорони атмосферного повітря. Зазначено, що у рамках державного статистичного спостереження з охорони атмосферного повітря здійснюється облік викидів забруднюючих речовин та парникових газів від виробничих та технологічних процесів, технологічного устаткування (установок) згідно з рекомендаціями Статистичної комісії ООН щодо інвентаризації атмосферних викидів (CORINAIR 2000). Проаналізовано основні джерела та види викидів від рослинництва, сільськогосподарських ґрунтів та від утримання сільськогосподарських тварин.

Зроблено висновок, що облік і інвентаризація викидів в атмосферне повітря від усіх сільськогосподарських підприємств надає органам статистики можливість проводити статистичний аналіз викидів у атмосферне повітря як рослинницької, так і тваринницької галузі, а відтак забезпечити користувачів повною та достовірною екологічною інформацією.

Ключові слова: *статистика сільського господарства, статистичний аналіз, статистика екології, викиди забруднюючих речовин, інвентаризація викидів, атмосферне повітря.*

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Методология формирования и инвентаризации выбросов загрязняющих веществ в атмосферный воздух сельскохозяйственными предприятиями

Развитие сельскохозяйственной отрасли способствует повышению материального благосостояния населения, укреплению экономической и продовольственной безопасности страны, росту ее экспортного потенциала. В то же время сельскохозяйственное производство является одним из наиболее рисковых секторов экономики, поскольку на его развитие влияет целый спектр природных и биологических факторов. Совершенствование ныне действующей системы обеспечения экологической безопасности в Украине должно стать одним из приоритетных направлений государственной политики на основе системного анализа и учета процессов трансформации в экономике и государственном управлении.

Целью исследования является: статистический анализ методологических основ инвентаризации выбросов в атмосферный воздух от сельскохозяйственной деятельности, анализ государственного статистического наблюдения охраны атмосферного

воздуха. Отмечено, что в рамках государственного статистического наблюдения охраны атмосферного воздуха осуществляется учет выбросов загрязняющих веществ и парниковых газов от производственных и технологических процессов, технологического оборудования (установок) в соответствии с рекомендациями Статистической комиссии ООН по инвентаризации атмосферных выбросов (CORINAIR 2000). Проанализированы основные источники и виды выбросов от растениеводства, сельскохозяйственных почв и от содержания сельскохозяйственных животных.

Сделан вывод, что учет и инвентаризация выбросов в атмосферный воздух от всех сельскохозяйственных предприятий позволяет органам статистики проводить статистический анализ выбросов в атмосферный воздух як растениеводческой, так и животноводческой отрасли, и, следовательно, обеспечивать пользователей полной и достоверной экологической информацией.

Ключевые слова: *статистика сельского хозяйства, статистический анализ, статистика экологии, выбросы загрязняющих веществ, инвентаризация выбросов, атмосферный воздух.*

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