BASE Project - Implementation of the Baltic Sea Action Plan in Russia

Final report: Preparation of long-term

Manure Management Plan for Kaliningrad Region

Photo: Harri Huhta/MTT

Pilot Activity	Preparation of Long-Term Manure Management Plan for Kaliningrad Region
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English editing	Howard McKee, Key Image Ltd
For bibliographic purposes this document should be cited as	HELCOM 2014, BASE project 2012-2014: Preparation of Long-Term Manure Management Plan for Kaliningrad Region
Design and layout	A. Briukhanov, L. Levchenko, HELCOM Secretariat
Cover photo	Harri Huhta MTT Agrifood Research Finland
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Implemented in the framework of:	
Project	Implementation of the Baltic Sea Action Plan in Russia (BASE)
Funded by	EU
Implemented by	HELCOM Secretariat and St. Petersburg Public Organisation 'Ecology and Business'

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Executive Summary

The Agriculture Development Program in Kaliningrad Region up to the year 2020 stipulates a substantial increase in farm animal and poultry stock. This will be achieved through the reconstruction of the existing and the construction of new livestock complexes employing the use of highly intensive technologies and high concentration of farm animals. The experience of intensive farming development in Leningrad Region demonstrates, however, that high concentrations of animal stocks create major problems in securing ecological compliance.

In this regard, one of the assignments within the HELCOM BASE project, which supports the implementation of the Baltic Sea Action Plan (BSAP) in Russia, was to prepare proposals on improving the public administration system within the sphere of environmentally sound development and functioning of agricultural production in Kaliningrad Region. The system of using livestock and poultry farm waste (animal and chicken manure) on the basis of nutrients (N and P) balance was suggested as the key measure to secure ecological safety. The overall animal and poultry stocks in farms and the amounts of animal and poultry manure produced were studied, and the farmland areas used for growing crops were determined.

There were around 60,000 heads of cattle, 63,000 pigs and 1.5 million heads of poultry (egg and meat chicken) at agricultural enterprises in Kaliningrad Region in 2013. This stock of farm animals and poultry produces some 1.26 million tonnes of manure per year. This figure will increase to 2.7 million tonnes per year if the long-term future farming development and the planned herd expansion are realised. The approximate amount of manure nitrogen in 2013 was 4,500 tonnes (in perspective 8,700 tonnes by 2015) and manure phosphorus 1,400 tonnes (2,650 tonnes by 2015).

Currently, arable farms make intensive use of around 360,000 hectares; if, however, the development plans were to be carried out, the used land area would be more than 700,000 hectares in 2016. Also, if the increase of plant and livestock production in Kaliningrad Region is realized, the average N load will be around 12 kg/ha and P load 4 kg/ha.

Despite the general positive balance between livestock and plant production in Kaliningrad Region, the regional farm survey revealed a number of substantial environmental problems in animal and poultry manure management. It is mainly associated with the lack of environmental coordination efforts by the executive bodies, the low profitability of agricultural production in

general, and the fact that farms cannot make their own arrangement for the introduction of state-of-the-art and reliable technologies for the processing and application animal and poultry manure.

With the aim to assist the Kaliningrad Region Government to implement the Baltic Sea Action Plan and to contribute to environmental soundness of regional farming, a database on the farms in Kaliningrad Region and the guidelines on the substantiation of environmentally sound locations and operations of animal and poultry farms were developed within the HELCOM BASE Project. The database and guidelines are designed to establish an effective coordination system by the local executive agencies to ensure environmentally safe farming. The elaborated documents include:

- Basic technologies for animal/poultry manure processing (on-line database).
- Proprietary standard. Technological Regulations for environmentally sound animal and poultry manure processing and fertilizer application.
- Substantiation procedures for the environmentally sound siting and operation of livestock and poultry farms in Kaliningrad Region.

The allocation pattern of subsidies to agricultural producers to compensate a portion of expenditures on organic fertilizer use is substantiated and is proposed as a tool for state economic support.

The introduction of measures developed within the framework of the project will minimize the risk of the uncontrolled access of nutrients to the water bodies and to bring the performance of agricultural enterprises concerning the processing manure and the application of organic fertilizers closer to best European practice

Contents

Introduction 5

1. Analysis of the production and accumulation of animal/poultry manure in Kaliningrad Region 6

1.1. Data analysis of the amount of produced cattle manure in the districts of Kaliningrad Region 7

1.2. Data analysis of the amount of produced pig manure in the districts of Kaliningrad Region 9

1.3. Data analysis of the amount of produced poultry manure on poultry farms in Kaliningrad Region 11

2. Quality characteristics of animal and poultry manure and their application potential as organic fertilizers 11

3. Basic technologies for animal/poultry manure processing 17

4. Online database of technologies, machines and equipment for animal/poultry manure processing 18

5. Proprietary standards - Technological regulations for environmentally sound animal and poultry manure processing and the application of fertilizers 20

6. Substantiation procedure of environmentally sound siting and operation of livestock and poultry farms on the territory of Kaliningrad Region 21

6.1. Calculation procedure of N and P balance in animal/poultry manure production, processing and use 23

6.2. Decision-making procedure concerning the environmentally sound siting of agricultural enterprises . 26

6.2.1. Sequence of actions when the Agriculture Ministry of Kaliningrad Region deals with a potential investor regarding the siting of a new animal/poultry complex 26

6.2.2. Sequence of actions when the Agriculture Ministry of Kaliningrad Region deals with an agricultural enterprise regarding the increase of animal/poultry production (herd expansion) 29

6.2.3. Coordination of production, processing and the use of animal/poultry manure as an organic fertilizer by the Agriculture Ministry of Kaliningrad Region 30

6.2.4. Ecological and economic criteria to substantiate the processing and use of animal/poultry manure as an organic fertilizer 31

7. Economic motivation of manure processing and organic fertilizers use 32

Conclusions 35

References 37

Appendix 1 38

Appendix 2 39

Appendix 3 41

Appendix 4 42

Introduction

The Agriculture Development Program in Kaliningrad Region up to the year 2020 stipulates a substantial increase in farm animal and poultry stock. This will be achieved through the reconstruction of the existing and the construction of new livestock complexes employing the use of highly intensive technologies and high concentration of farm animals. This development path adds to the marketability and effectiveness of farming owing to the rational distribution of productive forces and the choice of highly efficient and power saving technological solutions for livestock production growth.

The experience of intensive farming development in Leningrad Region demonstrates, however, that high concentrations of livestock create major problems in securing ecological compliance and in utilizing large amounts of animal and poultry manure – annually up to 100,000 tonnes per farm.

At the same time, our research, together with the results of the BALTHAZAR project (Phases I and II), shows that most agricultural enterprises in Leningrad and Kaliningrad Regions do not have state-of-the-art environmental technologies in place for handling animal and poultry waste. When inefficient practices, machines and equipment are used, the risk of nutrients accessing the nearest water bodies grows significantly and arable farming wastes thousands of tonnes of organic matter, nitrogen and phosphorous, which otherwise could maintain soil fertility and preserve rural landscapes.

The Concept of Sustainable Development of Rural Areas in the Russian Federation up to the Year 2020, approved by the Russian Federation Government Decree No. 2136-p of 30 November 2010, provides for the inventory of environmental status of rural areas, the development of their 'ecological passports' and the ecological and economical maps. With this aim in view, a system of estimation criteria will be developed, which would address the issue of environmentally sound locations of production facilities, and elaborate the guidelines for optimal decision making as far as the environmental projects and environmental investments distribution between separate rural territories and production facilities are concerned.

The actions aimed to secure the environmental safety of agricultural enterprises are an essential and integral part of the "Agriculture Development Program of the Russian Federation" and the regional programme of agriculture development in Kaliningrad Region.

Organic livestock and poultry waste is a concentrated source of nitrogen, phosphorus, potassium, calcium, magnesium and other elements required to improve soil fertility. Animal and poultry manure has thus always been considered a valuable organic fertilizer in this respect. State-of-the-art processing practices of animal/poultry manure allow the production of high-quality organic fertilizers, which would improve both the efficiency of mineral fertilizers and soil texture.

In the case that animal/poultry manure is not used as an organic fertilizer, it loses its valuable properties, becomes a source of pollution and is regarded a production waste with all ensuing consequences. According to the Federal Classificatory Catalogue of Wastes, it is ranked Environmental Hazard Class III-IV [1]. The cost for accumulating and storing such waste according to the legislation of the Russian Federation may be sizable for a livestock farm.

The research objective of the assignment "Preparation of Long-Term Manure Management Plan for Kaliningrad Region" within the BASE project is to assist the Kaliningrad Region Government to implement the Baltic Sea Action Plan and also the current state programmes aimed at ensuring the environmental safety of regional farming. This objective may be reached through the performance analysis of farms in Kaliningrad Region, with the focus on the manure utilization system and the resulting development of proposals that would enhance the environmental soundness of regional farming with due account of its long-term growth.

1. Analysis of the production and accumulation of animal/poultry manure in Kaliningrad Region

One objective was to assess the production and accumulation of animal/poultry manure in Kaliningrad Region, identify the potential as an organic fertilizer, and prepare substantiation materials for the environmentally sound location and operation of livestock and poultry farms in Kaliningrad Region.

The amount of animal/poultry manure produced in each municipal district was calculated in accordance with the authorized procedures and the experience gained when designing systems for the removal and processing of animal/poultry manure [2, 3, and 4]. For this purpose, the performance of livestock and poultry farms was analysed. The data available through Federal Statistical Service and the data obtained during the farm survey in Kaliningrad Region were used, including those received within the framework of the BALTHAZAR project (Phase I). To calculate

the cattle and pig manure output, the equations were derived by calculating the cattle herd structure (the number of cows on each farm), the pig farm stock (number of pigs on each farm) and the farm type (fattening, closed cycle, reproduction, etc.) [5].

The data on the availability of agricultural land in each district in Kaliningrad Region were taken from the Federal Statistical Service [6].

1.1. Data analysis of the amount of produced cattle manure in the districts of Kaliningrad Region

The data on cattle stock and amount of manure produced in each district of Kaliningrad Region are shown in Table 1. The data are taken from the web site of Federal Statistical Service [6].

Table 1. Cattle stock and the amount of produced manure (based on the natural moisture content of fresh manure with due account of the cattle housing and manure removal systems).

Municipal District	Cattle stock, head	Daily manure output, tonne
Bagrationovskij	2,670	124.6
Gvardeiskij	1,030	49.2
Gurievskij	4,635	221.5
Gusevskij	3,694	176.0
Zelenogradskij	1,778	85.0
Krasnoznamenskij	4,307	205.9
Nemanskij	3,910	186.9
Nesterovskij	9,621	460.3
Ozerskij	3,243	155.0
Polesskij	3,010	140.7
Pravdinskij	5,688	270.6
Slavskij	10,345	487.7
Cherniakhovskij	3,254	154.0
Total	**57,185**	**2,717.4**

All the cattle farms in Kaliningrad Region produce some 2,717 tonnes of fresh manure daily. The district-wise distribution of cattle stock and manure output are given in Figures 1 and 2.

