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ECOLOGICAL SPECIFICITIES OF THE INTERACTION BETWEEN ANIMAL BREEDING AND CLIMATE CHANGES, CAUSED BY GREENHOUSE GAS EMISSIONS

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Aim. Proper development of animal breeding in the conditions of current global problems and the decrease of anthropogenic burden on environment due to greenhouse gas emissions, caused by animal breeding activity, require the study of interaction processes between animal breeding and external climatic conditions. **Methods.** The theoretical substantiation of the problem was performed based on scientific literature, statistical information of the UN Food and Agriculture Organization and the data of the National greenhouse gas emissions inventory in Ukraine. Theoretically possible emissions of greenhouse gases into atmosphere due to animal breeding in Ukraine and specific farms are calculated by the international methods using the statistical information about animal breeding in Ukraine and the economic-technological information of the activity of the investigated farms. **Results.** The interaction between the animal breeding production and weather-and-climate conditions of environment was analyzed. Possible vectors of activity for the industry, which promote global warming and negative processes, related to it, were determined. The main factors, affecting the formation of greenhouse gases from the activity of enterprises, aimed at animal breeding production, were characterized. Literature data, statistical data and calculations were used to analyze the role of animal breeding in the greenhouse gas emissions in global and national framework as well as at the level of specific farms with the consideration of individual specificities of these farms. **Conclusions.** Current global problems require clear balance between constant development of sustainable animal breeding and the decrease of the carbon footprint due to the activity of animal breeding.

Keywords: natural resources, animal breeding, climate changes, greenhouse gases, dairy cattle breeding, pig breeding.

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Modern organizational forms of animal breeding production are limited by regulatory mechanisms of anthropogenic character or there is simplified application of specific algorithms of agroecosystem functioning which impairs integral understanding of the place and role of each component. As the environment of animals is a complex multi-faceted system, the determination and selection of parameters to estimate the interactions between organisms and the environment requires understanding of the mechanisms of these interactions. In the course of its activity, animal breeding has constant interaction with the environment, thus affecting the formation of its status, and the negative impact is mainly manifested via excessive use of natural resources or the emission of different pollutants into the environmental objects [1, 2].

It is believed that the animal breeding is the factor, directly forming the problem of global warming due to the greenhouse gas emissions which lead to a series of negative changes both in ecological and economic

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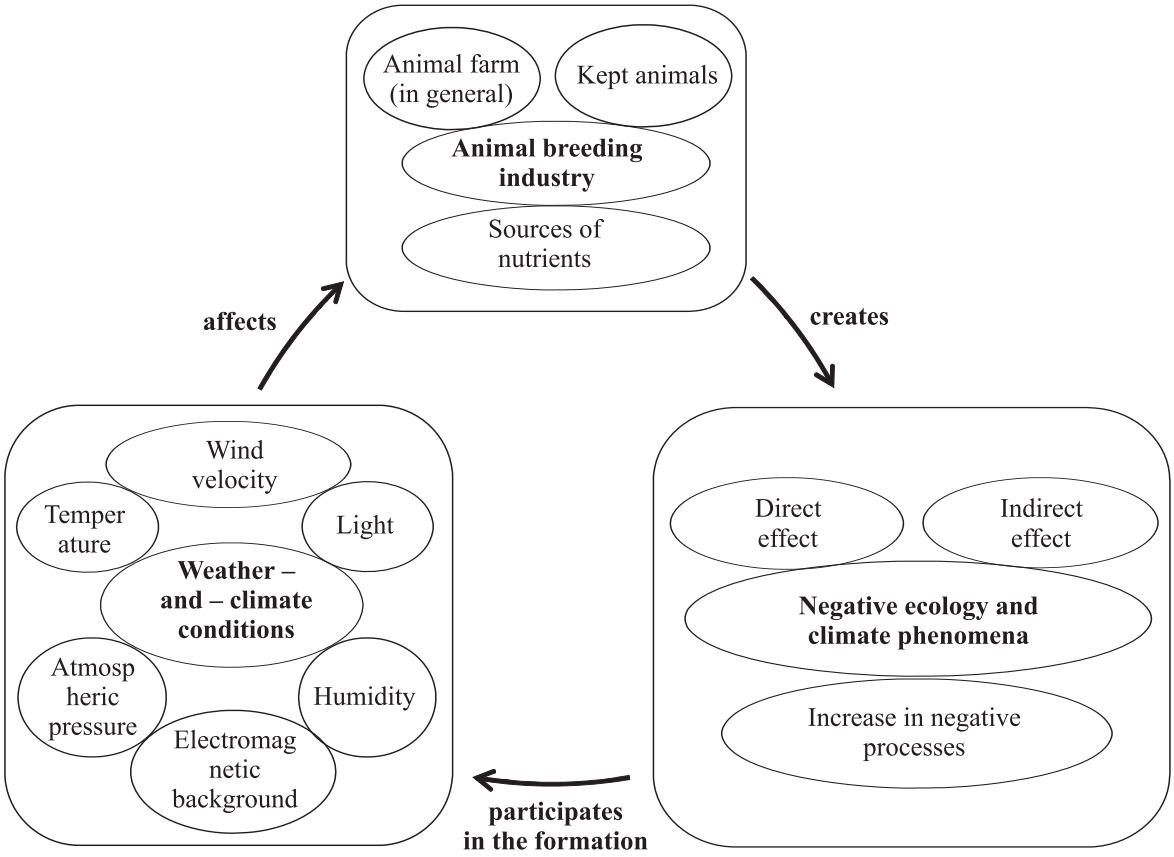

Fig. 1. The scheme of interaction between animal breeding and climatic environmental conditions

fields, as it requires fast adaptation of living organisms and economic activity to new external natural conditions.

