

## **REPORT ON INDUSTRIAL PIG-FARMS IN THE BALTIC SEA CATCHMENT AREA OF BELARUS**

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The report is based on field trips and interviews with representatives of management of industrial pig farms in Vitebsk, Grodno and Brest regions of Belarus, representatives of Vitebsk regional committee of natural resources and protection of the environment, Grodno regional committee of natural resources and protection of the environment, Association Vitebskzhivprom, Ministry of Agriculture and Food of Belarus, Institute of melioration and grass farming of National Academy of Sciences of Belarus.

Also data from a number of statistical and scientific reports and articles were used during preparation of the current report.

The chapter on legal assessment of management of wastewater from pig farms was prepared by attorney **Grigoriy Fedorov**.

The GIS map with locations of industrial pig farms in the Baltic Sea catchment area in Belarus was prepared by **Maxim Yermohin**.

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- Officials in regional organizations of the Ministry of Natural Resources and Protection of the Environment;
- Officials in the Ministry of Agriculture and Food;
- Officials in association Vitebskzhivprom.

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## Executive summary

Pork production is one of the important fields of agriculture in Belarus. Annually, around 2.7 millions of pigs are bred in Belarus, and around 400 000 tons of pork were produced in 2008.

According to available statistical data, there are 107 large-scale industrial pig farms in Belarus, all of them are state owned.

Annually, Belarusian industrial pig farms produce approximately 20-22 million tons of waste water. The main sources of pollution of surface and underground water are manure sedimentation tanks, liquid manure storage ponds and agricultural fields for irrigation.



Typical industrial pig farm, Vitebsk region

The use of clarified liquid manure for irrigation on designated fields, leads to the surface run-off with corresponding impact on open water sources. On many industrial pig farms, construction plans made provisions for direct waste water discharge into open water sources during spring tide, which also can lead to negative consequences on the environment. Such cases are, however, quite rare at the moment.

There are no environmental permits, which should be obtained by industrial pig farms on regular basis. However, all pig farms, as large water consumers are obliged to apply for water usage permits, which are issued by the Ministry of Natural Resources and Protection of the Environment, or its regional committees. Such permit is usually issued for the period of several years (2-4) and determines the amount of water, which can be used by the pig farm for its production purposes. But it does not regulate the content of nitrogen or phosphorous in the waste water.

The Belarusian part of the Baltic Sea catchment area is formed by basins of 3 major rivers – Zapadnaya Dvina/Daugava in Vitebsk region, Neman/Nemunas in Grodno region, and Zapadnyi Bug in Brest region.

### Findings

There are 56 large scale industrial pig farms, ranging from 3000 to 108 000 pigs in the Baltic Sea catchment part of Belarus (Brest, Grodno, and Vitebsk regions) with about 890 000 pigs.

There are several large scale pig farms (e.g. “Zapadnyi”, Brest region, “Mostovskiy kumpyachok”, Grodno region, “Severnyi”, Vitebsk region, and others) which have effective systems of manure management and utilization, including biogas reactors, biological cleaning, and bioengineering constructions, which allow to mitigate the negative environmental impact of manure.

There are quite many pig farms with significant environmental impact on the environment and the water resources.

The report also contains recommendations for relevant Belarussian and Baltic Sea region authorities and institutions.

## Introduction

Pork production is one of the important fields of agriculture in Belarus. Annually, around 2.7 millions of pigs are bred in Belarus, and around 400 000 tons of pork were produced in 2008.

Apart from playing an important role in agriculture and economy, pork production has a significant impact on the environment, and especially water resources. This is particularly important for Belarus – a country which is very rich in different water resources, lakes and rivers. Being a part of the Baltic Sea catchment area, Belarus plays a role in forming the ecological status of the whole Baltic marine environment.

The environmental situation in the Baltic Sea has drastically changed over recent decades. Human activities both on the sea and throughout its catchment area put a rapidly increasing pressure on marine ecosystems. Of the many environmental challenges, the most serious and difficult to tackle with conventional approaches is the continuing eutrophication of the Baltic Sea. The eutrophication is caused by excessive inputs of nitrogen and phosphorous which mainly originate from inadequately treated sewage, agricultural run-off and airborne emissions from shipping and combustion processes. Eutrophication leads to problems such as intensified algae blooms, murky water, oxygen depletion and lifeless sea bottoms<sup>i</sup>.

The agricultural sector is considered the largest non-point source of eutrophication of the Baltic Sea. Therefore changes in agriculture production methods and practices in countries around the Baltic Sea are keys to reduce the run-off of phosphorous and nitrogen. About 75% of the nitrogen load and at least 95% of the phosphorous load enter the Baltic Sea via rivers or as direct waterborne discharges<sup>ii</sup>.