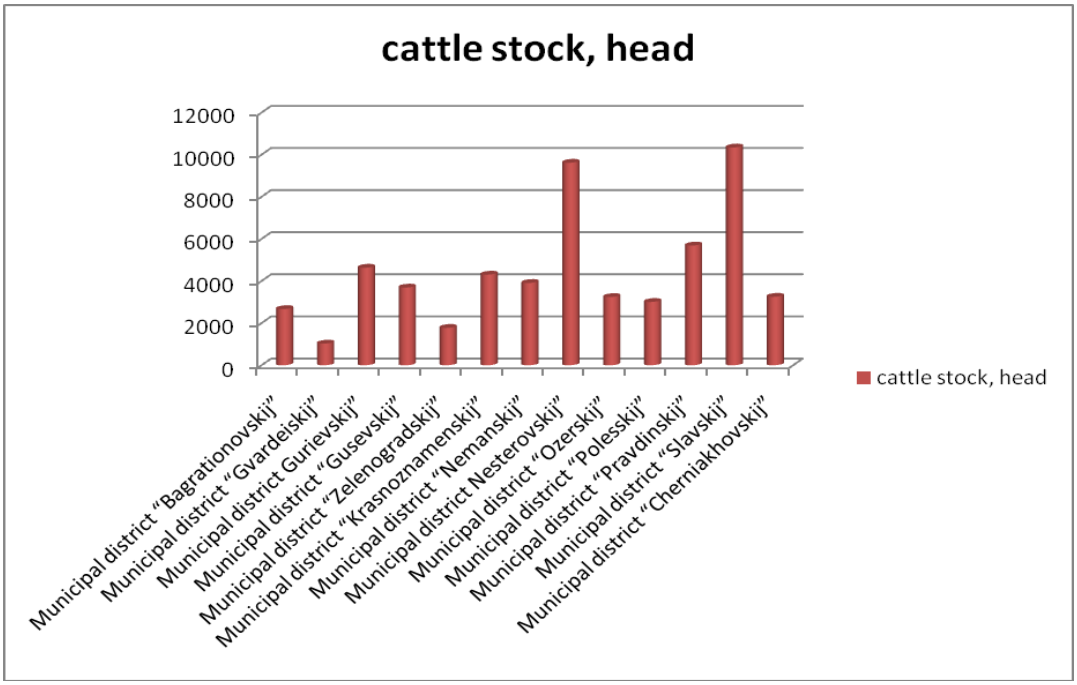

Fig.1. District-wise cattle stock in Kaliningrad Region.

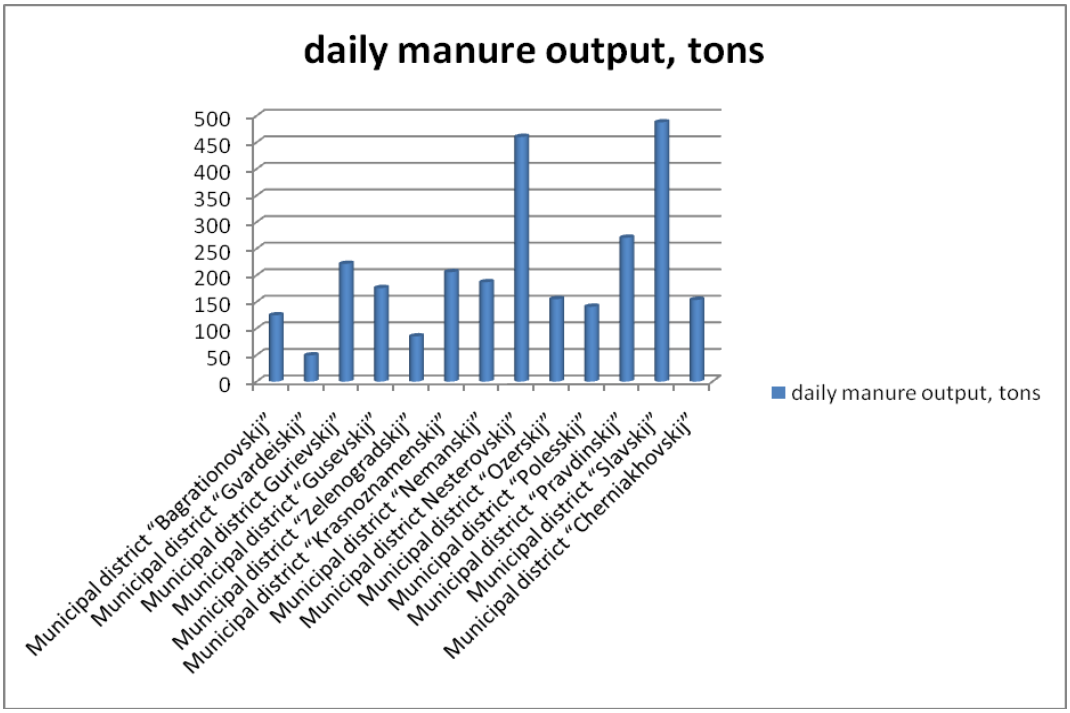

Fig.2. District-wise cattle manure output in Kaliningrad Region.

1.2. Data analysis of the amount of produced pig manure in the districts of Kaliningrad Region

The data on pig stock and produced manure in each district of Kaliningrad Region is given in Table 2. The data are taken from the web site of Federal Statistical Service [6].

Table 2. District-wise pig stock and produced manure (based on natural moisture content of fresh manure with due account of the pig housing and manure removal system).

Municipal District	Pig stock, head	Daily manure output, tonne
Bagrationovskij	2,600	22.1
Gvardeiskij	600	5.1
Gurievskij	1,100	9.4
Gusevskij	10,077	85.7
Zelenogradskij	13,713	116.6
Krasnoznamenskij	600	5.1
Nemanskij	1,790	15.2
Nesterovskij	4,297	36.5
Ozerskij	900	7.7
Polesskij	800	6.8
Pravdinskij	23,996	204.0
Slavskij	2,081	17.7
Cherniakhovskij	875	7.4
Total	**63,429**	**539.2**

All the pig farms in Kaliningrad Region produce approximately 539 tonnes of manure daily. The district-wise distribution of pig stock and manure output is given in Figures 3 and 4).

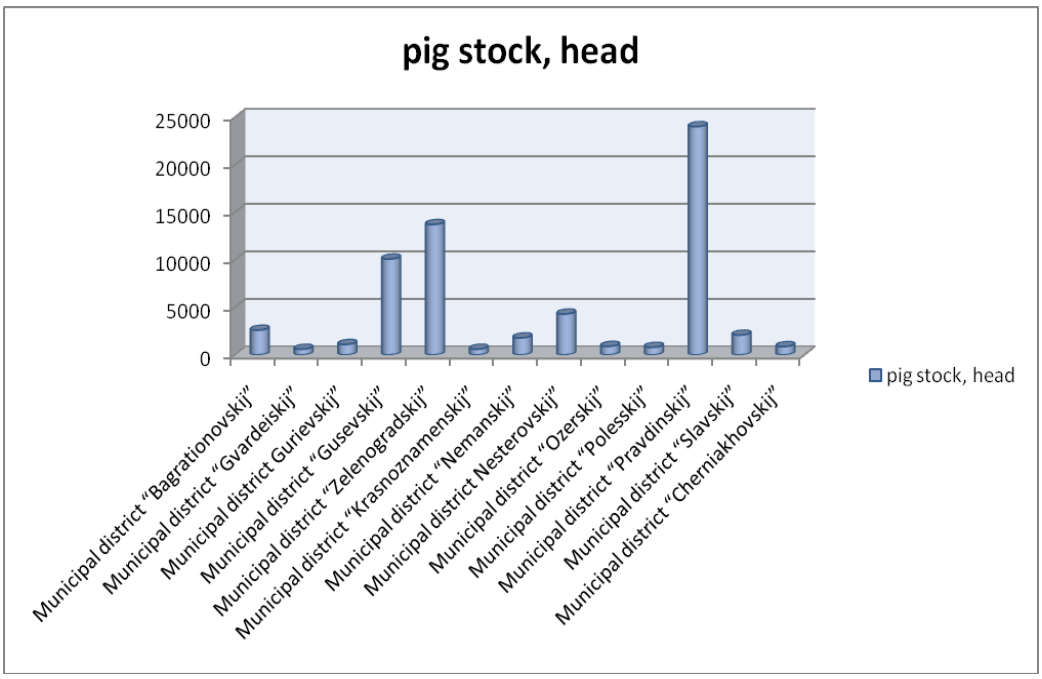

Fig. 3. District-wise pig stock in Kaliningrad Region.

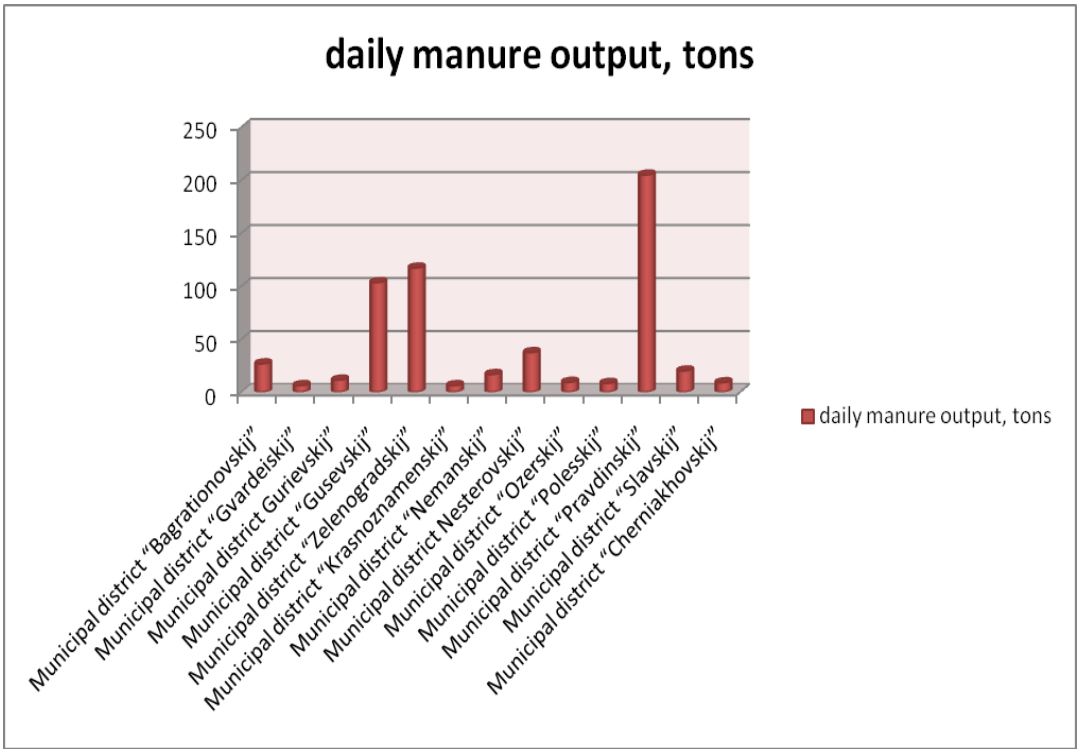

Fig. 4. District-wise daily manure output in Kaliningrad Region.

1.3. Data analysis of the amount of produced poultry manure on poultry farms in Kaliningrad Region

The acquired data were analysed following the Management Directive for Agro-Industrial Complex (РД-АПК 1.10.15.02-08) "Recommended Practice for Engineering and Designing of Animal and Poultry Manure Removal Systems and the Systems of Animal and Poultry Manure Preparation for Application" [2]. The drying loss of adult chicken manure is taken as 27%; young chicken manure 33%; young broiler manure 33%; and broiler manure 50% (according to the above РД-АПК 1.10.15.02-08). The data on poultry stock and manure output per each farm are given in Table 3.