The indirect participation of animal breeding in greenhouse gas emissions is manifested via the involvement of additional raw materials and energy resources for animal breeding production: additional use of fossil fuels, extraction of timber in the forests to have more fields for pastures, cultivation of agricultural crops for fodder, impact of farms on soil cover and the lowest atmospheric layer on the adjacent territory, which also influences the microclimate formation in this territory and promotes ecological problems, related to the temperature increase on the Earth [2–15].

THE SPECIFICITIES OF INTERACTION

Along with other kinds of anthropogenic activity, the process of animal breeding production is an integral constituent of the formation of global climatic conditions; in its turn, the vital activity of kept animals and the functioning of the industry depends on weather-and climate conditions of the environment considerably (Fig. 1).

As seen in Fig. 1, the activity of animal breeding, including different elements of technology during the animal breeding production, as well as animals, which are kept, may create negative processes that are involved in the formation of weather-and-climate conditions of the region. This impact is mainly manifested via direct emissions of greenhouse gases (GG) as well as other gases which are the source of secondary formation of GG (nitrogen compounds) both from the animals directly, and from all the stages of the process of disposing organic wastes of animals.

In their turn, weather-and-climate conditions are relevant for keeping the animals, they affect both the vital functions of animals and the activity of the farm in general, namely, growth, development, well-being and performance of animals, the formation of the diet of animals (summer and winter diets are considerably different in traditional technologies of keeping animals, and thus affect the composition of products and wastes), the conditions of keeping wastes, etc. In addition, the weather-and-climate conditions create an indirect effect on animals as these conditions are a required component while cultivating agricultural crops for fodder; the performance and quality of cultivated fodder depend on climatic conditions considerably [16–21].

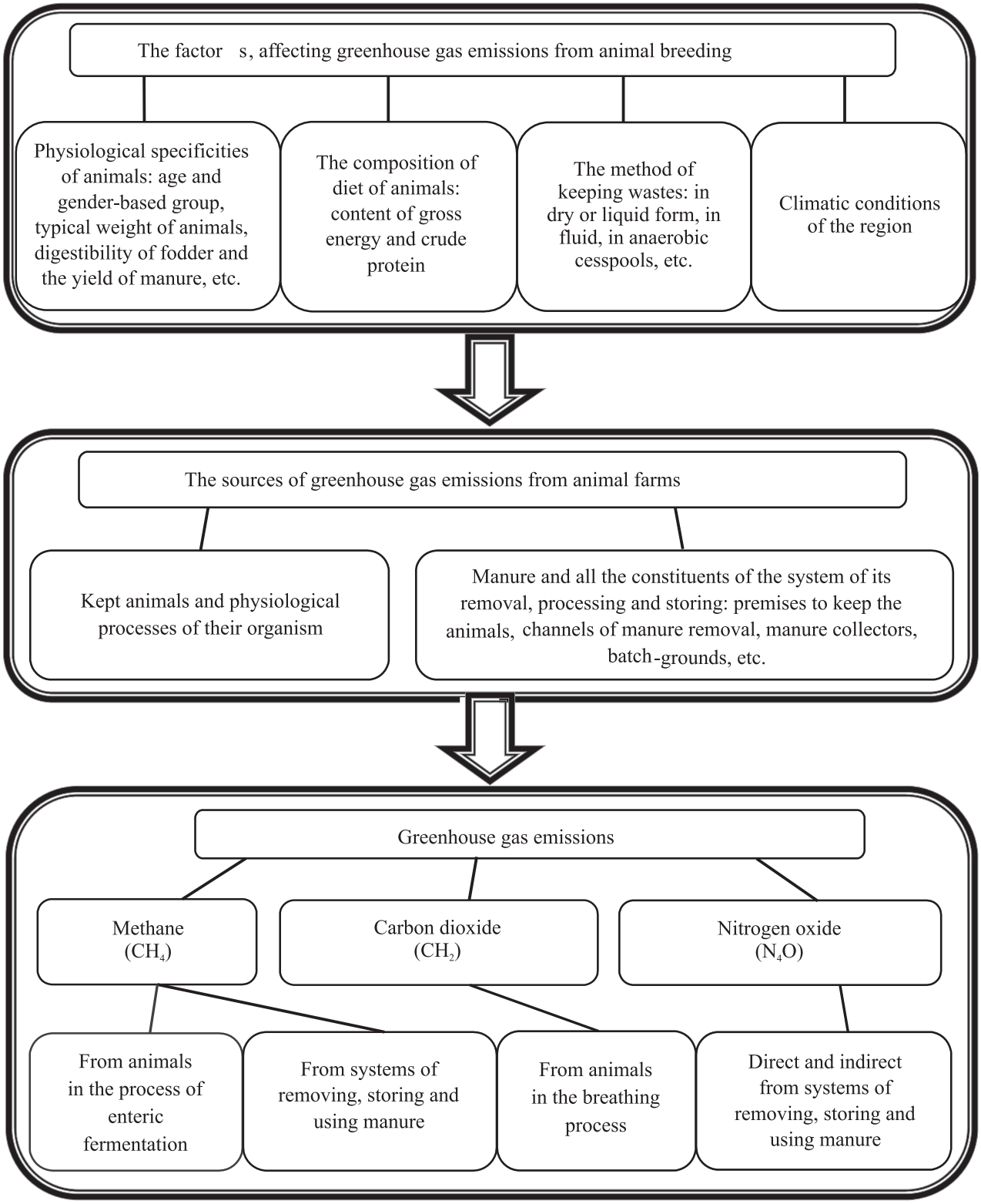

Fig. 2. The scheme of greenhouse gas emissions from animal breeding

Climatic and weather factors, affecting the organism of animals, include air temperature, pressure, humidity as well as vegetative cover, which defines the quantitative and qualitative composition of fodder [17, 18]. First and foremost, the deviation of climatic conditions from optimal ones leads to the change in energy exchange, consumption and use of fodder and thus to the change in the performance of animals [20].