Animal intensive farming causes a number of hazards, which may have a negative effect on the condition of the environment. This possible influence concerns all components of the environment: air, soil and – the most important for the Baltic Sea region – water (surface water, subsoil water, rainwater). The negative impact depends on the design and size of the animal production. The most negative impact on the environment is caused by farms without bedding, most often used in swine production. Industrial pig rearing farms with non-bedding production system results in production of enormous amounts of liquid manure<sup>iii</sup>.

The aim of the report was to analyse the situation with manure management on large industrial pig farms in the Baltic Sea catchment area in Belarus.

In the first part of the report the general situation with all industrial pig farms in Belarus, including available environmental regulations and environmental impact of industrial pig farms, are being presented. This information covers farms located in the Baltic Sea catchment area of Belarus.

The second part of the report specifically points out the situation with industrial pig farms in the Baltic Sea catchment part of Belarus, including available practices of manure management.



## Overview of the situation with industrial pig farms in Belarus

Pig-breeding is one of the important kinds of agriculture in Belarus. Pork production takes the leading place in the meat market of Belarus.

In 2003 there were about 3.3 million of pigs, including about 2.2 million in agricultural enterprises (66.7%) and 1.1 million in farms with contracted staff and small private agricultural units<sup>iv</sup>.

On 1<sup>st</sup> of April 2008 there were 2.7 million of pigs<sup>v</sup> in all farms, including private household farms.

According to the governmental plan, 395 000 tons of pork should be produced in Belarus in 2008, which is 10.5 % more than in 2007<sup>vi</sup>.

At present the majority of pork is produced on large industrial pig farms (complexes), located in different regions of Belarus (up to 80%).



Zheludok pig farm, Grodno region

According to available statistical data<sup>vii</sup>, there are 107 large-scale industrial pig farms in Belarus, including the following:

- 3 very large scale industrial pig farms – each on 108 000 places (Borisovskiy, Sozh, Belovezhskiy)
- 9 large scale industrial pig farms – each on 54 000 places
- 43 large scale industrial pig farms – each on 24 000 – 27 000 places
- 52 large scale industrial pig farms – each on 12 000 places

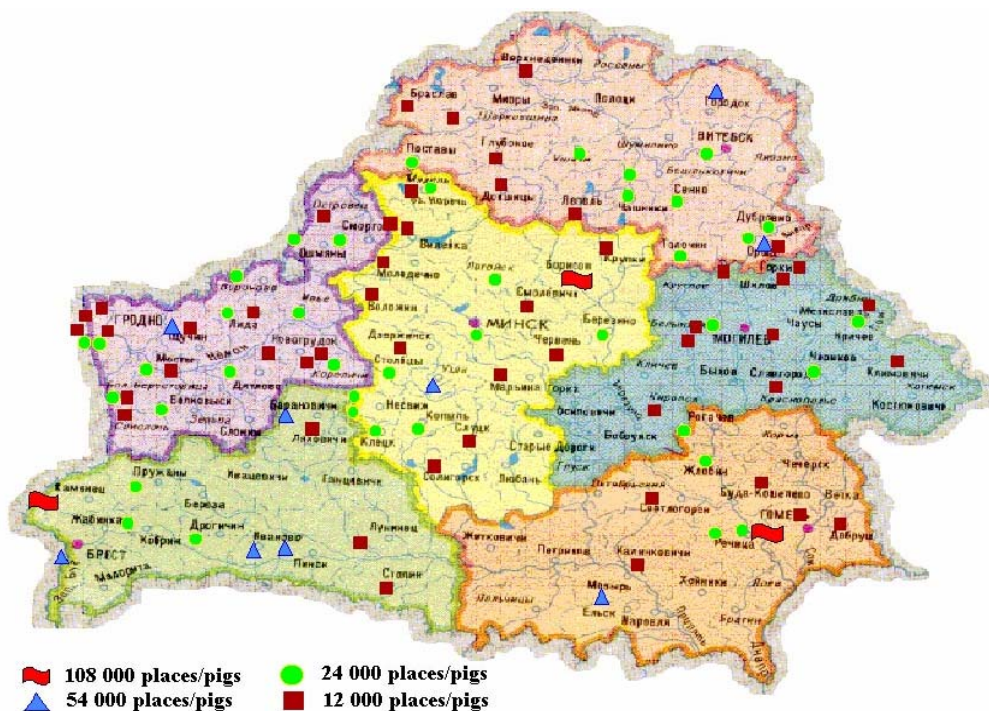


Fig. 1. Location of industrial large-scale pig farms in Belarus<sup>viii</sup>.