Table 3. Data on poultry stock and daily manure output at each poultry farm (based on the natural moisture content of fresh manure with due account of the poultry housing and manure removal systems).

Poultry factory	Stock, head	Daily output of poultry manure taking account of drying loss, tonnes
Poultry Factory Gurievskaja Ltd.	783,600	100.1
Trade and Poultry Company Baltptitseprom Ltd.	821,600	64.9
Total	**1,605,200**	**165.0**

Poultry farms in Kaliningrad Region produce 165 tonnes of fresh manure daily.

2. Quality characteristics of animal and poultry manure and their application potential as organic fertilizers

Animal/poultry manure produced on livestock and poultry farms should be used initially to manufacture organic fertilizers for agricultural crops. The district-wise data on the annual output of animal/poultry manure in Kaliningrad Region are given in Figures 5 and 6.

The district-wise data on farmland areas (private farms and agricultural enterprises) used for growing potato, grain and grain legumes, feed crops, vegetables as well as other crops and pastures in Kaliningrad Region are given in Figure 7.

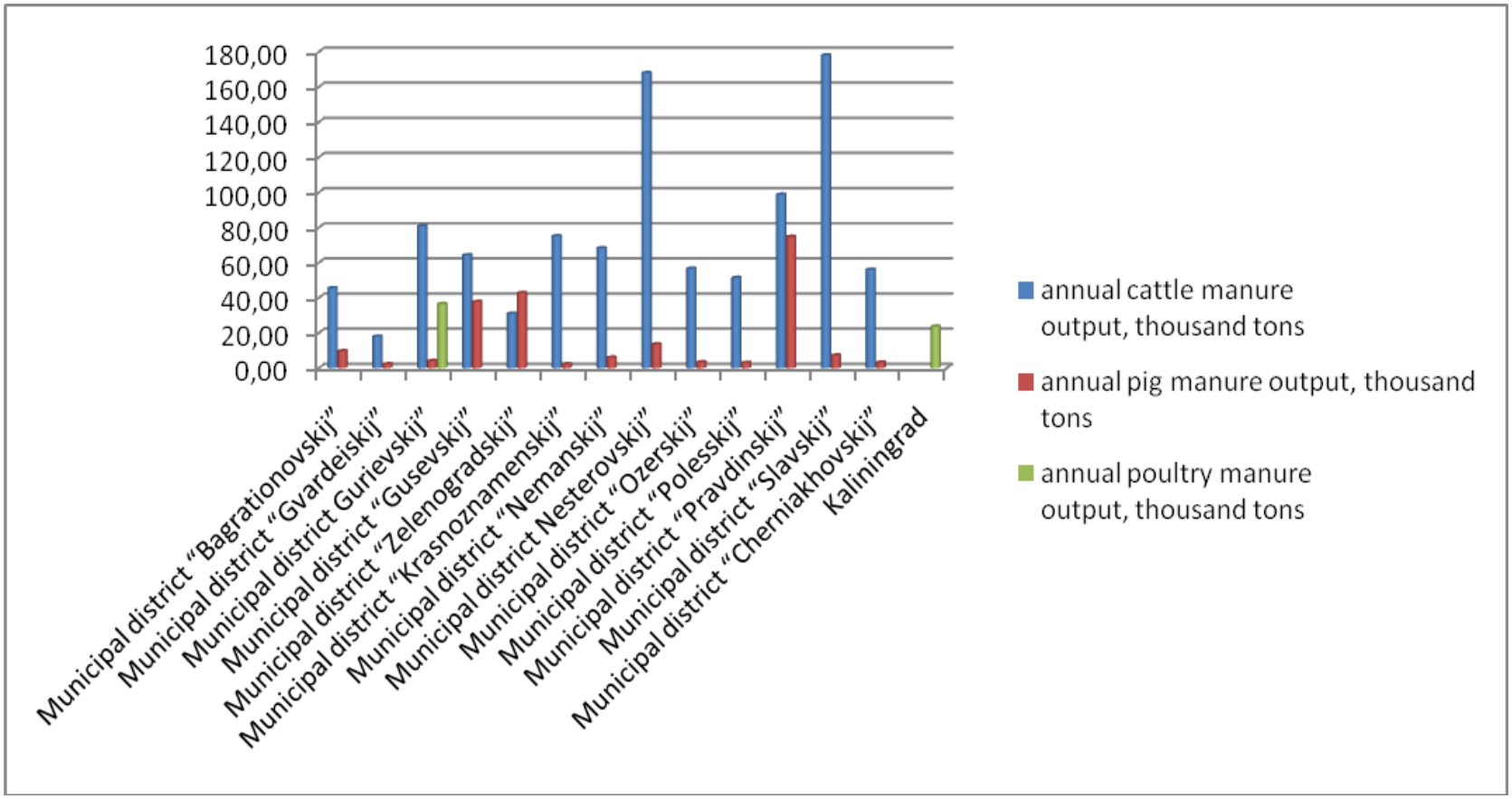

Fig. 5 District-wise data on the output animal/poultry manure in Kaliningrad Region (1,000 tonnes).

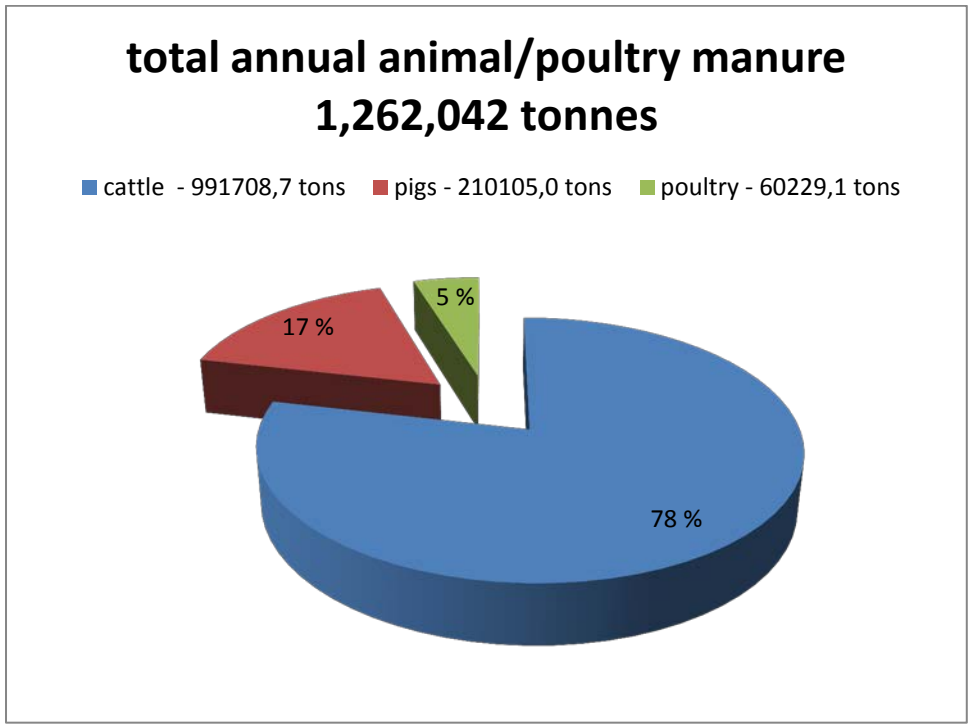

Fig. 6. Data on the annual output of animal/poultry fresh manure in Kaliningrad Region (1,000 tonnes).

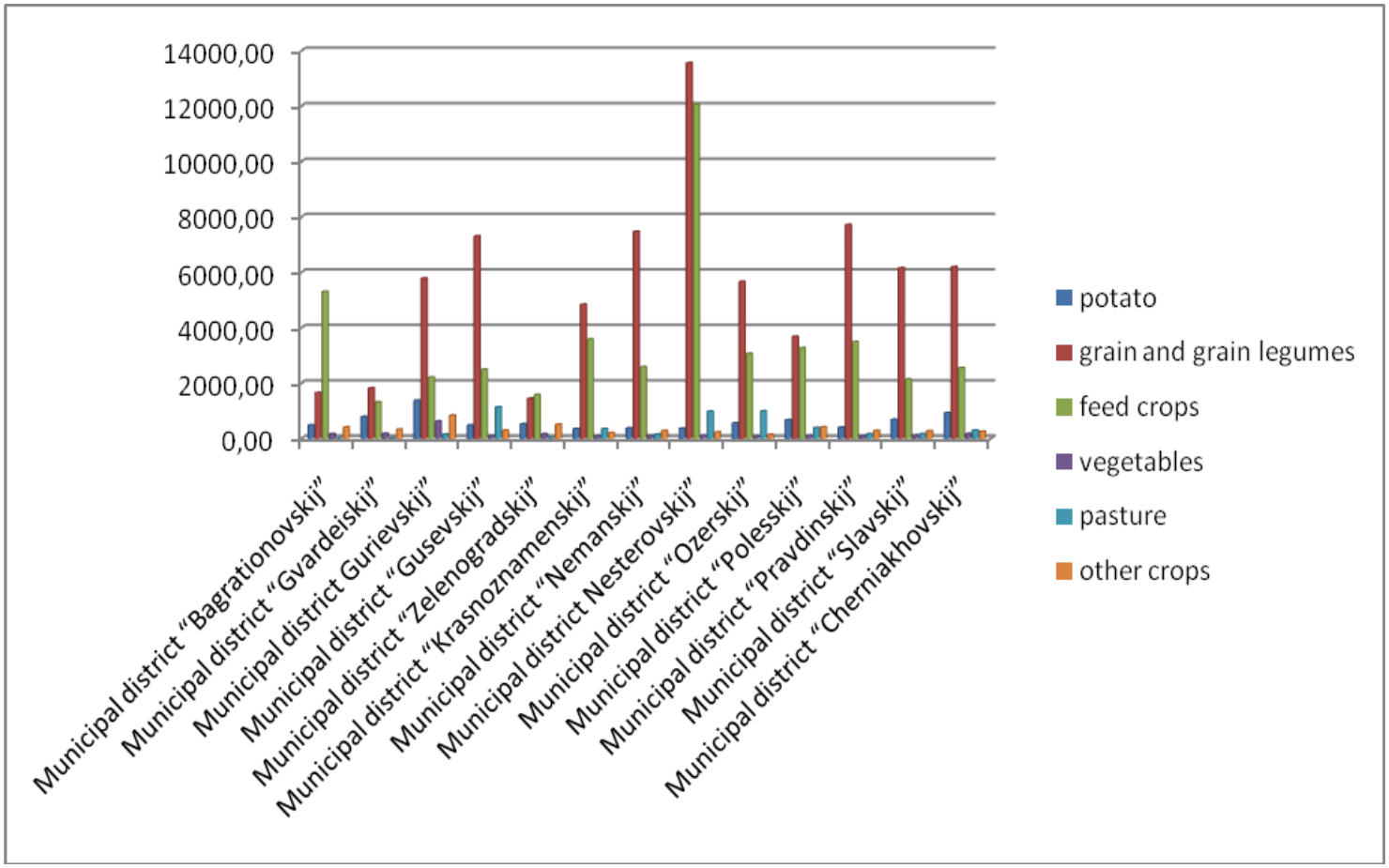

Fig. 7. District-wise data on the farmland area (hectares) used for growing potato, grain and grain legumes, feed crops, vegetables, and other crops and pastures in Kaliningrad Region.