Thus, the optimization of the conditions of keeping animals should consider the environmental conditions – temperature, humidity, air flow velocity, radiative energy, precipitation and individual qualities of animals – species, status of metabolism, hair cover, age, gender, acclimatization, fodder consumption, nervous system disorders, morbidity and individual variation [21].

THE CONTRIBUTION OF ANIMAL BREEDING INDUSTRY TO GREENHOUSE GAS EMISSIONS AT THE GLOBAL, NATIONAL AND FARM LEVELS

One of the most dangerous ecology and climate-related moments in animal breeding production is greenhouse gas emission. It is believed [6, 22, 23] that three main GG are emitted into the atmosphere in the process of keeping animals and animal breeding production: methane (CH_4), nitrogen oxide (N_2O) and carbon dioxide (CO_2) (Fig. 2).

The main reason of the GG formation and its emission into the atmosphere due to animal breeding is the fact that the whole technological process of animal breeding production is accompanied with the use and formation of organic matter, the decomposition of which both in aerobic and anaerobic conditions involves GG emissions. Also, methane is produced due to enteric fermentation, as a side product of microorganisms digesting carbohydrates in fodder. This process mainly occurs in the organism of ruminants and is related to the specificities of their digestive system. Here the amount of methane emissions depends on the gross amount of the energy, consumed by the animal, i.e. the energy, which is spent by animals to maintain the processes of vital activity, growth and development, physical activity, bearing offspring, lactation, tractive force, walking while grazing, growing wool, etc., consumption of this energy (digestibility of the consumed fodder).

According to the estimates of FAO, the total volume of GG emissions from animal breeding in the world amounts to 7.1 Ht in CO_2-equiv. per year, which is 14.5 % of all the anthropogenic emissions, here CO_2 emissions amount to 2 Ht or 5 % of all the anthropogenic emissions, CH_4 – 3.1 Ht in CO_2 equiv. (44 %), N_2O – 2 Ht in CO_2-equiv. (53 %) [2]. It is evident that the animal breeding is liable for over a half of global emissions of nitrogen oxide which is rather harmful for environment. The hazard of this gas lies in the fact that it has high potential of global warming – it is almost 300 times more intense than CO_2, and it also promotes the destruction of stratospheric ozone.

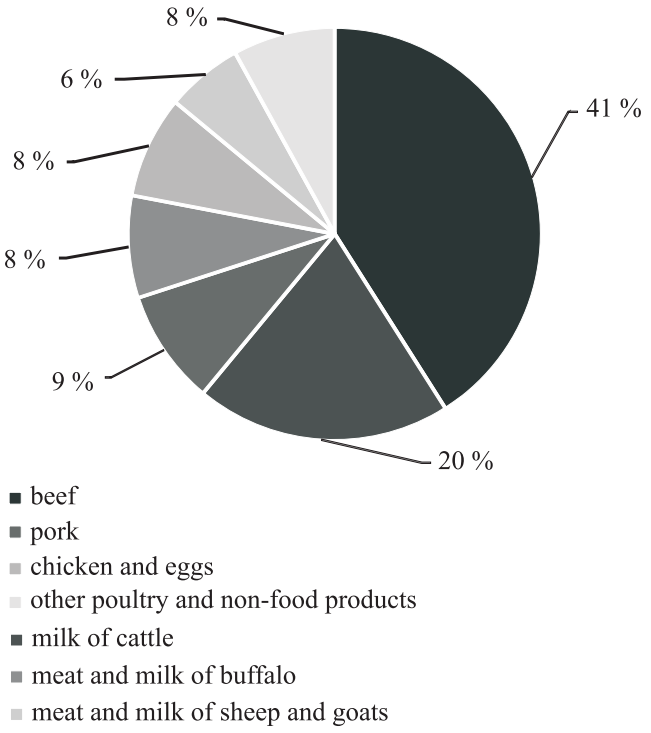

Fig. 3. The distribution of greenhouse gas emissions in terms of animal breeding products in the world, %