Annually, large-scale industrial pig farms produce 20-22 million of tons of wastewater and manure, which requires significant treatment and management to minimize possible harm for the environment<sup>ix</sup>.

All industrial pig farms are state-owned and their activities are guided by regulations of the Ministry of Agriculture and Food of Belarus and its regional bodies.

Some industrial pig farms which belong to the republican property are managed on the national level, and others are directly managed by the regional and local committees of agriculture and food.

12 industrial pig farms, which belong to the republican property, are united in the association Glavzhivprom, which is a state enterprise, managing large industrial pig and cattle farms.

Pig farms on regional levels are united in regional associations, e.g. Vitebskzhivprom. The main tasks of these associations are to provide technical, informational, and methodological support to pig farms.

All industrial pig farms in Belarus are conventional, and there are no organic pig farms at the moment.



Middle-scale industrial pig farm, Grodno region

Apart from large-scale industrial pig farms, there are 27 middle-scale industrial pig farms with 3000-6000 pigs.

There is also a significant number of small-scale pig farms (up to 1000 pigs or 100 sows) and private households, where owners keep pigs.

In 2009-2010 30 new pig farms are planned to be built in different regions of Belarus<sup>x</sup>.

## **Environmental and legal regulations of possible locations for animal farms and complexes**

The legislation of Belarus considers animal farms and complexes as objects that potentially can cause considerable harm to the environment, and especially water objects. The reason is the danger connected to waste water from farms and complexes.

According to the Article 41 'The Requirements in the Sphere of Protection of the Environment at Exploitation of Objects of Agriculture' of the Law of the Republic of Belarus 'On Protection of the Environment', legal entities and citizens that carry out the exploitation of objects of agriculture are obliged to carry out measures on protection of lands (including soils), bowels, surface and underground waters, atmosphere air, forests, objects of flora and fauna, particularly protected natural territories, as well as typical and rare natural landscapes. Furthermore, legal entities and individual entrepreneurs who carry out production and processing of agricultural products and also storage of organic fertilizers must have sanitary protection zones around the industrial objects and purifying constructions providing the fulfilment of requirements in the sphere of protection of the environment.

There are a few important regulations in the current Water Code of Belarus. According to Article 44, the use of water objects for agricultural needs is carried out on the basis of both general and special water use. Article 61 says that the use of water objects for waste water treatment can be realized only with the special water use permit issued by a national state administrative body, responsible for usage of natural resources and environmental protection or its territorial bodies in concordance with the bodies of the state sanitary inspection and other governing state institutions that are interested. Waste water draining using the relief of the landscape (gullies, ravines, quarries, bogs) is completely forbidden. Waste water draining into water objects is allowed, unless the consequence is the excess of the level of maximum permissible concentration



of substances in a water object, or/and provided that sewage is purified to fixed limits by a water user (Article 62).

**It should be noticed that in existing practice, taking organic substances off industrial animal farms and complexes to fields is considered to prevent pollution of water objects, especially when purification plants are out of repair or absent on farms and complexes.**

One of the most important factors that should be taken into account in the present content, is the legal restrictions imposed by water protection policy of water protection areas and coastal (riverside, lakeside) areas. Coastal areas form part of water protection areas, though they are characterized by a stricter water protection policy. The abovementioned policy is established in the Water Code and the Regulations 'On Rules of Establishing the Sizes and Borders of Water Protection Areas and Coastal Areas of Water Objects and the Policies of Agricultural and Other Activities', which is approved by Decree of the Council of Ministers of the Republic of Belarus No. 377 dated March 21, 2006. According to Article 77 of the Water Code, it is forbidden to establish temporary summer animal farms, animal farms and complexes, sewage ponds, fields irrigated with untreated sewage and burial ground of cattle within the water protection area.

The sizes and borders (width) of water protection areas and riparian areas, as well as the policies of economic and other activities, are determined in projects of water protection areas and riparian areas, which are worked out in view of existing environmental conditions, the character of anthropogenic load and the borders of prohibited forest belts. Local executive and regulatory bodies (executive committees) act as the customers of project work out. They also ratify these projects after having submitted them to the approval of the bodies exercising state sanitary control, State Inspectorate for Fauna and Flora Protection under the President, corresponding regional or Minsk city services of land use planning and surveying, Ministry of Forestry, and after having received favourable State environmental impact assessment. Local executive committees have already taken corresponding decisions in many regions of Belarus. For example, the decision of Khoyniki regional executive committee, dated October 9, 2006, No. 1359 'On ratification of minimum sizes and borders of water protection areas and coastal areas of water objects'. At the same time established water protection policy of water protection areas and coastal areas corresponds to the requirements of the Water Code.