Total nitrogen content is taken to be 0.48% in the organic fertilizer produced from cattle manure; 0.24% in the organic fertilizer produced from pig manure; and 1.1% in the organic fertilizer produced from poultry manure. Phosphorous content is taken to be 0.08% in the organic fertilizer produced from cattle manure; 0.07% in the organic fertilizer produced from pig manure; and 0.21% in the organic fertilizer produced from poultry manure. In most organic fertilizer samples the phosphorous content is shown as P2O5. Thus, when defining the percentage of phosphorous in the physical mass of organic fertilizers, the coefficient 0.44 was applied (P →0.44*P2O5).

The numerical values of N and P content were derived from the results of analyses performed within the framework of research projects at SZNIIMESH and also with the data obtained during the implementation of the BALTHAZAR project (Phase II). These values were used to calculate the potential field application rates of organic fertilizers.

Nitrogen loss during accumulation and storing of the organic fertilizer produced from cattle, pig and poultry manure is taken to be 30%. The numerical values of nitrogen loss are taken from the statistical data collection at the Analytical Laboratory of SZNIIMESH. Organic fertilizer loss during its accumulation and storing is taken to be 25% for organic fertilizers produced from cattle and poultry (chicken) manure and 15% for organic fertilizers produced from pig manure.

Figure 8 gives the district-wise acreage reserve for the application of organic fertilizers in Kaliningrad Region. The calculations were made with due account of the HELCOM Recommendations on nitrogen (170 kg/ha) and phosphorous (25 kg/ha) application, but ignored the mineral fertilizer application due to a lack of complete and reliable data.

When organic fertilizers are applied on poor soils - taking into account the farming practices already in place (crop rotations) - a decision might be taken to apply higher rates of nutrients (N and P), provided this decision is reasonably substantiated [9]. The results of an agro-chemical analysis of farmland soils in Kaliningrad Region in 2011 demonstrated the impoverishment of soil for the last decades and the need for soil quality improvement measures.

As the substantiation of the higher-than-recommended application rates of nutrients requires more detailed analysis and reasoning, HELCOM Recommendations were used to estimate the agricultural land reserves for the application of organic fertilizers.

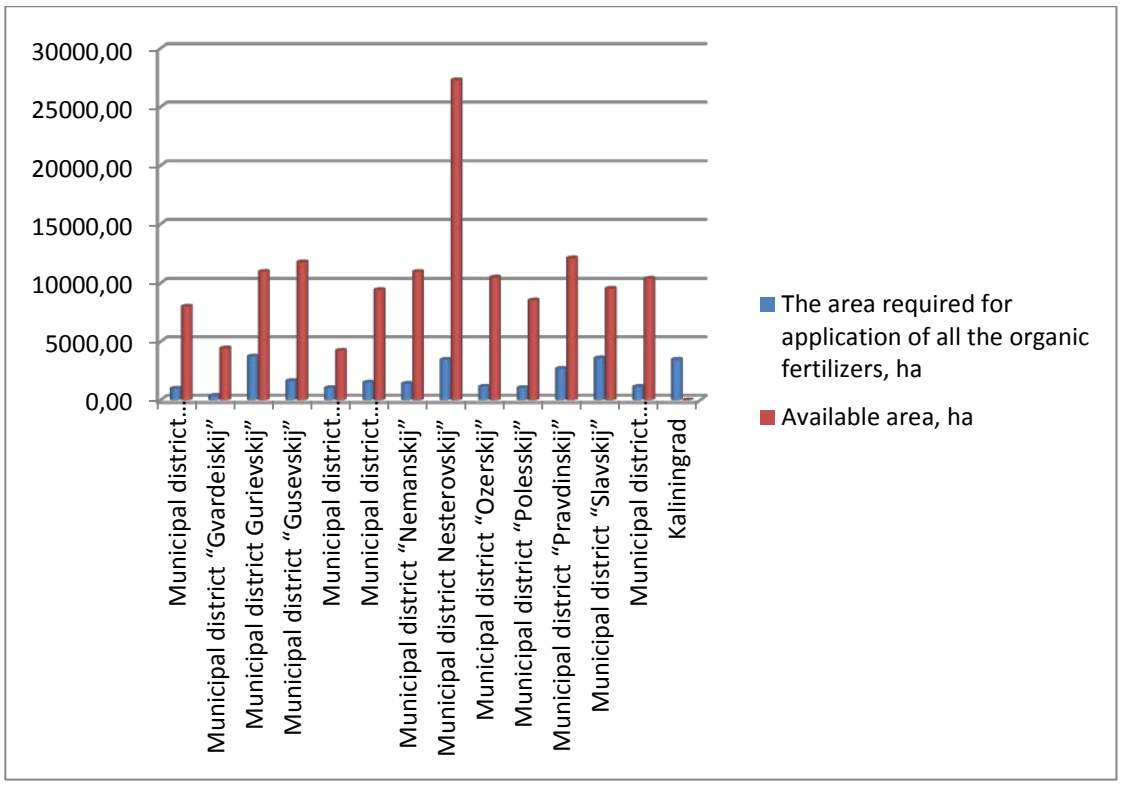

Fig. 8. District-wise land reserve for the application of organic fertilizers in Kaliningrad Region.

Figure 8 shows that in the whole Kaliningrad Region, only Kaliningrad City lacks the land to apply the total produced amount of poultry manure, specifically 3,470 hectares. All the other districts have enough farmland to apply all the animal/poultry manure produced on their land.

Appendix 1 summarises in table form animal/poultry manure output, organic fertilizers and their application (land).

According to priorities and programmes adopted in Kaliningrad Region, the step-by-step development of agriculture is stipulated based on the intensification of production [7]. Intensive development involves the construction of large-scale livestock and poultry complexes and, consequently, a greater risk of negative environmental impact. In livestock and poultry farming, the major source of hazard is the animal/poultry manure processing system and application. At the same time, the plant growing subsector in Kaliningrad Region requires high-quality organic fertilizers. Even when taking into account the substantial increase in animal and poultry stock, all the manure produced will be in demand as an organic fertilizer [7].

The experience from intensively developing regions, such as Leningrad Region, demonstrates the fact that even under the positive balance between livestock and plant production, serious environmental problems might arise with the utilization of animal/poultry manure. These problems are mainly the result of low agricultural production profitability in general and the inability of farms to make

independent decisions on the introduction of state-of-the-art and reliable techologies for handling manure.

Important factors affecting the environmentally sound utilization of animal/poultry manure include:

- Insufficient knowledge of the agricultural producers on the most reliable, economically and ecologically substantiated technologies for handling animal/poultry manure.
- Non-observance of the technological regulations for processing animal/poultry manure and the application of organic fertilizers.
- Inefficient coordination on the part of executive authorities on issues concerning the location of newly built livestock complexes and the reconstruction of operating complexes in terms of their environmental impact (processing technologies and logistics of animal/poultry manure use).
- The lack of economic incentives to introduce the practices of environmentally safe processing of animal/poultry manure; usually such practices are cash consuming and have a material effect on the costs of products, especially those of pig and poultry farms which have no agricultural land of their own.

This is why when fulfilling the assignment “Preparation of Long-Term Manure Management Plan for Kaliningrad Region” within the framework of the BASE Project, the focus was on developing proposals on how to address the above problems.

3. Basic technologies for animal/poultry manure processing

The main trend in animal/poultry manure use today, and also in the foreseeable future, is its application as a high-quality organic fertilizer to improve the soil fertility. Technologies for the generation of heat and electric energy are only considered in exceptional circumstances due to the specific features of the Russian legislation and economy.

Of great importance are the sanitary and hygienic properties of produced fertilizers (absence of pathogens and odour) as they directly affect the air, surface and ground water pollution, as well as agrochemical indices such as nutrients content, absence of weed seeds and homogeneous structure.

Manure quality can be largely improved by its lower dilution with water and, consequently, higher solid matter content that may be achieved through the prevention of uncontrolled water access to the manure.

Depending upon the moisture content and the amount of produced animal/poultry manure on farms and complexes, different processing technologies, machines and equipment are used. According to the Managerial Directive for Agro-Industrial Complex РД-АПК 1.10.15.02-08 [2], animal/poultry manure is rated as **bedding (solid)** manure with up to 85% moisture content; **bedding-free (semi-liquid)** manure with up to 92% moisture content; **liquid** manure with up to 97% moisture content; and **manure effluents** with over 97% moisture content.

Accordingly, the relevant technologies of manure pre-application treatment are being developed, improved and implemented. Basic technologies of the kind recommended and applied in the North-West of Russia, Kaliningrad Region included, are as follows:

1. For bedding (solid) animal/poultry manure – the preparation of solid organic fertilizers (composts) using moisture absorbing materials (peat, straw, wood waste, etc.).

2. For semi-liquid and liquid manure and manure effluents – long-term storage or separation into solid and liquid fractions with subsequent composting of the solid fraction and the long-term storage of the liquid fraction.

3. As an exception, when an agricultural enterprise has absolutely no land for manure application, one possible option is an integrated treatment of the liquid fraction to reach the discharge standard onto the filtration fields.

4. To produce organic fertilizers with enhanced properties from poultry manure, bio-fermentation technology in chamber- or drum-type bioreactors may be used.

4. Online database of technologies, machines and equipment for animal/poultry manure processing

The above are the basic technologies recommended and applied in the North-West Federal District for animal/poultry manure processing and use. However, it should be noted that the Russian market currently offers a wide range of manure handling technologies, machines and equipment. At the same time, there is a problem to select the technologies and machines suited to particular farm

conditions. To partially address this problem, SZNIIMESH has designed an online database of technologies, machines and equipment for animal/poultry manure processing. The database was designed with the support of the BALTHAZAR project (HELCOM) and within the framework of the international project “Sustainable animal and poultry manure handling in farms of Leningrad Oblast, Russia”, realized with the support of NEFCO, Ministry of the Environment of Finland and NDEP. This database includes both the above and a number of other technologies (biogas, combustion, integrated cleaning, etc.).

The database supports final decision making and is created on the basis of expert knowledge formalised as a data model and algorithms to select the optimal technology options. According to a number of pre-set farm operation factors, such as the type and number of livestock, the availability and amount of land for organic fertilizer application, the system suggests the techniques most suitable for each specific case and calculates the consolidated economic indices of each proposed technique. This system is web-available to all interested parties at http://eco.sznii.ru. [8]. The interface of the home page of the above system is given in Figure 9.