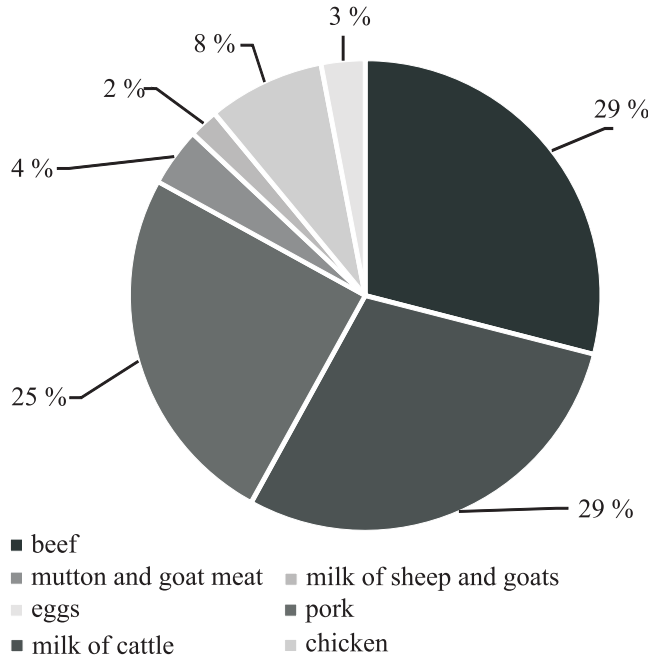

Fig. 4. The distribution of greenhouse gas emissions in terms of animal breeding products in EU, %

The highest share in the structure of GG, emitted by animal breeding, is that of methane ~ 44 %, nitrogen oxide ~ 29 %, carbon dioxide ~ 27 % [2]. The distribution of GG emissions in terms of animal breeding products is demonstrated in Fig. 3 and 4.

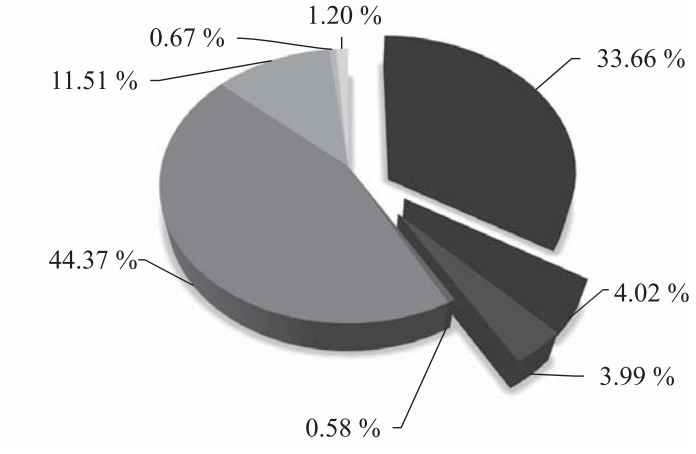

Fig. 5. The structure of greenhouse gas emissions in Ukraine in the Agriculture category

While estimating the life cycles of animal breeding production, including the categories of land use and change of land use, it was established by international researchers in 27 EU member-states using CAPRI method that the highest share of emissions in the structure of animal breeding production is that of beef – 29 % (191 mln t of CO_2-equiv.) and milk of cattle – 29 % (193 mln t CO_2-equiv.), the emissions for pig breeding are 25 % (165 mln t CO_2-equiv.), the rest being that (111 mln t CO_2-equiv.) of poultry breeding – 11 % and milk and meat of sheep and goats – 6% [24].

At the same time the carbon footprint (emissions of GG in CO_2-equiv. while producing a unit of respective production) for the production of different kinds of products is as follows: 22 kg of CO_2-equiv./kg of beef, 20 kg of CO_2-equiv./kg of meat of sheep and goats, 7.5 kg of CO_2-equiv./kg of pork, 5 kg of CO_2-equiv./kg of poultry meat, 3 kg of CO_2-equiv./kg of eggs, 3 kg of CO_2-equiv./kg of milk of sheep and goats and 1.4 kg of CO_2-equiv./kg of milk of cattle. The production of milk of cattle has the lowest carbon footprint [24].

While producing the animal breeding products the highest share of GG emissions is that of beef – 41 %, followed by milk of cattle – 20 %, pork – 9 %, meat of buffalo – 8 %, chicken and eggs – 8 %, meat and milk of sheep and goats – 6 %, the rest – the products of other kinds of poultry breeding and production of non-food products. Here the intensity of emissions per one unit of finished products is as follows: for beef – almost 300 kg of CO_2-equiv. per one kilo of obtained protein, meat of sheep and goats – 165 kg of CO_2-equiv., milk of sheep and goats – 112 kg of CO_2-equiv., milk of cows, chicken and pork – under 100 kg of CO_2-equiv. per one kilogram of protein.

Cattle farming is the most dangerous branch of animal breeding in terms of changes of climatic processes. According to international studies, cattle is responsible for over 60 % of GG emissions in the animal breeding sector. Here the emissions of GG during the cattle production are divided as follows: 45 % – while producing fodder, including land use; 39 % – intestinal fermentation; 10 % – storing and processing of manure, the rest – processing and transportation of products.

The emissions of GG due to animal breeding in Ukraine may be traced using the data of the National inventory which demonstrates the data of the conducted inventory of GG emissions for different kinds of anthropogenic activity. Compared to the basic year of 1990, the emissions of GG due to animal breeding decreased considerably, which is related to the reduction in the number of animals. In 2013 the emission of methane due to intestinal fermentation of animals was 10,727.10 thousand tons of CO_2-equiv., methane from manure – 1,282.26 thousand tons of CO_2-equiv., nitrogen oxide from manure – 1,271.71 thousand tons of CO_2-equiv., which amounted to a total of almost 4 % of all the emissions for all the categories and over 40 % in the structure of agriculture of Ukraine (Fig. 5). These estimates do not take into consideration the share of animal breeding in the category of emissions from agricultural fields – pastures, where manure remains after animals have grazed, and tilled fields, where manure is introduced as an organic fertilizer [23].