'Veterinary and sanitary regulations of milk-commercial farms belonging to the organizations that carry out milk production activities', approved by Decree of the Ministry of Agriculture and Foodstuffs of the Republic of Belarus No. 16 dated March 17, 2005, are of great importance. Article 17 of these regulations says, 'territory for the location of premises of milk-commercial farms is chosen in accordance with current projects of district planning, the plan of their regional location, maintaining zoo-veterinary gaps, sanitary protection zones and considering the opportunity of manure and manure sewage treatment and utilization, the prospects of the extension of populated areas and industrial enterprises of the region at the beginning of the construction that is at the design stage'.

It is said in Article 25 that 'building of manure reservoirs must be carried out in accordance with the current normative and technical documentation. The territory of purification plants must be fenced, planted with trees and shrubs, equipped with modern amenities, and there must be a paved access road and passages. Treatment plants must be established before milk-commercial farms are put into operation. Systems of liquid manure removal must ensure timely excrement removal from cow-sheds, maximum cleanness of stock-raising facilities with the minimum consumption of pure water, resources and man-hours. Liquid manure must be disinfected by one of the possible means – long term storage, chemical or biological treatment- on each milk-commercial farm. Manure from milk-commercial farms adversed on tuberculosis and brucellosis are disinfected according to current directions for disinfecting manure in organizations that are adversed on tuberculosis and brucellosis'.



Inside the pig farm

The sizes of sanitary protection zones are in turn determined in accordance with the requirements of Sanitary Rules and Standards 10-5 of the Republic of Belarus 'Sanitary Classification of Enterprises, Constructions and other Objects. Sanitary Protection Zones'.

The sanitary protection zone is 1000 meters for pig-breeding complexes with 12000 pigs and more, battery farms with more than one million broilers and more than one hundred thousand layer hens and also cattle complexes with 3000 head and more.

The sanitary protection zone is 500 meters for pig farms with less than 12000 pigs.

The sanitary protection zone is 300 meters for cattle farms (of all specializations), sheep-breeding, horse-breeding with less than 3000 head and cattle summer farms as well as for poultry farms with less than one million broilers a year, or less than 100 000 layer hens.

It should also be mentioned that according to the Aarhus Convention and the Instruction 'On procedure of environmental impact assessment of planned economic and other activities in the Republic of Belarus', approved by Decree of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus No. 30 dated June 17, 2005, growing-finishing complexes with more than 2000 pigs a year, more than 2000 head of cattle a year and poultry farms with a capacity of more than 40 000 birds a year. Also fur-farming complexes are included in the list of objects that require environmental impact assessment (EIA) including public hearings when being designed.

## Environmental impact of industrial pig farms

Majority of industrial pig farms are significant sources of pollution of neighbouring environment.

Each pig farm emits some amount of ammonia, hydrogen sulphide, fodder dust, nitrates, phosphates and other.

The negative impact of (mainly pig) industrial rearing can be defined as<sup>xi</sup>:

- **air pollution** – the anaerobic fermentation, taking places in manure, causes pollution of air with such gases as ammonia, hydrogen sulfides, carbonyl compounds, amines, mercaptan, dinitrogen monoxide etc.. The gases cause offensive odour, danger for human health (e.g. pernicious effect on air-stream mechanism transformation of haemoglobin into hematine, plugged nose, lacrimation, headache, stress). Content of organic compounds in the atmospheric air on the territory of pig farm can be 40-50 mg/m<sup>3</sup>, and on the distance of 1 km – 18.6 mg/m<sup>3</sup>. Offensive odour can be spread on the distance of 5-7 km<sup>xii</sup>.
- **microbiological pollution** – sanitary danger (microbiological pollution of water) related with using liquid manure from industrial swine farming is caused by such microbes as: *Staphylococcus sp.*, fecal streptococci, *Escherichia coli*, rubella bacilli, tubercle bacilli, foot-and-mouth disease viruses, various fungi and parasites;
- **water pollution** – main danger related with agricultural usage of liquid manure is washing out the nutrition microelements (like nitrogen and phosphorus) to the ground waters and surfaces waters,

which can take effect in **eutrophication** of water – inland waters and also sea water, by surface and underground run-off, as an effect of over-fertilization;

- indirect and secondary factor contribute to formation of **acid rain** and increase **greenhouse effect**.