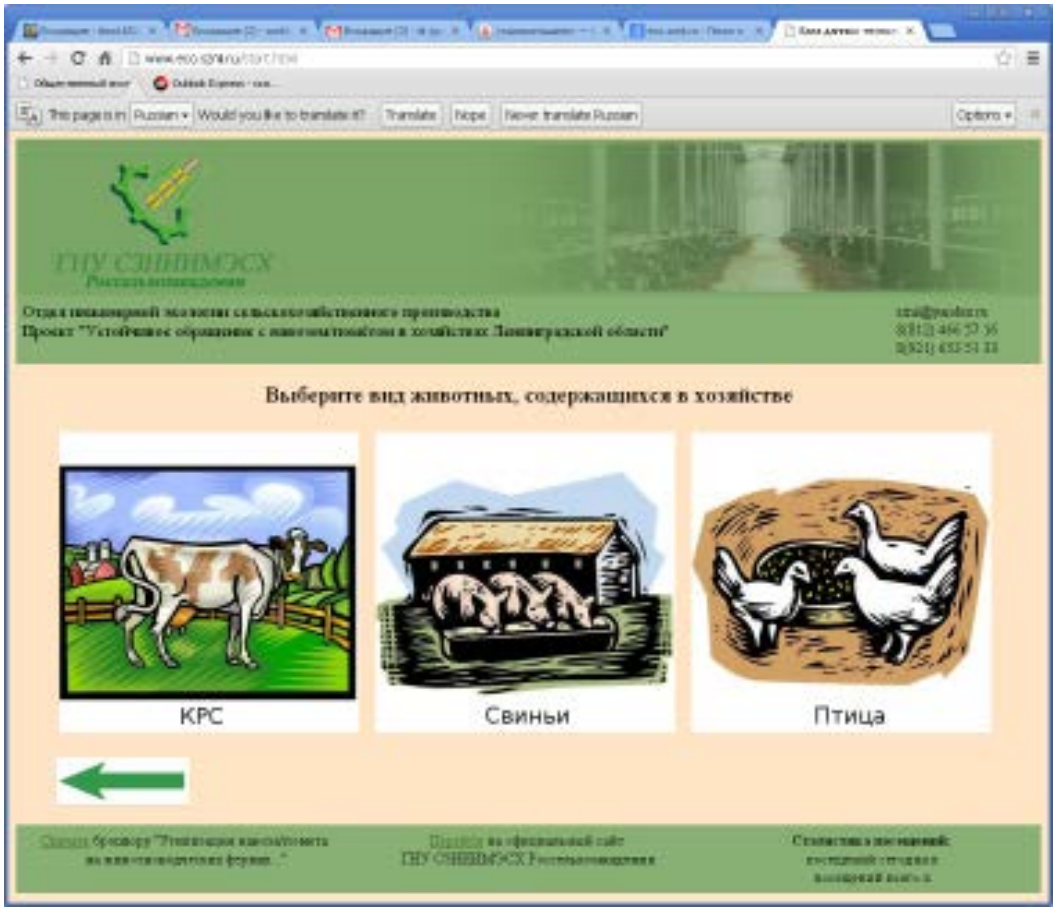

Fig. 9. Home page of the information system (http://eco.sznii.ru).

5. Proprietary standards - Technological regulations for environmentally sound animal and poultry manure processing and the application of fertilizers

The survey of agricultural enterprises in Leningrad and Kaliningrad Regions within the framework of Phase I and Phase II of the "Baltic Hazardous Waste and Agricultural Releases Reduction – BALTHAZAR Project" in 2009–2012 demonstrated the growing concern of most farm managers and specialists over environmental issues. But at the same time, the survey revealed that the systematic internal ecological control of technological processes of animal/poultry manure processing and application was not efficient enough, even on farms where new technologies are in place.

The lack of strict control and exact operating instructions for the above processes results in nutrients (N and P) loss and environment pollution. To establish the on-farm control system over the processing of such waste as animal and poultry manure, the farms need to have special manure handling plans. According to the Federal Law No.184-ФЗ "Concerning Technical Regulation" such plans have the status of a regulatory legal act and are called "Proprietary Standard. Technological Regulations for Environmentally Sound Animal and Poultry Manure Processing and Fertilizing Application".

Technological Regulations are developed for particular farms and describe the conditions and sequence of the technological process of animal/poultry manure processing into an organic fertilizer resulting in environmentally safe product with the quality indices, which comply with the requirements of approved standards or technical specifications. This document also describes how to secure the work safety and to achieve the optimal technical and economic production indices on a particular farm.

Farm introduction of the above Technological Regulations means that the farm manager appoints by an administrative order the persons who are responsible for the observance of these regulations and for establishing the permanent compliance control. As the farm manager approves Technological Regulations for his farm by signing this document, he bears personal liability to regulatory environmental authorities for compliance with its provisions. When there is a rigidly programmed process scheme in place, it is much easier for the farm manager and the persons, who are appointed responsible for the observance of Technological Regulations, to monitor and control technological operations. As our experience shows, the on-farm introduction of Technological Regulations results in

30% reduction of nitrogen and phosphorus loss owing to the efficient organization of work on a point of order.

In the framework of Phase II of the BALTHAZAR Project “Recommendations on arrangement of full-scale ecological monitoring and control of animal and poultry manure processing and application systems. The order of development of Technological Regulations” were prepared, published and disseminated on the farms in Kaliningrad Region [10].

6. Substantiation procedure of environmentally sound siting and operation of livestock and poultry farms on the territory of Kaliningrad Region

The key task of the assignment was to elaborate the decision-making guidelines for the local executive agencies responsible for agriculture development on the siting of new livestock complexes and modernizing existing ones in terms of their environmental impact (processing technologies and logistics of animal/poultry manure use) (Fig.10). The proposed methodological approach will initiate the coordination of activities aimed at ensuring the ecological safety of agricultural production by the Agriculture Ministry of Kaliningrad Region.

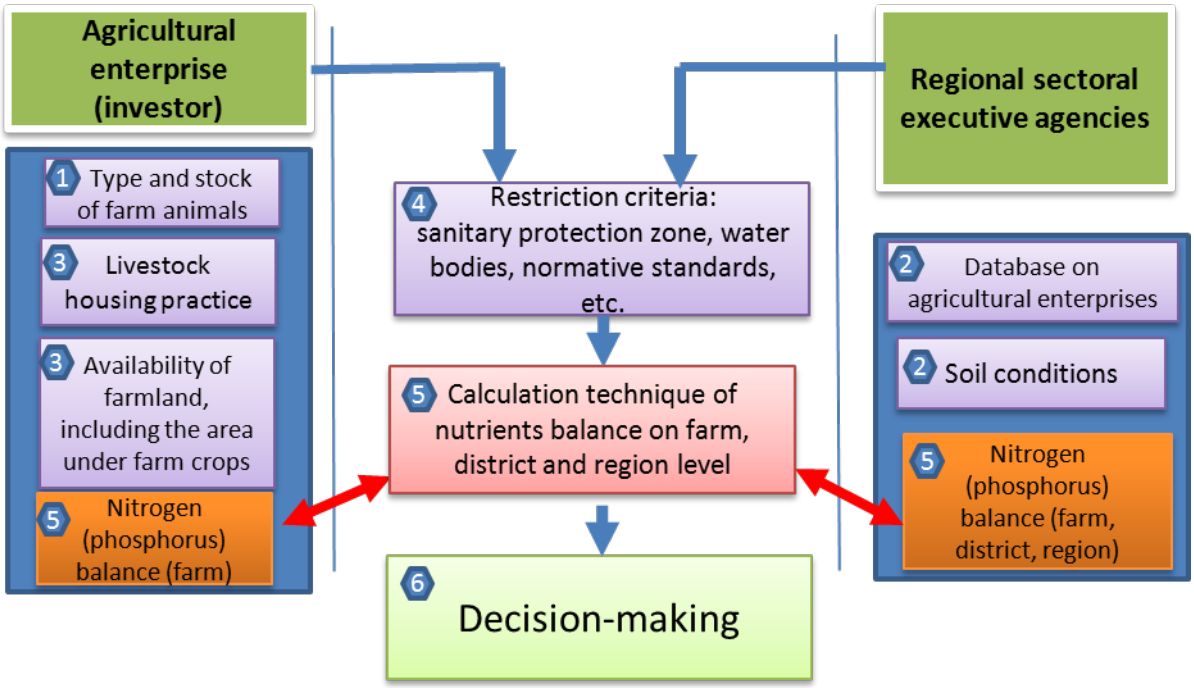

Fig. 10. Decision-making scheme of the environmentally sound location and operation of animal and poultry farms.

The scheme provides for the interaction between two stakeholders: an agricultural enterprise (investor) and the Agriculture Ministry of Kaliningrad Region. When the construction of a new or the capacity increase of an existing enterprise is planned, these take priority.

The sequence of actions is as follows:

1. Specification of farm profile and production capacity (the initial data source is the agricultural enterprise).

2. Choosing the construction site (the initial data source is the agricultural enterprise and the Agriculture Ministry of Kaliningrad Region).

3. Specification of space and layout design, and the technical and technological options (the initial data source is the agricultural enterprise).

4. Review for compliance with restriction criteria (Appendix 2): sanitary protection zone, water bodies, normative standards, etc. (the initial data source is the agricultural enterprise and the Agriculture Ministry of Kaliningrad Region)

5. Comparison of nutrients (N, P) balance in the designed enterprise and N and P balance in the district selected for the location of the farm (the initial data source is the agricultural enterprise and the Agriculture Ministry of Kaliningrad Region).

6. Decision making on the farm location or production expansion. In case of N and/or P surplus in the enterprise and its economically viable inapplicability at the district(s) level, it is necessary to revise the results of actions 1, 2 and 3.

6.1. Calculation procedure of N and P balance in animal/poultry manure production, processing and use

The composite index of environmental impact of a livestock farm (N_{bal}, P_{bal}) is an estimated value of the N and P balance taking into account the available land for their application. Following HELCOM's Requirements, the application limits below 170 kg/ha of N and 25 kg/ha of P were used in the calculations.

To determine this index, the amount of nitrogen and phosphorus in organic fertilizers produced on the enterprise was calculated per one hectare of available farmland in its possession. If the N value exceeds 170 kg/ha, the farm has a surplus of nitrogen (N_{sur}); if the P value exceeds 25 kg/ha it has a surplus of phosphorus (P_{sur}).

$$\mathbf{N_{bal} = ((N_{prod} + N_{pur}/S_{av} - 170), kg/ha, \quad (1)}$$

where

N_{prod} – amount of nitrogen in organic fertilizer, kg

N_{pur} – amount of nitrogen purchased/applied with mineral fertilizers, kg

S_{av} – cultivated area, available for organic fertilizer application, ha

If $N_{bal} > 0$, the enterprise has too little land for the application of produced organic fertilizers.
If $N_{bal} < 0$, the enterprise has enough land to apply organic fertilizers but needs additional nitrogen inputs.

$$\mathbf{P_{bal} = ((P_{prod} + P_{pur})/ S_{av} - 25), kg/ha, \quad (2)}$$

where

P_{prod} – amount of phosphorus in organic fertilizer, kg

P_{pur} – amount of phosphorus purchased/applied with mineral fertilizers, kg

If $P_{bal} > 0$, the enterprise has too little land for the application of produced organic fertilizers.
If $P_{bal} < 0$, the enterprise has enough land to use the produced organic fertilizers but needs additional phosphorus inputs.

Below are some examples of N and P balance calculations. In these examples, N_{pur} and P_{pur} are assumed to be equal to zero.

EXAMPLE 1

A poultry farm with the capacity of 109,000 chickens produces 137 t of manure per day or 50,000 t/year. The manure is processed by passive composting with the output of ready organic fertilizer being around 30,000 t/year (taking into account processing losses) with a nitrogen content of around 300,000 kg and phosphorus 75,000 kg. The poultry farm has 500 ha of farmland, with 350 ha being cultivated and available for organic fertilizer application. Using formulae 1 and 2 we get:

N_{bal} ***= (300,000/350 – 170) = 687 kg/ha***

P_{bal} ***= (75,000/350 – 25) = 189 kg/ha***

The calculations show that as the amount of produced organic fertilizers together with contained N and P substantially exceeds the requirements of the farm, it should search for buyers to purchase the surplus organic fertilizer or expand its cultivated area.