The estimated emissions of GG using the average coefficients [22] and statistical data as of November 01, 2016 demonstrate that in Ukraine the highest share of emissions is that of cattle farming – about 84 %, whereas in the structure of conditional livestock, the cattle farming takes 32.4 %, pig breeding – 8 % of GG emissions and 21.9 % in conditional livestock, sheep and goat breeding – 3 % and 1.5 % respectively, poultry breeding – 5 % and 44 % respectively (Fig. 6). Compared to 2013, the structure of methane emission almost did not change: over 84 % was attributed to

cattle farming, almost 12 % – pig breeding, the rest – by other branches

According to our estimates, GG emissions in the natural weight per one conditional head are as follows: cattle – 2.08 t/head/year, pigs – 0.28 t/head/year, sheep and goats – 1.44 t/head/year, poultry – 0.09 t/head/year.

The development of animal breeding in the world mainly occurs due to the intensification of this industry. However, traditional ways of managing animal breeding and the private sector are also a factor. The application of different ways of breeding and technologies of keeping animals have a different impact on the level of environment pollution in general, and on GG emissions in particular.

The analysis and estimation of greenhouse gas emissions from specific farms were conducted by us based on our own calculations, using relevant methods [22] and initial data of the investigated farms of different agroecological zones of Poltava and Ternopil regions (Tables 1, 2, 3). The farms, typical in technologies of managing their activity, specialized in milk and pork production, were selected for the investigation. Taking into consideration a complex of factors, which may influence the intensity of GG emissions, we determined the coefficients of these emissions from separate pig farms, where different technologies of pork production are applied. It is unreasonable to consider the impact of each factor separately as they interact in a complex (Table 1).

Our estimation of total GG emissions for different technologies of pork production demonstrated that the coefficients of these emissions (*i.e.* per one head a year) are quite different for each farm and depend considerably on individual specificities of these farms (Table 1). As the emission of methane due to intestinal fermentation of pigs is insignificant, the main GG emissions were from the systems of manure storing. Here the amount of accumulated manure, its composition and the processes of decomposition in it, accompanied with the emission of methane, nitrogen oxide and other compounds which are a secondary reason of greenhouse gas formation, depended on many factors, the most significant among them being the way of storing the wastes – dry or liquid form or a fluid.

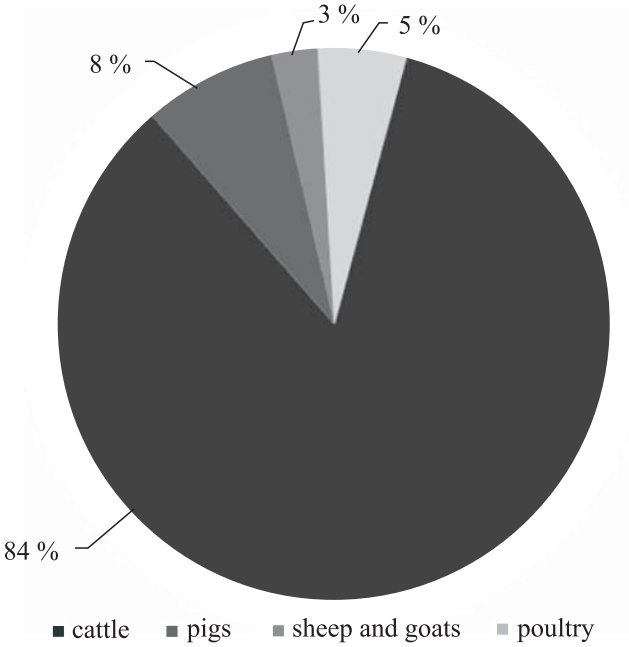

Fig. 6. The structure of greenhouse gas emissions from the main species of animals in Ukraine as of November 01, 2016

It was established that GG emission coefficients are higher compared to farms, which practice the use of water to remove the wastes and keep them in a liquid form. Methane is produced more intensely in anaerobic conditions. However, there is a decrease in the intensity

Table 1. The coefficients of greenhouse gas emissions for different technologies of pig breeding production, kg/head/year

Name of pig farm	The method of keeping wastes	Coefficients of greenhouse gas emissions		
		Natural weigh	CO_2-equivalent	Average global warming potential of emitted gases
State enterprise research farm (AERF) "Stepne"	dry/liquid	7.67	231.01	30.1
AERF named after Dekabristy	dry	2.14	103.16	48.2
Limited liability company (LLC) "Medobory" Agrocompany	dry	1.97	84.12	42.7
Private agricultural enterprise (PAE) Agroprodservice	anaerobic cesspools	26.78	635.35	23.7

of the formation of nitrogen oxide which absorbs infrared radiation much better and thus has more impact on global processes of warming – it has a high global warming potential (GWP). Our calculations determined the average GWP for two GG, emitted from pig farms. It was established that it was the highest for dry storing of wastes and for higher content of protein in the given fodder (AERF named after Dekabristy), and it was the lowest for the removal of wastes using water and keeping them in anaerobic cesspools (PAE Agroprodservice).

Therefore, the intensity of GG emissions at the level of a specific farm depends considerably on individual economic-technological specificities of the farm, which combines different links of the technological process of production as well as the level of application in the industrial process of methods and recommendations which allow increasing the production with optimal use of ecological resources. The distinguishing criteria for GG production during animal breeding production are as follows: species, age and gender-related group and number of animals; method and duration of keeping animals; amount of given fodder and its composition for each category of kept animals; the level of digestibility of given fodder, which depends both on the nutrition value of the fodder and on the ability of the organism of animals to digest it; performance of animals and intensity of enhancing economically useful features; amount of accumulated wastes at the enterprise for the investigated period of time and the presence of non-digested consumption products in it; way and term of keeping wastes; external temperature regime.