### Impact on water resources

Annually, Belarusian industrial pig farms produce app. 20-22 million tons of waste water<sup>xiii</sup>. Also significant amount of manure was accumulated in reservoirs over the past years. The problem of manure management from industrial farms shall be considered as one of the most important environmental problems.



Old manure tank on the industrial pig farm, Grodno region

It is known, that production of 1 ton of pork requires 88-110 m<sup>3</sup> of clean water. It can be explained by multiple dilution of animal waste, which leads to significant increase in amounts of waste water. So, a complex on 54000 pigs will produce around 1200 m<sup>3</sup> of waste water daily<sup>xiv</sup>.

It is known that most of the, today, available manure utilization technologies are not fully in line with strict requirements of environmental protection. Only quite a few industrial pig farms have biological manure treatment technologies.

The main sources of pollution of surface and underground water come from manure sedimentation tanks, liquid manure storage ponds, and agricultural fields for irrigation. The content of nitrate nitrogen in underground water depends on the depth of groundwater.



Drainage from old reservoirs, Grodno region



Table 1. Nitrogen content in waste water from an industrial pig farm (for 54000 pigs)<sup>xv</sup>

Content of Nitrogen, mg/l / Parameter	Original waste water	Clarified waste water	% of cleaning
General nitrogen	1255.8	522	58.4
Ammonia nitrogen	705.7	481.5	31.8
Nitrate nitrogen	4.5	1.9	57.6

Table 2. Content of biogenic matter in products of manure and waste water treatment<sup>xvi</sup>, % (in every case is a subject for specification in agrochemical lab).

Substance	Dry substance	Total nitrogen	Ammonia nitrogen	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Non-bedding manure	2.0 – 4.4	0.15 – 0.18	0.07 – 0.11	0.03 – 0.05	0.10 – 0.15
Liquid manure	0.4 – 0.5	0.05 – 0.06	0.04 – 0.05	0.014 – 0.032	0.03 – 0.04
Solid manure	21.6 – 24.2	0.25 – 0.58	0.02 – 0.15	0.12 – 0.25	0.07 – 0.23

Using of clarified liquid manure for irrigation on designated fields, leads to the surface run-off with corresponding impact on open surface water. On many industrial pig farms, construction plans made provisions for direct waste water discharge into open water sources during spring tide, which also can lead to negative consequences on the environment. But such cases are quite rare at the moment.

There are no environmental permits, which should be obtained by industrial pig farms on regular basis. However, all pig farms, as large water consumers are obliged to apply for water usage permits, which are issued by the Ministry of Natural Resources and Protection of the Environment or its regional committees. Such a permit is usually issued for the period of several years (2-4) and determines amount of water, which can be used by the pig farm for its production purposes. But it does not regulate content of nitrogen or phosphorous in waste water.



Environmental monitoring is organized on periodical basis by local inspections of natural resources and protection of the environment, but without proper laboratory testing, mainly by site visits, and with proper testing in case of emergency situations. Other organizations (centres of hygiene, institutes of academy of sciences and other) do their own monitoring and testing on some of the farms, but the data was not provided to the Ministry of the Environment.

## Industrial pig farms in the Baltic Sea catchment area in Belarus

Belarusian part of the Baltic Sea catchment area is formed by basins of 3 major rivers – Zapadnaya Dvina/Daugava in Vitebsk region, Neman/Nemunas in Grodno region, and Zapadniy Bug in Brest region.

In frame of this study we paid special attention to Vitebsk and Grodno regions with Zapadnaya Dvina and Neman river basins.