EXAMPLE 2

A cattle farm with 1,780 head (820 dairy cows) produces 90 t of manure per day or 32,850 t/year. The manure is processed by composting with the addition of 6,000 tonnes of moisture absorbing material. By the application time, the organic fertilizer output will be around 28,000 t/year (taking into account the processing losses) with the nitrogen content being around 134,400 kg and phosphorus content 22,400 kg. The farm has 3,000 hectares of farmland, 2,200 ha of which is being cultivated and available for organic fertilizer application.

Using the formulae 1 and 2 we get:

N_{bal} ***= (134,000/2,200 – 170) = - 109.1 kg/ha***

P_{bal} ***= (22,400/2,200 – 25) = - 14.8 kg/ha***

The calculations show that the amount of produced organic fertilizers together with contained N and P may be used on the farm to the full extent. Moreover, the farm needs to make up for the nutrients deficiency by applying mineral fertilizers or purchasing organic fertilizers from other farms.

In the same way it is possible to calculate the resources for fertilizer application at the district or region levels. In this case, the manure output from all the livestock on the land is taken into account. Under the known herd composition, the calculation follows the Management Directive for Agro-Industrial Complex РД-АПК 1.10.15.02-08 [2].

To determine the amount of produced manure, an integrated calculation technique was developed for the specific daily output of animal/poultry manure taking into account the basic practices of manure removal. The calculation factors obtained from the data in the regulatory documents [2, 3, 4] are given in Table 4.

It is suggested to use the following values from Table 5 [9] when calculating the tentative nitrogen and phosphorus content in organic fertilizers produced by basic technologies.

Table 4. Daily output of manure at an agricultural enterprise (integrated calculation).

Animal type	Technology, farm profile	Daily manure output, kg	Symbols
Cattle	Tied housing	97X	X- number of dairy cows
	Loose housing	109X	
Pigs	Farms with complete production cycle	8.4 X	X – overall pig stock on a farm
	Reproduction farms	7.3 X	
	Fattening farms	10.25X	
Poultry	Egg factories	0.13X+0.12x	X – number of chickens in market egg flock (adult birds), x – replacement chicks (10-12 weeks old)
	Broiler factories, floor housing	0.11X	X – number of broilers
	Broiler factories, cage housing	0.09x	x - number of broilers

Table 5. Nitrogen and phosphorus content in organic fertilizers.

Organic fertilizer on the basis of:	N, kg/t	P, kg/t
Cattle manure	4.8	0.8
Pig manure	2.4	0.7
Chicken manure	10	2.1

6.2. Decision-making procedure concerning the environmentally sound siting of agricultural enterprises

An algorithm of decision making on the environmentally sound location and operation of animal/poultry farms is given in Figure 11.

6.2.1. Sequence of actions when the Agriculture Ministry of Kaliningrad Region deals with a potential investor regarding the siting of a new animal/poultry complex

Step 1. Assess the district's (site) compliance with the relevant legislative and regulatory requirements (Appendix 2)

In case of compliance, proceed to the next step. In case of non-compliance, the construction is prohibited and another site is searched for.

Step 2. Concerning an agricultural enterprise: specification of the farm profile, calculation of the produced manure output, calculation of nutrients content in produced fertilizers.

Calculation of farmland area required for the application of produced fertilizers S_{req}

$$\mathbf{S_{req}1= (N_{prod} + N_{pur})/170, ha} \qquad \mathbf{(3)}$$

$$\mathbf{S_{req}\ 2= (P_{prod} + P_{pur})/25, ha} \qquad \mathbf{(4)}$$

From the values of $S_{req}1$ and S_{req} 2, the larger is taken for further actions.

Step 3. Concerning the district intended for siting a new agricultural enterprise.

Comparing S_{req} with the farmland area available for organic fertilizers application on the district level $S_{dist\ av}$ we get the area reserves S_{res}:

$$\mathbf{S_{res}= S_{dist\ av} – S_{dist\ req},} \qquad \mathbf{(5)}$$

where

$\mathbf{S_{dist\ av}}$ is the cultivated area available for organic fertilizers application in the district under consideration;

$\mathbf{S_{dist\ req}}$ is the farmland area required for the produced fertilizer application in the district under consideration; is defined as the largest value between $S_{req}1$ and S_{req} 2**.**

$$S_{dist\ req}1 = (N_{dist\ prod} + N_{dist\ pur})/170, \text{ ha} \quad (6)$$

$$S_{dist\ req}2 = (P_{dist\ prod} + P_{dist\ pur})/25, \text{ ha}, \quad (7)$$

where

$N_{dist\ prod}$ is the nitrogen amount in organic fertilizers on the district level, kg;

$P_{dist\ prod}$ is the phosphorus amount in organic fertilizers on the district level, kg;

$N_{dist\ pur}$ is nitrogen application with mineral fertilizers on the district level, kg;

$P_{dist\ pur}$ is phosphorus application with mineral fertilizers on the district level, kg.

To use the formula 5, the larger value between $S_{district\ required}1$ and $S_{district\ required}2$ is taken.

Tentative values of $S_{reserved}$, $S_{district\ available}$ and $S_{district\ required}$ are presented in Appendix 1.

Step 4. Comparison of $S_{district\ required}$ and $S_{district\ available}$

If $S_{dist\ req} \leq S_{dist\ av}$, a decision is made on the possibility of construction, in principle, and on starting the design phase.

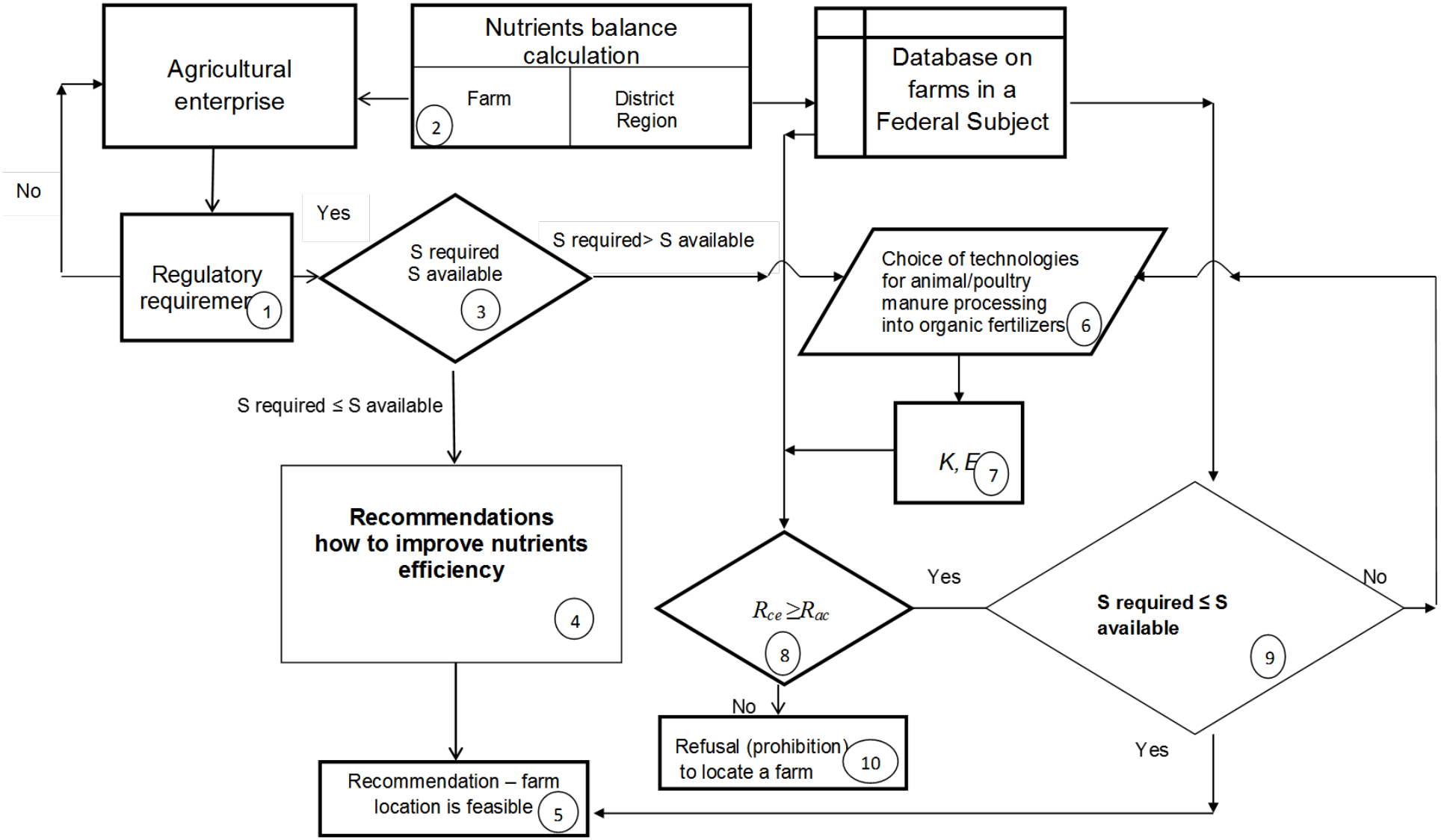

Fig. 11. Algorithm of decision making on the environmentally sound location and operation of animal and poultry farms.

If $S_{dist\ req} > S_{dist\ av}$, a decision is made to either: cease the plans for the construction of a new enterprise on this particular site; reconsider the planned production capacity of a new enterprise or to select another animal/poultry manure processing technology; or search for consumers in other districts who ready to purchase the organic fertilizers, in which case they are selected on the basis of economic and ecological considerations.

6.2.2. Sequence of actions when the Agriculture Ministry of Kaliningrad Region deals with an agricultural enterprise regarding the increase of animal/poultry production (herd expansion)

Step 1. Assess the farm's compliance with the relevant legislative and regulatory requirements (Appendix 2).

In case of compliance, proceed to the next step. In case of non-compliance, the herd expansion is not permitted.

Step 2. Concerning an agricultural enterprise: specification of farm profile, calculation of produced manure output, calculation of nutrients content in produced fertilizers with due account of the planned herd expansion.

Calculation of the farmland area required for the application of produced fertilizers $S_{required}$

$$S_{req}1 = (N_{prod} + N_{pur})/170, \text{ ha} \quad (8)$$

$$S_{req}\ 2 = (P_{prod} + P_{pur})/25, \text{ ha} \quad (9)$$

From the values of $S_{req}1$ and $S_{req}\ 2$, the largest is taken for further actions.

Step 3. Comparison of S_{req} with S_{av} – the cultivated area available for the application of organic fertilizers on the farm.

In case $S_{req} \leq S_{av}$, the farm may freely increase animal/poultry production (expand the herd).

In case $S_{req} > S_{av}$, a decision is made to wither: cease plans for the increase of animal/poultry production (herd expansion); reconsider the planned increase of livestock number or the animal/poultry manure processing technology; or search for consumers in other districts who are ready to purchase the organic fertilizers, in which case they are selected on the basis of economic and ecological considerations.

6.2.3. Coordination of production, processing and the use of animal/poultry manure as an organic fertilizer by the Agriculture Ministry of Kaliningrad Region

To secure coordination of production, processing and the use of animal/poultry manure as organic fertilizer by the Agriculture Ministry of Kaliningrad Region, it is essential to update and replenish the database on agricultural enterprises in the Region in terms of the amount of produced animal/poultry manure with corresponding N and P content; the farmland area suitable for organic fertilizers application; and amount of utilizable organic fertilizers. Examples of data integration on the regional and district levels in Kaliningrad Region are given in Appendices 1 and 3.