One of the main factors of forming global climate changes is the pollution of atmospheric air with the emissions from cattle as the main source of methane emission, which is mainly formed due to intestinal fermentation, while emissions from the manure of cattle are much less considerable. A negative moment may also be found in the fact that the emission of methane due to intestinal fermentation is practically not subject to any regulation, contrary to the emissions of methane from manure masses (where it could be caught, if desired, as manure is mostly kept in one place in large quantities, except for the manure, left on the pastures).

Taking into consideration a complex of factors, which may influence the intensity of GG emissions, we determined the coefficients of these *emissions from cows in separate farms, where different technologies of milk production* are applied. It is unreasonable to consider the impact of each factor separately as they interact in a complex (Tables 2, 3).

The total emissions of GG (even with the consideration of all the factors, some of which increase and some decrease the intensity of emissions) are still the highest in the farms with a greater number of kept cows both in the natural weight and in CO_2-equivalent. Thus, it is more reasonable to characterize the intensity of emissions as per one head a year and as per one unit of produced products.

Table 2. The greenhouse gas emissions from all the livestock of cows in the investigated farms, kg/day

Greenhouse gases	Farms					
	Private agricultural enterprise (PAE) Horyn Agrocompany	Private lease enterprise (PLE) Ivanivske	PAE Dzvin	PE AC Medobory	LLC Halychyna	Private enterprise (PE) Progress K
CO_2 – from animals	596.56	437.79	225.60	399.09	152.6	134.77
CH_4 – total	240.85	187.60	78.14	136.55	52.12	45.98
from intes.ferm.	230.34	179.40	74.15	130.59	49.84	43.98
from manure	10.51	8.19	3.99	5.96	2.28	2.00
CO_2-equivalent	5540	4315	1797	3141	1199	1058
N_2O – total	2.43	1.8	0.60	0.75	0.29	0.25
directly from manure	1.89	1.4	0.38	0.47	0.18	0.16
indirectly from manure	0.54	0.4	0.23	0.28	0.10	0.1
CO_2-equivalent	719	532	178	221	84	75
CH_2 – total	6856	5285	2201	3761	1436	1268

The cumulative estimation of all the factors, which impact the level of emissions, demonstrates that as per one head the highest amount of emissions was in PLE Ivanivske (whereas in terms of total emissions of GG the first place was taken by PAE Horyn) – as PLE Ivanivske has somewhat higher average live bodyweight of cows and the highest yield of milk, which increases the gross consumed energy and emissions of methane from intestinal fermentation.

Although PE AC Medobory, LLC Halychyna and PE Progress K have additional expenses of energy for grazing, they have lower yield of milk (lower expenses of energy for lactation) and lower emission of nitrogen oxide from manure (30 % of which is left on the pastures), which, as a result, leads to the decrease in the emission of all GG in CO_2-equivalent per one cow a year.

If the intensity of emissions per one unit of products is selected for the estimation criterion, the highest amount of GG emissions per 1 kg of milk is that of PE AC Medobory (the lowest performance), and the lowest amount of GG emissions per 1 kg of milk – in PLE Ivanivske (the highest performance).

Thus, high yields of milk require additional expenses of energy (fodder) for lactation which results in the increase in methane emissions due to enteric fermentation and due to manure, and keeping these cows in stalls leads to the increase in nitrogen oxide from manure. However, the emissions of all GG per unit of produced products (1 kg of milk) are considerably inferior to the farms where the yield of milk is much lower.

The analysis of the obtained calculations of probable emissions of greenhouse gases from dairy cows indicates that the amount of emissions depends on the following factors: live bodyweight of cows; yield of milk and its fat content; way of keeping animals and keeping wastes.

During stall-keeping, all the manure is kept in one place in a dry form, the emissions of methane and nitrogen oxide are calculated based on it.

Keeping in stalls and on ground runs affects the increase in the share of direct emissions of nitrogen oxide, but also the decrease in the emissions of methane and indirect emissions of nitrogen from manure in the sites, as about 30 % of manure is left there.

Stall-camp keeping is characterized by the fact that the emissions of methane from manure in the pasture are much less considerable, and direct and indirect emissions of nitrogen oxide are not calculated at all, as this nitrogen will belong to the category of "emissions from pastures" where about 30 % of manure is left. However, the share of methane increases during grazing, when it is formed due to intestinal fermentation, as the animals also need the energy to maintain their activity during grazing.

PROBLEMS OF ANIMAL BREEDING DUE TO THE CHANGE IN CLIMATIC CONDITIONS

Stable development of animal breeding depends on external factors and conditions of keeping and

Table 3. The greenhouse gas emissions from one cow in investigated farms per year

Farms	Livestock of cows, heads	Yield of milk, kg/head/ year	The way of keeping animals	Greenhouse gas emissions, kg/head/year				
				CO_2	CH_4	N_2O	CO_2-equiv.	per 1 kg of milk
(PAE) Horyn Agrocompany	664	6522	S*: stall-camp W**: stall-tie-up	327.93	132.40	1.34	3768	0.578
PLE Ivanivske	480	7150	S: stall-camp W: stall-tie-up	332.14	142.70	1.37	4017	0.562
PAE Dzvin	230	5035	S: stall W: stall	358.02	124.00	0.96	3493	0.694
PEAC Medobory	430	4108	S: stall-camp W: stall-tie-up	338.76	115.90	0.68	3204	0.780
LLC Halychyna	168	4237	S: stall-camp W: no tie-up	331.54	113.23	0.62	3119	0.736
PE Progress K	150	3967	S: stall-camp W: stall-tie-up	327.93	111.89	0.61	3083	0.777