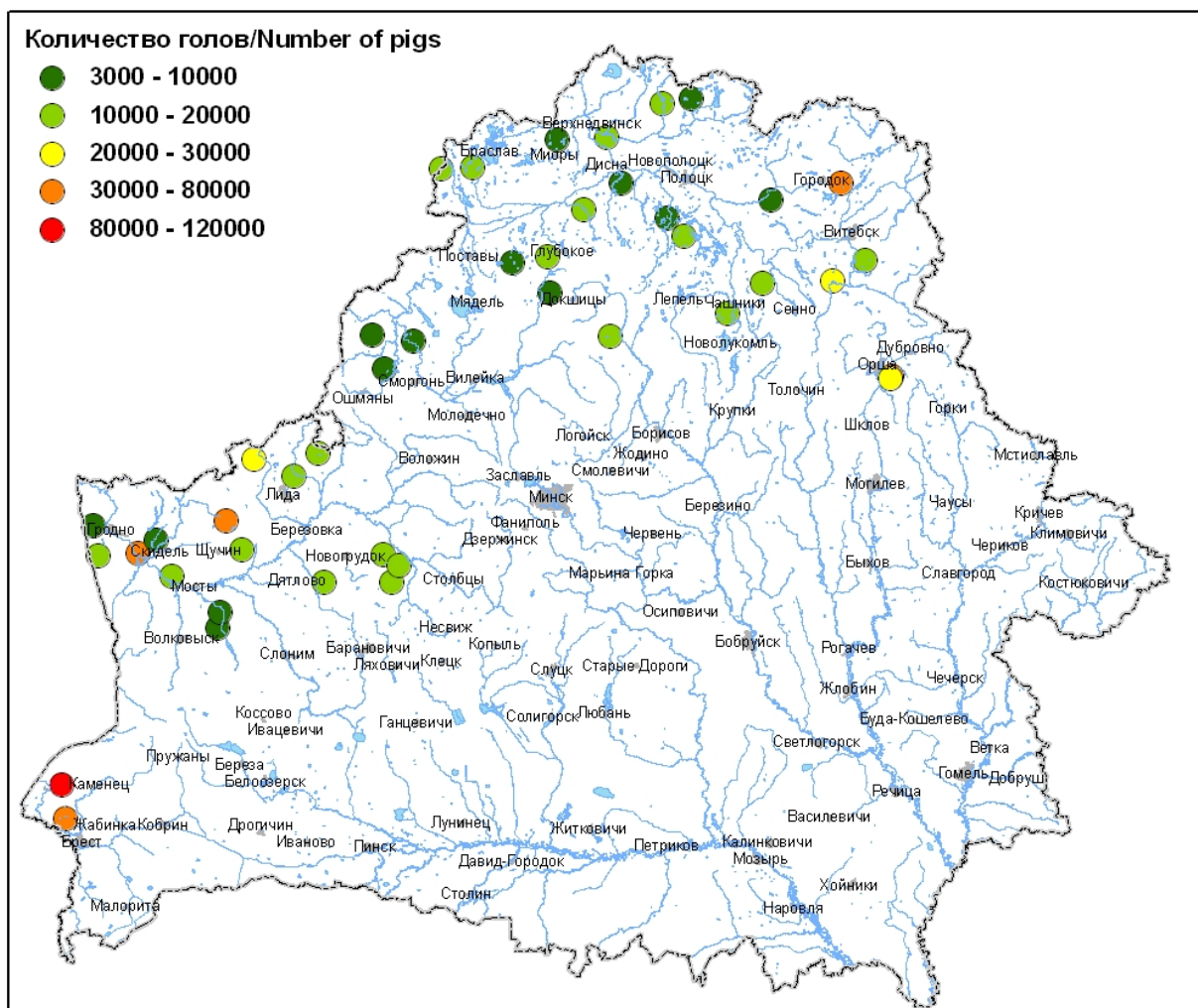


Fig. 2. Location of large-scale industrial pig farms in the Baltic Sea catchment part of Belarus

### Vitebsk region

According to official information, there are 26 agricultural enterprises with industrial pig farms in Vitebsk region (capacity ranges from app. 3000 to 46000 pigs per farm).

But 5 farms, despite location in Vitebsk region, do not belong to the Baltic Sea catchment area, being actually located in Dnepr river basin.

So, 21 large-scale industrial pig farms are located in BS catchment area part of Vitebsk region, including:

1 farm on 54000 pigs;

8 farms on 24000 pigs;



4 farms on 12000 pigs and less;  
8 farms with 3000-7000 pigs and less.

All industrial pig farms are state-owned.

A total number of pigs on industrial farms in BS catchment part of Vitebsk region is 300873 (on 01.12.2008).

It was not possible to estimate exact number of pigs on smaller farms and in private household farms.

### **Grodno region**

According to official information, there are 28 agricultural enterprises with industrial pig farms in Vitebsk region (with capacity of up to 48000 pigs per farm), including the following:

1 farm on 54000 pigs (around 48000 pigs at present moment);

17 farms on 24000 pigs;

10 on 12000 pigs and less;

All industrial pig farms are state-owned.

A total number of pigs on industrial farms in BS catchment part of Grodno region is around 320 000 (at the end of 2008).

It was not possible to estimate the number of pigs on smaller farms and in private households.

### **Brest region**

According to official information, there are 9 large scale industrial pig farms in Brest region.

At least 5 of them are located in the Baltic Sea catchment area.

1 farm on 108000 pigs;

2 farms on 54000 pigs (78 000 pigs on one of them at present moment)

2 farms on 24000 pigs;

All industrial pig farms are state-owned.

A total number of pigs on industrial farms in BS catchment part of Grodno region is around 260000 (2008).

At the moment, a new industrial pig farm is being constructed by Belarussian-Danish private consortium in Brest region.