According to the table in Appendix 3, it is possible to identify the potential suppliers and consumers of organic fertilizers on the district level.

EXAMPLE 3

Fig.12 exemplifies the would-be users of organic fertilizers, the surplus of which is in place on one of the livestock farms in the Zelenogradskij District of Kaliningrad Region.

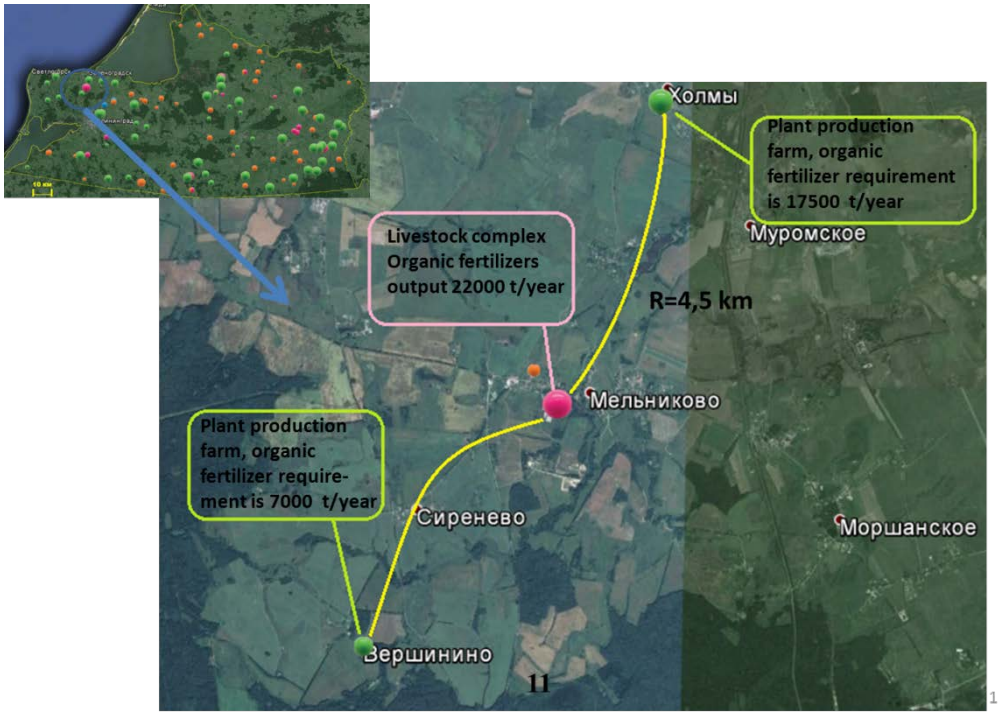

Fig. 12. Example of the database use on agricultural enterprises in Kaliningrad Region for the coordination of production, processing and use of animal/poultry manure as organic fertilizers by the Agriculture Ministry of Kaliningrad Region.

6.2.4. Ecological and economic criteria to substantiate the processing and use of animal/poultry manure as an organic fertilizer

The basis for the ecological and economic substantiation of processing and use of animal/poultry manure as an organic fertilizer are indicators such as: specific capital expenditures (K), specific operating expenses (E), the ecological effect of organic fertilizer use, and the cost-effective transportation distance of organic fertilizers (R_{ce}) (Fig.11).

Table 6 presents some tentative values of specific operating expenses on the processing and transportation of organic fertilizers (E) within the cost-effective transportation distance (R_{ce}) for the basic technologies for animal/poultry manure processing.

Table 6. Some tentative indicators of technologies for animal/poultry manure processing.

Processing technologies	Cattle			Pigs		Poultry	
	Specific operational expenses on processing and transportation of manure, RUB/t		Cost-effective transportation distance, km	Specific operational expenses on processing and transportation of manure, RUB/t	Cost-effective transportation distance, km	Specific operational expenses on processing and transportation of manure, RUB/t	Cost-effective transportation distance, km
	liquid	solid					
Passive composting	-	375	7-8			650	32-33
Composting with regular aeration	-	370	7-8	-		645	32-33
Disinfection through long-term storing	320	-	7-8	320	4-5	-	
Separation into solid and liquid fractions with subsequent composting of the solid fraction and long-term storing of the liquid fraction	390	-	10-11	290	7-8	-	
Biofermentation in chamber bioreactors	-	-		-		1,215	43-44
Biofermentation in drum-type bioreactors	-	-		-		1,500	43-44

The cost-effective transportation distance (R_{ce}) meets the condition when the received additional profit (ecological effect from the use of organic fertilizers – net profit) exceeds the expenditures on processing and transportation of fertilizers.

The net profit on the use of organic fertilizers is determined as the extra yield cost minus the related harvesting costs.

Specific operating expenses on the processing and transportation of organic fertilizers are calculated with due account taken for depreciation deductions on the renovation of machines and equipment; labour costs with social welfare deductions; costs associated with maintenance and the repairs of machines and equipment, buildings and structures; and fuel and electricity costs.

7. Economic motivation of manure processing and organic fertilizers use

Paragraph 6.2.4 shows that the economic efficiency of organic fertilizers is limited by the cost-effective distance of their transportation to the application site. Transportation distances longer than the cost-effective ones result in higher operational costs, a negative economic effect on organic fertilizers use and, ultimately, to higher costs of the end products. An analysis of the agricultural enterprises in Kaliningrad Region shows that the actual transportation distance of organic fertilizers (R_{ac}) exceeds the cost-effective distance (R_{ce}) for all types of farms (cattle farms, pig farms, poultry factories). Thus, animal/poultry manure processing and its use as an organic fertilizer is unprofitable.

Table 7 presents the integrated data from Tables 5 and 6 and the data on the actual averaged transportation distances of organic fertilizers.

Table 7. Initial data to corroborate the need for financial motivation of manure processing and organic fertilizers use.

Organic fertilizer on the basis of	Specific operating expenses, RUB/t	Recommended application rate, t/ha	Cost-effective transportation distance (R_{ce}), km	Actual transportation distance (R_{ac}), km	Cost of ton-km of organic fertilizer, RUB/t/km
Cattle manure	350	35	9	12	30
Pig manure	300	35	7	15	30
Chicken manure	800	12	40	45	40

The data from Table 7 were used to calculate the expenses, which have a negative effect on the economic efficiency of organic fertilizer use. The results of the calculation are given in Table 8.

Table 8. Justification of the financial motivation of manure processing and organic fertilizers use.

Organic fertilizer on the basis of	$R_{ac} - R_{ce}$, km	Transportation expenses, RUB/t	Per hectare expenses, with due account for application rates, RUB/ha
Cattle manure	3	90	3,150
Pig manure	8	240	8,400
Chicken manure	5	200	2,400

Table 8 shows that expenses per one hectare of fertilized area vary from RUB 2,400-8,400; there is little or no return on their expenditure due to the long transportation distances.

According to the present study and calculations, there is a good reason to take the following values (Table 9) as a basis when formulating the proposals on decoupled income support for agricultural producers in Kaliningrad Region.

Table 9. Proposed subsidies on rendering decoupled income support to agricultural producers in Kaliningrad Region.

	Type of expenses	Rate (size) of a subsidy (annual), RUB/ha	Rate (size) of a subsidy (annual), RUB/t
1	Preparation and application of organic fertilizers based on cattle manure	3,150	90
2	Preparation and application of organic fertilizers based on chicken manure	2,400	200
3	Preparation and application of organic fertilizers based on pig manure	8,400	240

The major ecological and economic effect of organic fertilizers produced from animal/poultry manure is a higher quality of farmland soils and higher crop yields. This is why it seems reasonable to consider the proposed subsidies within the framework of Russian Federation Government Resolution No. 869 of 04.10.2013 "On approval of subsidy allocation rules from the federal budget to the budgets of the Russian Federation subjects on rendering decoupled income support to agricultural producers in the field of plant production".

According to this resolution, the subsidies on rendering decoupled income support for agricultural producers in the sphere of plant production are financed from the budgets of the Russian Federation (local budgets). These include funds from the federal budget by way of co-financing (e.g. partial compensation of the costs of 'agro-technological work packages', raising the environmental safety of farming, as well as increasing the soil fertility and quality per hectare of crop land).

Livestock and poultry farms, which do not have their own land for organic fertilizer application, sell their fertilizers by complying with State Standard ГОСТ Р 53117-2008 "Organic fertilizers produced from livestock waste" to arable farms and thus compensate a portion of the expenditure for processing animal/poultry manure. In Kaliningrad Region, it seems reasonable to establish the minimal purchase rate of one tonne of organic fertilizer. These rates may be based on the values from Table 9.

The suggested pattern of economic support of agricultural production in Kaliningrad Region is not in conflict with the terms of Russia's WTO accession. The decoupled income support aimed to improve the ecological situation and sustainable development of rural areas is in line with WTO 'Green Box' subsidies, which are allowed without limits.

Conclusions

1. A general analysis of the amount of animal/poultry manure produced in Kaliningrad Region and the area of agricultural cropland has indicated that **all the processed animal/poultry manure may be used as an organic fertilizer**. Moreover, since there is a shortage of organic fertilizers in the region, even in the case of a significant growth in animal/poultry stock all the produced manure will be in high demand.

2. To produce high-quality fertilizers and to ensure the environmental safety and economic efficiency of their application, the **relevant technologies should be used for animal/poultry manure processing**. Kaliningrad Region offers demonstrative examples of such farms ("Dairy Factory Ltd."). Most farms, however, require their materials and technical facilities for animal/poultry manure handling to be modernized/renovated at the same time employing best region-specific practices. Two workshops were held within the framework of the project for the representatives of executive agencies in charge of agriculture and specialists from agricultural enterprises. The aim was to acquaint the participants with the basic technologies for animal/poultry manure processing and use, and to recommend the wide introduction of Technological Regulations for an on-farm environmental control system that would oversee the processes under consideration. In order to raise the awareness of the stakeholders, it was recommended make extensive use of the on-line database of technologies, machines and equipment for manure processing at http://eco.sznii.ru.

3. The **decision-making guidelines for the local executive agencies** responsible for agriculture development on the siting of new and modernizing existing livestock complexes were elaborated. The guidelines are based on nutrients (N and P) balance calculation. The offered methodological approach will initiate the coordination of activities - aimed at ensuring the ecological safety of agricultural production - by the Agriculture Ministry of Kaliningrad Region.

4. The basic ecological and economic performance indicators of production and the use of various organic fertilizers were determined to propose **financial motivation measures**. The calculation basis was the cost-effective (rational) transportation distance (R_{ce}) of organic fertilizers to the

application site. The cost-effective transportation distance (R_{ce}) meets the condition when the received additional profit (ecological and economic effect from the use of organic fertilizers) exceeds the expenditures on the processing and transportation of the fertilizers. The net profit on the use of organic fertilizers is determined as the extra yield cost minus harvesting costs.

5. The proposals on the **subsidies for decoupled income support of agricultural producers** in Kaliningrad Region were prepared based on results of the technical and economic analysis of manure processing and transportation technologies. According to Russian Federation Government Resolution No. 869 of 04.10.2013 "On approval of subsidy allocation rules from the federal budget to the budgets of the Russian Federation subjects on rendering the decoupled income support to agricultural producers in the field of plant production", the subsidies on rendering decoupled income support for agricultural producers in the sphere of plant production are financed from the budgets of the Russian Federation (local budgets). These include funds from the federal budget by way of co-financing (e.g. partial compensation of the costs of 'agro-technological work packages', raising the environmental safety of farming, as well as increasing the soil fertility and quality per hectare of crop land).