Note. S* summer; W** winter

breeding animals. At present agricultural animals, like all the living organisms of the planet, suffer from changes, occurring in the environment. Along with different ecological problems, the researchers also note the negative impact of the increase in the air temperature on the development of animal breeding which may be manifested in the following ways: stress reactions of the organism to the temperature increase and thus the decrease in performance; increase in the risk of exposure to diseases of animals due to the fact that increased temperatures promote the increase in the area of spreading the agents of diseases and due to the decrease in the period of grazing, required for health improvement of the cattle and the use of natural fodder; the decrease in genetic diversity of species due to their inability to adapt to external conditions (genetic erosion); side effects due to the negative impact of climate changes on the status of resources, required for normal vital functions of animals – water, quality of fields and the conditions of fodder, the impairment of vegetative biodiversity of pasture, etc. [1, 2, 18, 20].

THE WAYS OF SOLVING PROBLEMS OF THE DEVELOPMENT OF ANIMAL BREEDING IN THE CONDITIONS OF GLOBAL CLIMATE CHANGE

Thus, taking into account current global problems, the development of the animal breeding industry should occur with the consideration of the problem of limited natural resources, namely, it is extremely urgent to keep the balance between ensuring sustainable development of animal breeding, achieving food safety, decreasing the level of poverty and shortage of food products and decreasing the ecological footprint and using natural resources in a rational way.

One of the leading tasks should be the search for ways of adaptation and resistance of animals to negative external weather-and-climate factors. This is the work of geneticists-breeders in determining adaptation features of specific individuals as well as genotypes; measures of technologists of creating comfortable conditions of keeping animals and selection of relevant technologies of keeping animals in the conditions of climate change; territorial approach towards the location of farms and determination of the area of spreading the species of animals. It is believed that one of the promising trends of adapting the animal breeding to climate changes and solving issues with food is preservation and expansion of genetic diversity of animals. Here the basis for adaptation selection may be found in the aborigine species, genetically adapted to the environmental conditions of a specific region.

Екологічні особливості взаємодії тваринництва із змінами клімату, викликаними викидами парникових газів

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Ціль. Для належного розвитку галузі тваринництва в умовах глобальних проблем сьогодення та зниження антропогенного навантаження на навколишнє природне середовище через викиди парникових газів від діяльності тваринництва актуальним є вивчення процесів взаємовідносин тваринництва із зовнішніми кліматичними умовами. **Методи**. Теоретичне обґрунтування проблеми проведено на основі літературних джерел, статистичної інформації Продовольчої і сільськогосподарської організації ООН та даних Національного кадастру викидів парникових газів в Україні. Теоретично можливі викиди у атмосферу парникових газів від тваринництва в Україні та окремих господарств розраховані за міжнародною методикою із використанням статистичної інформації діяльності тваринництва в Україні та господарсько-технологічної інформації діяльності досліджуваних господарств. **Результати**. Проаналізовано взаємозв'язок виробництва продукції тваринництва із погодно-кліматичними умовами середовища. Визначено можливі вектори дії галузі, що сприяють глобальному потеплінню та негативним процесам, що пов'язані з цим. Охарактеризовано основні чинники, що впливають на утворення парникових газів від діяльності підприємств з виробництва продукції тваринництва. На основі літературних джерел, статистичних даних та власних розрахунків проаналізовано роль тваринництва у викидах парникових газів в глобальному, національному масштабах та на рівні окремих господарств з урахуванням індивідуальних господарсько-технологічних особливостей цих господарств. **Висновки.** В умовах глобальних проблем сьогодення необхідно дотримуватися збалансованості між забезпеченням стійкого розвитку тваринництва та зниженням вуглецевого сліду внаслідок діяльності тваринництва.

Ключові слова: природні ресурси, тваринництво, зміни клімату, парникові гази, молочне скотарство, свинарство.

Экологические особенности взаимодействия животноводства с изменениями климата, вызванными выбросами парниковых газов

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Цель. Для надлежащего развития отрасли животноводства в условиях глобальных проблем современности и снижения антропогенной нагрузки на окружающую среду из-за выбросов парниковых газов от деятельности животноводства актуальным является изучение процессов взаимоотношений животноводства с внешними климатическими условиями. **Методы.** Теоретическое обоснование проблемы проведено на основе литературных источников, статистической информации Продовольственной и сельскохозяйственной организации ООН и данных Национального кадастра выбросов парниковых газов в Украине. Теоретически возможные выбросы в атмосферу парниковых газов от животноводства в Украины и отдельных хозяйств рассчитанны по международной методике с использованием статистической информации о деятельности животноводства в Украине и хозяйственно-технологической информации о деятельности исследуемых хозяйств. **Результаты.** Проанализирована взаимосвязь производства продукции животноводства с погодно-климатическими условиями среды. Определены возможные векторы действия отрясли, которые способствуют глобальному потеплению и негативным процессам, связанным с этим. Охарактеризованы основные факторы, влияющие на образование парниковых газов от деятельности предприятий по производству продукции животноводства. На основании литературных источников, статистических данных и собственных расчетов проанализирована роль животноводства в выбросах парниковых газов в глобальном, национальном масштабах и на уровне отдельных хозяйств с учетом индивидуальных хозяйственно-технологических особенностей этих хозяйств. **Выводы.** В условиях глобальных проблем современности необходимо соблюдать сбалансированность между обеспечением устойчивого развития животноводства и снижением углеродного следа в результате деятельности животноводства.