### **Applied manure utilization technologies and methods of handling of wastewater from animal housing**

Industrial pig farms implement different methods of manure and wastewater utilization and management, starting from direct storing on agricultural fields and concluding with complicated technological processes, including biogas production.

In general, different technologies can be divided into several groups<sup>xvii</sup>:

1. The manure is mowed away with water wash technology and goes to reception reservoir-neutralizer, and then to quarantine reservoirs. Usually, there are 3 such reservoirs on a farm. In each of them the manure is stored for 6 days, and then goes to separators in order to separate liquid and solid manure. Liquid manure goes to vertical sedimentation tanks, and after sedimentation, clarified liquid manure goes to storage ponds. Storage ponds are designed to store liquid manure, further used for irrigation, for the period of several months. Finally, liquid manure goes to fields through a system of sprinkling-machines. Solid manure is added to fields as usual litter manure.



Solid manure clamp in the field near the pig farm, Grodno region

2. Second scheme is used on industrial farms with mechanical method of mowing away manure. Semi-liquid manure (water content of 90-92%) goes to reception reservoir-neutralizer, and then to quarantine reservoirs. After quarantine period (6 days), the manure goes to sedimentation tanks for



Transportation of liquid manure to the field, Vitebsk region

further separation on fractions. Clarified liquid manure is transported to field reservoirs by pipeline system or mobile transport. After 3-6 month of storage period effluents are used for irrigation or watering.

3. Third type of manure treatment technology includes biological treatment, when the manure is mowed away with water wash technology, separated into liquid and solid fractions, and liquid fraction goes through an aeration process. Finally, the active sludge from aerated liquid fraction is separated and biologically-treated liquid goes for further usage on fields.

These technologies include receiving of clarified liquid manure, which further goes to special reservoirs. From these reservoirs clarified liquid manure is being transported to fields, either through sprinkling machines or through mobile transport, which is quite expensive and costly, from energy and man-power point of view. Clarified liquid manure is further used on limited field territory around the pig farm. In fact, it leads to potential pollution of the environment, including ground water.



Clarified liquid manure in the field near the pig farm, Grodno region

Sometimes it may happen that due to the problems with waste treatment equipment or absence of proper fertilization plan, liquid manure from pig farms can go directly to fields and pollute the environment. Another problem of present manure utilization technologies is quite high costs, involved into transportation of clarified liquid manure by mobile transport into fields.

However, if a farm implements all technical requirements and storage capacity period, the negative effect on the environment can be minimized. But, as it was said above, it involves significant financial resources.



System of consecutive cleaning reservoirs on one of the pig farms, Grodno region



At the same time there are some other positive examples of waste water management on industrial pig farms in BS catchment area of Belarus.

There is one example of manure treatment technology, which involves biogas production. This scheme is implemented on large (app. 78000 pigs) industrial pig farm “Zapadnyi” (Brest region, Zapadnyi bug river basin).

The biogas production unit on the pig farm “Zapadnyi” was constructed as an innovation project. The unit was constructed at the end of 2007, and in fact started its operation in 2008. The capacity of the unit is 520 kW (planned). The project allows treatment of app. 43 tons of liquid and 43 tones of solid manure daily. The final biological product is used as a fertilizer on fields, because the biogas fermentation process does not remove the nitrogen and phosphorus from the rest product. Depending on time of the year, the unit produce from 300 to 500 kW of electro energy and hot water. One of the problems, which was faced during the biogas production, is that pure manure shall be mixed with straw or some silage materials for better production of biogas.



Construction of biogas unit on the pig farm “Zapadnyi”, Brest region

Based on this example, biogas units will be constructed in other 3 industrial pig farms in BS catchment part of Belarus in 2009-2010<sup>xviii</sup>:

- “Belovezhskiy” (340 kW), Brest region;
- “Oktyabr’-Grodno” (340 kW), Grodno region;
- “Dotishki” (340 kW), Grodno region.

Another example is complex biological manure treatment scheme, which apart from gathering and quarantine reservoirs and separation, involves a number of consecutive biological ponds - algae-ponds, crayfish ponds, fish ponds, and clean water ponds. Liquid manure after separation goes to the ponds, for consecutive passing through and transformation of nutritive materials.

This system was implemented on the pig farm “Zapadnyi” (Brest region, Zapadnyi bug river basin) and the large (app. 21000 pigs) industrial pig farm “Luchesa” (Vitebsk region, Zapadnaya Dvina river basin).