6. The introduction of measures developed within the framework of the project will minimize the risk of uncontrolled access of nutrients to the water bodies and to bring the performance of agricultural enterprises concerning manure processing and organic fertilizers applications closer to best European practices. **Experts estimate that the implementation of a manure handling plan for Kaliningrad Region will reduce the entry of nutrients into the environment from animal/poultry manure** as follows: nitrogen by 20-30% and phosphorus by 15%, which is equal to 1,100 tonnes and 210 tonnes per year, respectively.

7. The study outcomes were discussed at meetings and workshops attended by representatives of Kaliningrad Region Government as well as managers and specialists of large-scale agricultural enterprises. At the concluding meeting on 23 April, 2014, **it was decided to submit the project outcomes and recommendations for consideration to the Agriculture Minister of Kaliningrad Region.**

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Appendix 1

District	Annual animal/poultry manure output, 1,000 tonnes			Produced organic fertilizers per year, 1,000 tonnes*	Content in produced organic fertilizer per year, tonnes*		Cropland, ha						Total cropland, ha	Required land for total organic fertilizer application, ha	Reserve, ha
	cattle	pigs	poultry		N	P	potato	grain, legumes	feed crops	vegetables	pastures	other crops			
Municipal district "Bagrationovskij"	45.50	9.70		42.37	169.18	43.19	484.84	1,650.75	5,301.68	162.85	0.00	411.84	8011.96	995.15	7,016.81
Municipal district "Gvardeiskij"	18.00	2.20		15.37	64.18	15.94	787.70	1,822.13	1,311.59	181.84	4.00	328.91	4,436.17	377.51	4,058.66
Municipal district Gurievskij"	80.80	4.10	36.50	91.46	278.73	169.71	1,376.98	5,785.54	2,211.04	625.06	148.88	839.26	10,986.76	3,741.62	7,245.14
Municipal district "Gusevskij"	64.20	37.70		80.20	279.05	77.75	477.45	7,306.68	2,491.36	96.39	1,134.10	297.83	11,803.81	1,641.46	10,162.35
Municipal district "Zelenogradskij"	31.00	42.70		59.55	175.90	54.69	523.95	1,442.07	1,582.78	164.10	20.00	506.94	4,239.84	1,034.68	3,205.16
Municipal district "Krasnoznamenskij"	75.10	2.20		58.20	256.03	61.62	351.97	4,837.81	3,586.09	98.18	350.00	204.25	9,428.30	1,506.07	7,922.23
Municipal district "Nemanskij"	68.20	6.10		56.34	239.40	58.83	376.12	7,469.00	2,584.59	112.31	150.00	281.43	10,973.45	1,408.24	9,565.21
Municipal district Nesterovskij"	168.00	13.60		137.56	587.33	143.92	361.82	13,555.23	12,056.14	110.16	979.00	228.85	27,291.20	3,454.87	23,836.33
Municipal district "Ozerskij"	56.60	3.40		45.34	195.89	47.66	557.93	5,668.90	3,064.00	79.08	989.02	140.07	10,499.00	1,152.28	9,346.72
Municipal district "Polesskij"	51.40	3.00		41.10	177.74	43.22	671.93	3,679.86	3,266.60	109.74	390.00	417.82	8,535.95	1,045.55	7,490.40
Municipal district "Pravdinskij"	98.80	74.80		137.68	457.63	131.4	396.55	7,717.00	3,486.68	92.63	165.00	283.94	12,141.80	2,691.95	9,449.85
Municipal district "Slavskij"	178.00	7.30		139.71	610.34	147.51	681.64	6,155.65	2,140.77	121.07	168.00	271.65	9,538.78	3,590.26	5,948.52
Municipal district "Cherniakhovskij"	56.10	3.20		44.80	193.87	47.12	926.42	6,194.97	2,545.09	174.80	300.00	252.46	10,393.74	1,140.42	9,253.32
Kaliningrad City	0.00	0.00	60.20	45.15	0.59	168.56								3,470.35	-3,470.35

* with account of processing losses

Appendix 2

Sanitary and hygienic requirements for the location of agricultural enterprises.

No.	Criteria	Units	Conditions or comments
1	Size of sanitary protection zone.	meter	Not less than the size specified in Sanitary Regulations and Standards 2.2.1/2.1.1.1200-03 (depending upon the size and type of the enterprise).
2	Distance between the water bodies (if any) and the agricultural enterprise and its veterinary facilities.	meter	Observance of water protection zones according to Art. 65 of the Water Code of the Russian Federation, dated 3 June, 2006, No. 74-ФЗ. The distance from veterinary facilities should not be less than 500 meters according to Technological Design Standards for Agro-Industrial Complex НТП АПК 1.10.07.001-02 (Item 1.8).
3	The presence of landscape protection areas in the vicinity of the agricultural enterprise.	Presence/ absence	In the case of the presence of protection areas, the requirements specified in Article 16 of the Federal Law No. 26-FZ, dated 23 February, 1995, "On natural curative resources, medicinal and sanitary localities and health resorts" should be observed.
4	The distance between the veterinary facilities and federal and trans-regional railroads and highways of I and II category.	meter	Not less than 300 meters according to the Technological Design Standards for Agro-Industrial Complex НТП АПК 1.10.07.001-02 (Item 1.8).
5	The distance between the veterinary facilities and regional railroads and highways of III category and cattle routes (not related to the designed enterprise).	meter	Not less than 150 meters according to the Technological Design Standards for Agro-Industrial Complex НТП АПК 1.10.07.001-02 (Item 1.8).
6	The distance between the veterinary facilities and farm roads (excluding the approach road to the veterinary facility).	meter	Not less than 50 meters according to the Technological Design Standards for Agro-Industrial Complex НТП АПК 1.10.07.001-02 (Item 1.8).
7	The existence of former animal burial sites and/or sewage treatment facilities.	Yes/no	In the case of the existence of former animal burial sites or sewage treatment facilities on the site, construction is prohibited according to the Technological Design Standards for Agro-Industrial Complex НТП АПК 1.10.07.001-02 (Item 12.1).
8	The presence of slopes on the site.	%	A slope of below 5% is OK for construction. A slope of 5-10% should be taken into account during the design. It is not advised to construct on a slope of over 10% (according to Construction Standards and

			Regulations II-97-76, which are referred to in effective documents such as Technological Design Standards for Agro-Industrial Complex НТП - АПК 1.10.05.001-01 (Item 8.1). The slope of the farm's land should be not less than 0.3 and not more than 5 for clay soils; 3 for sand; and 1 for easily erodible soils (forest, fine sands).
9	The presence of areas with gullies, hills and other elements of broken ground on the land.	Presence/ absence	In the case of presence, construction should be avoided.
10	Minimal distance from the foundations of the building to underground water.	meter	No less than 0.5 meters (Construction Standards and Regulations II-97-76).
11	Its location near other agricultural objects and residential zone to take into account the prevailing wind directions.		Livestock, poultry, fur farms, veterinary institutions as well as large-scale milk, meat and egg production facilities should be located so as to shelter agricultural objects and residential zones from the construction (Construction Standards and Regulations II-97-76).
12	Soil. Soil pollution with radioactive elements and chemical compounds.		Federal Law No. 163. Land Code of the Russian Federation (Articles 13-14). Sanitary Regulations and Standards 42-128-4433-87 "Sanitary norms of admissible concentration of chemicals in soil". Sanitary-Hygienic Standard 2.1.7.2511-09 "Target concentration level of chemical substances in soil". Agricultural activity should be limited and special land rehabilitation should be developed by the agricultural enterprise
13	Soil. Erosion risk.		Federal Law No. 163. Land Code of the Russian Federation (Articles 13-14); Federal Law No. 101 "Concerning the state regulation of ensuring the fertility of land characterized as agricultural". Special agricultural techniques are to be applied on erodible plots.

Appendix 3

The structure of the initial data for estimating the reserves for farming development in Zelenogradskji District (Case study).

Agricultural enterprise (farm)	Farm profile	Amount of produced organic fertilizer per year, 1,000 tonnes	Required cropland area for application of all the produced organic fertilizer, ha	Available cropland area, ha	Cropland area reserve, ha
Federal State Institution Svetlogorskij	Cattle farming + Pig farming + Crop farming	19.10	320.98	546.00	225.02
BaltZangasNefteorgsintez Ltd.	Pig farming	33.15	385.40	0.00	-385.40
Personal smallholdings	Cattle farming	16.80	310.90	0.00	-310.90
Personal smallholdings	Pig farming	1.50	17.40	0.00	-17.40
Vershininskoje Ltd.	Crop farming			208.00	208.00
BaltAgroKorm Ltd.	Crop farming			1,399.00	1,399.00
Joint-stock company LUGOVSKOJE	Crop farming			918.00	918.00
Peasant farm economy LUNKOVA G.N.	Crop farming			625.00	625.00
Peasant farm economy TASALIEV D.M.	Crop farming			544.00	544.00
Total		59.55	1034.68	4,240.00	3205

Appendix 4

The structure of the initial data for estimating the reserves for farming development in Gurievskij District (Case study)

Agricultural enterprise	Farm profile	Amount of produced organic fertilizer per year, 1,000 tonnes	Required cropland area for application of all the produced organic fertilizer, ha	Available cropland area, ha	Cropland area reserve, ha
Voskhod Ltd.	Cattle farming	3.40	89.59	0.00	-89.59
GURIEVSKIJ Ltd.	Pig farming	3.49	40.58	0.00	-40.58
Peasant farm economy KLIVTSOVA O.G.	Cattle farming + crop farming	0.40	10.54	34.00	23.46
Peasant farm economy SHEPELINA A.I.	Cattle farming + crop farming	0.70	18.45	115.00	96.55
Peasant farm economy TOLMACHEV AND FAMILY.	Cattle farming	0.58	15.29	0.00	-15.29
Agricultural production cooperative VASILKOVO	Cattle farming + Crop farming	4.25	111.99	410.00	298.01
Temp Ltd.	Cattle farming	3.26	85.90	0.00	-85.90
Joint-stock company Melnikovo	Cattle farming	1.30	34.26	0.00	-34.26
Poultry Factory Gurievskaja Ltd.	Poultry farming	27.38	2,104.46	0.00	-2,104.46
Peasant farm economy VOLOGZHANIN V.V.	Crop farming			6.00	6.00
Peasant farm economy SHCHEGOLKOVA G.V.	Crop farming			70.00	70.00

Peasant farm economy KLINDUKHOVA A.E.	Crop farming			6.00	6.00
Peasant farm economy MSTOJAN Z.K.	Crop farming			317.00	317.00
Peasant farm economy GULIN B.A.O.	Crop farming			44.00	44.00
Peasant farm economy BAULIN K.A.	Crop farming			12.00	12.00
Peasant farm economy LUCHKOV V.S.	Crop farming			0.00	0.00
Zarechije Ltd.	Crop farming			1,300.00	1,300.00
Personal smallholdings	Cattle farming	46.70	1,230.56	0.00	-1,230.56
Personal smallholdings	Crop farming			8,672.70	86,72.70
Total		91.46	3,741.62	10,986.70	7,245.00

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