Ключевые слова: природные ресурсы, животноводство, изменения климата, парниковые газы, молочное скотоводство, свиноводство.

REFERENCES

1. *Steinfeld H, Gerber P, Wassenaar T, Castel V, Rosales M, de Haan C* Livestock's Long Shadow: Environmental Issues and Options. Food and Agriculture Organization of the United Nations. Rome. 2006:390 p.
2. *URL*: http://www.fao.org/news/story/en/item/197623/.
3. *Climate* Change 2013. The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change: Summary for Policymakers. IPCC. Switzerland. 2013 (October); 27 p. URL: http://www.climatechange 2013.org.
4. *Management* strategies in agriculture and forestry for mitigation of greenhouse gas emissions and adaptation to climate variability and climate change. Technical Note (202). WMO (969). 2004:165 p.
5. *Metzger MJ, Bunce RGH, Jongman RHG, Milcher CA, Watkins JW.* A climatic stratification of the environment of Europe. *Global Ecol. Biogeogr*. 2005;**14**:549–63.
6. *European* Commission. Analysis of methodologies for calculating greenhouse gas and ammonia emissions and nutrient balances. Publications Office of the European Union. Luxembourg. 2011:59 p.
7. *Goodland R, Anhang J.* Livestock and Climate Change: What if the key actors in climate change are cows, pigs, and chickens? World Watch. 2009; (November/ December):10–19.
8. *MacLeod M, Gerber P, Mottet A, Tempio G, Falcucci A, Opio C, Vellinga T, Henderson B, Steinfeld H.* Greenhouse gas emissions from pig and chicken supply chains: A global life cycle assessment. Food and Agriculture Organization of the United Nations (FAO). Rome. 2013:172 p.
9. *Greenhouse* Gas Emissions from the Dairy Sector: A Life Cycle Assessment. A report prepared by: Food and Agriculture Organization of the United Nations (FAO), Animal Production and Health Division. Rome. 2010:94 p.
10. *Gerber PJ, Steinfeld H, Henderson B, Mottet A, Opio C, Dijkman J, Falcucci A, Tempio G.* Tackling climate change through livestock. A global assessment of emissions and mitigation opportunities. Food and Agriculture Organization of the United Nations (FAO). Rome. 2013:115 p.
11. *Nykyforuk O.* The impact of complex factors on greenhouse gas emissions from pigs. *Visnyk ahrarnoi nauky*. 2014;(5):73–5.
12. *Zhukorskyi O, Nykyforuk O, Boltyk N.* Emission of greenhouse gases from cows on a milk producing farm. *Visnyk ahrarnoi nauky*. 2015;(5):45–8.
13. *Meat* Eaters Guide to Climate Change + Health. Environmental Working Group: Report. By K. Hamerschlag, EWG Senior Analyst. 2011:25 p.

14. *Herrero M, Havlik P, Valin H, Notenbaert A, Rufino MC, Thornton PK, Blümmel M, Weiss F, Grace D, Obersteiner M.* Biomass use, production, feed efficiencies and greenhouse gas emissions from global livestock systems. *Proc Natl Acad Sci.* 2013;**110**(52):20888–93.
15. *Zhukorskyi O, Moklyachuk L, Nykyforuk O.* Emissions of air pollutants from local livestock industry in Ukraine. *Agricultural science and practice*. 2014;**1**(2):39–44.
16. *Listwan JP.* Globalne ostrzezenie: zmiany klimatyczne a dobrostan zwierzat hodowlanych. Raport stowarzyszenia Compassion in World Farming. *Klub Gaja*. 2009:58 p.
17. *Zhukorskyi O.* Directions of biometeorology studies in animal breeding. *Agroecological j.* 2010;(2):87–93.
18. *Seifi HA, Mohri M, Shoorgi E, Farzaneh N.* Using hematological and serum biochemical findings as prognostic indicators in calf diarrhea. *Comp. Clin. Pathol.* 2006;15(3):143–47.
19. *Hartung J.* Contribution of animal husbandry to climatic changes. Interactions between climate and animal production. Editors: N. Lacetera, U. Bernabucci, H.H. Khalifa, B. Ronchi A., Nardone EAAP Technical Series. Wageningen Academic Publ., Wageningen. The Netherlands. 2003; 7: 73–80.
20. *Johnson HD.* Aspects of animal biometeorology in the past and future. *Int. J. Biometeorol.* 1997;**40**(1):16–8.
21. *Mader TL, Johnson LJ, Gaughan JB.* A comprehensive index for assessing environmental stress in animals. *J. Anim. Sci*. 2010;**88**(6): 2153–65.
22. *Eggleston HS, Buendia L, Miwa K, Ngara T, Tanabe K.* [eds]. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. IPCC, IGES. Japan. 2006; Vol.4, Ch.10; 89 p.
23. *Ukraine's* greenhouse gas inventory 1990–1913. Kiev. 2015:558 p.
24. *Leip A, Weiss F, Wassenaar T, Perez I, Fellmann T, Loudjani Ph, Tubiello F, Grandgirard D, Monni S, Biala K.* Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (GGELS): Final report. European Commission. Joint Research Centre. 2010: 23 p.