Yet, another example is bioengineering constructions on afterpurification of waste water on large industrial pig farm “Severnyi” (Vitebsk region, Zapadnaya Dvina river basin). Bioengineering constructions include several elements of soil purification: filtration, aeration, sedimentation and absorption of biogenic elements by water flora (*Typha latifolia* and *Phragmites communis*, some kind of wetland systems). In fact, the system represents a cascade of constructions, which work in gravity regime. At the end the water goes to the local river. Duration of this cleaning process is, in the warm period of year – 5 months.

Afterpurification of waste water with bioengineering constructions is an effective nature protection tool, and also they save some costs on transportation of cleaning water, as they work by gravity.



In general the content of biogenic elements in waste water after bioengineering constructions is significantly reduced: on ammonia nitrogen – at 77.1 – 89.1%, on phosphorous – at 66.9-89.7%<sup>xix</sup>.

Environmental impact of many pig farms is quite significant, especially of those, which remove their liquid manure to the fields by mobile transport or with outdated reservoirs system.

Majority of pig farms do not have observation holes for subsurface water in or around their agricultural fields of irrigation.



Also a majority of pig farms do not have possibility to control the quality of clarified liquid manure, which goes to irrigation of fields.

However, the largest and most advanced pig farms do have necessary observation holes and are monitored by relevant organizations, like local centres of hygiene and epidemiology, inspections of environmental protection, Institute of melioration, and others. Few of them also organise laboratory control of their clarified liquid manure, which goes to irrigation.



Pig farm “Mostovskiy kumpyachok”, Grodno region

According to information of the regional structures of Ministry of the Environment in recent years, there were almost no emergency cases with manure treatment facilities, when waste water from reservoirs was able to reach natural water objects.

According to the available information, there were no cases of exceeding maximum permissible levels of phosphorous and nitrogen in samples, from monitoring holes from several big industrial pig farms. But on the other hand, there is no data available of surface water monitoring near the pig farms.

## Conclusions

- There are 56 large scale industrial pig farms, ranging from 3000 to 108000 of pigs in the Baltic Sea catchment part of Belarus (Brest, Grodno, and Vitebsk regions) with about 890000 pigs;
- There are several large scale pig-farms (e.g. “Zapadnyi”, Brest region, “Mostovskiy kumpyachok”, Grodno region, “Severnyi”, Vitebsk region, and others) which have effective systems of manure management and utilization, including biogas reactors, biological cleaning, and bioengineering constructions, which allow to mitigate the negative environmental impact of manure;
- There are quite many pig farms with significant negative environmental impact on the environment, and water resources in the Baltic Sea catchment area part of Belarus;
- General situation with manure management on most of industrial large-scale pig farms in the Baltic Sea catchment part of Belarus can be characterised as non-satisfactorily, and requires urgent attention from relevant governmental bodies;
- Manure treatment systems on majority of plants are outdated and requires repairing and updating;
- The situation with local environmental monitoring requires improvement as only a few pig farms have necessary capacity for monitoring themselves;
- There is no exact data available on pig farms on actual run-off of phosphor and nitrogen elements.
- Fertilization plans, describing the spreading of manure in a balanced way, are not always in place and many times not correctly implemented.



## Recommendations

For relevant national and regional authorities of the Republic of Belarus, responsible for pork production and environmental control:

- 1) To ensure proper environmental monitoring of manure discharge on regular basis on all industrial pig farms, including monitoring of final discharge, soil, and water objects in terms of nitrogen and phosphorous contamination.
- 2) To consider introducing of environmental permits, to be renewed on regular basis, which will also consider measures, taken to reduce nitrogen and phosphorous content in final discharges.
- 3) To consider introduction of requirements for proper fertilization plans for all pig farms, including description of the spreading of manure on farmland (e.g. figures on kg manure per hectare) to implement a balanced fertilization approach and to avoid over fertilization.
- 4) To conduct detailed research of manure management systems and environmental impact of large scale industrial pig farms in the Baltic Sea catchment area part of Belarus.
- 5) To consider the Helcom Baltic Sea Action Plan (Eutrophication segment) as a voluntary guidance document to address the problems of nitrogen and phosphorous run off from the industrial pig farms.
- 6) To ensure proper implementation of the requirements of Aarhus convention, and organize public hearings during environmental impact assessment processes while constructing new pig farms.
- 7) To promote installation of biogas production technologies on large-scale industrial pig farms, as well, as biological manure treatment systems and bioengineering constructions, as important elements of manure management system.

For relevant Baltic Sea region authorities and institutions:

- 8) To ensure funding possibility of infrastructural projects with clear environmental benefits to be implemented on industrial pig farms in Belarus, e.g. the EU Neighbourhood Program, bilateral agreements, and other funding bodies.

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