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Pig production in the Neman/Nemunas River Basin:

A study on transboundary measures, institutional capacity, bio-security and local development

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ABSTRACT

Pig farming is an important industry in the Baltic Sea Region, but questions have been raised about its role in development and the environmental and health impacts associated with different types of farming practices. This study examines pig farming in the Neman/Nemunas river basin, which includes parts of Belarus, Lithuania, Latvia, Poland and Kaliningrad, Russia, allowing for comparisons between EU members and non-members. Our analysis focuses on the potential for innovative governance approaches to improve nutrient management and reduce pollution from this sector. We also explore the policy implications of the increasing dominance of large-scale operations that extend across national boundaries, the roles of both foreign and domestic investment, and the importance of household pig farming to food security. This paper is based on case studies in Belarus and Kaliningrad funded by the Swedish Institute, and a case study in Lithuania conducted as part of the Baltic COMPASS project.

CONTENTS

1. INTRODUCTION

Pig farming is an important industry in the Baltic Sea Region, but questions have been raised about its contributions to development and the environmental and health impacts associated with different types of farming practices. This study focuses on the Neman/Nemunas river basin,[1] which spans both European Union members and non-members, starting in Belarus and continuing through Lithuania, part of Latvia, Poland and Kaliningrad, Russia, before the river reaches the Baltic Sea via the Curonian Lagoon. In much of the area, pig farming has undergone a rapid transformation in the last two decades, driven by political changes after the fall of the Soviet Union, with new countries formed and established in the basin, industrialization, and more recently, foreign investment.

The political changes in the basin have significantly affected pig farming and its role in the region. During the Soviet era, the Neman/Nemunas basin was identified as a suitable place for large-scale, intensive pig production, and in 1990, the Kaliningrad region produced 270,500 pigs. By 2004, the number had decreased to 38,000, but since 2007, the sector has grown rapidly again, and some 166,000 pigs are now being raised in Kaliningrad. This has important environmental implications, because since the fall of the Soviet Union, water pollution due to pig farming had decreased, mainly due to changes in agricultural practices. It is likely that nutrient and water management in the region for the foreseeable future will be driven largely by the legacy of the past, but policy-makers could benefit from understanding the water pollution impact of different practices. With this study, we also aim to identify innovative approaches to improve nutrient management and reduce pollution from this sector.

Our study also explores the policy implications of the growing dominance in this sector of large-scale private actors who are not limited by national boundaries. Where once it was governments that drove unsustainable pig farming practices, it is now a joint endeavour by the public and private sectors. In Russia in particular, industrial-scale pig farming has rapidly increased since 2010, supported by both domestic and foreign investments. Thus there is a need to examine the role of the private sector in shaping this sector. At the same time, it is important to remember that household pig farming, which is also associated with environmental and health concerns, is still important for food security in Belarus and Russia.

This project has been funded by the Swedish Institute, which funded the case study in Belarus and Kaliningrad as well as the regional synthesis report. The case study in Lithuania was conducted as part of the Baltic COMPASS (Comprehensive Policy Actions and Investments in Sustainable Solutions in Agriculture in the Baltic Sea Region) project, which was funded by the EU Baltic Sea Region Programme from 2009 to 2012.

2. THE NEMAN/NEMUNAS RIVER BASIN

The Neman/Nemunas river is the 14th largest in Europe and the fourth largest in the Baltic Sea basin. The basin of the Neman/Nemunas river drains the territories of Belarus, Lithuania, Russia (Kaliningrad Region), Latvia (only about 100 km^2), and Poland (see Figure 1). The river originates in Belarus and flows through Lithuania before draining into the Curonian Lagoon and then into the Baltic Sea at Klaipeda. The last stretches of the river serve as a natural border between Lithuania and Russia's Kaliningrad region.

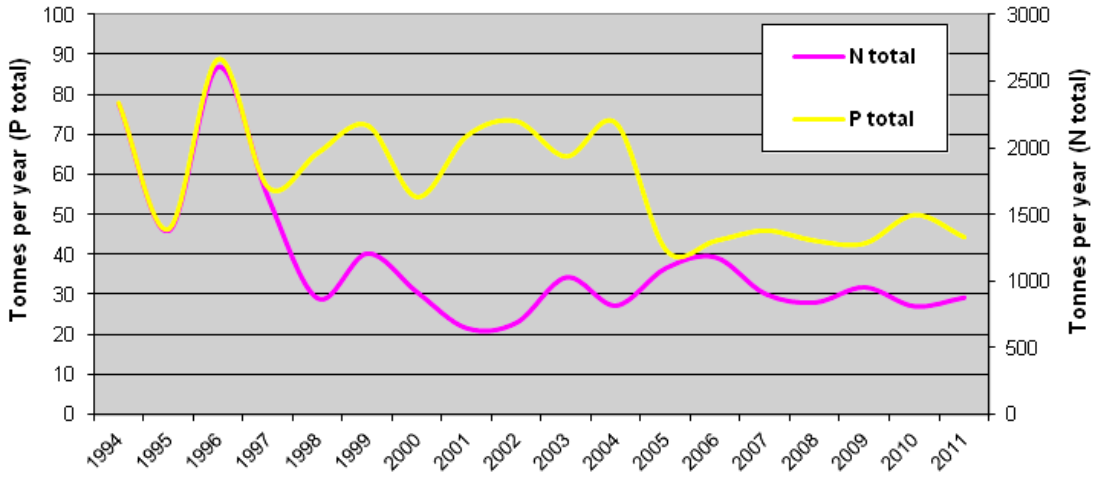
[1] The river is known as Neman in Russian and Nemunas in Lithuanian.

Figure 1: The Neman/Nemunas River Basin

Source: A. Pakhomau, Baltic COMPASS (2012).

The Neman/Nemunas river is important for water supplies, fisheries, hydropower generation, industry and agriculture, as well as for recreation, tourism and water transport. The quality of the water is influenced by a number of anthropogenic factors, primarily linked to industrial and agricultural production. In the upstream Belarus section, industry includes petro-chemistry, power production, metals, construction and food processing, among others. Household wastewater is also an important source of pollution. Chemical-test data in the final stretch of the river, the Curonian Lagoon, show that the nitrogen load over the last 10 years has been stable, while the phosphorus load has decreased significantly since 2005 (see Figure 2). This reduction can partly be explained by the operational start of biological treatment at the wastewater treatment plant in Kaunas, Lithuania. Agriculture contributes to both point- and diffuse-source pollution, and has also straightened and canalized river stretches for drainage projects and land reclamation. The share of land devoted to agriculture is 54% in Kaliningrad, 51% in Belarus and 60% in Lithuania.

Figure 2: Nitrogen and phosphorus loads in Curonian Lagoon, 1994–2011

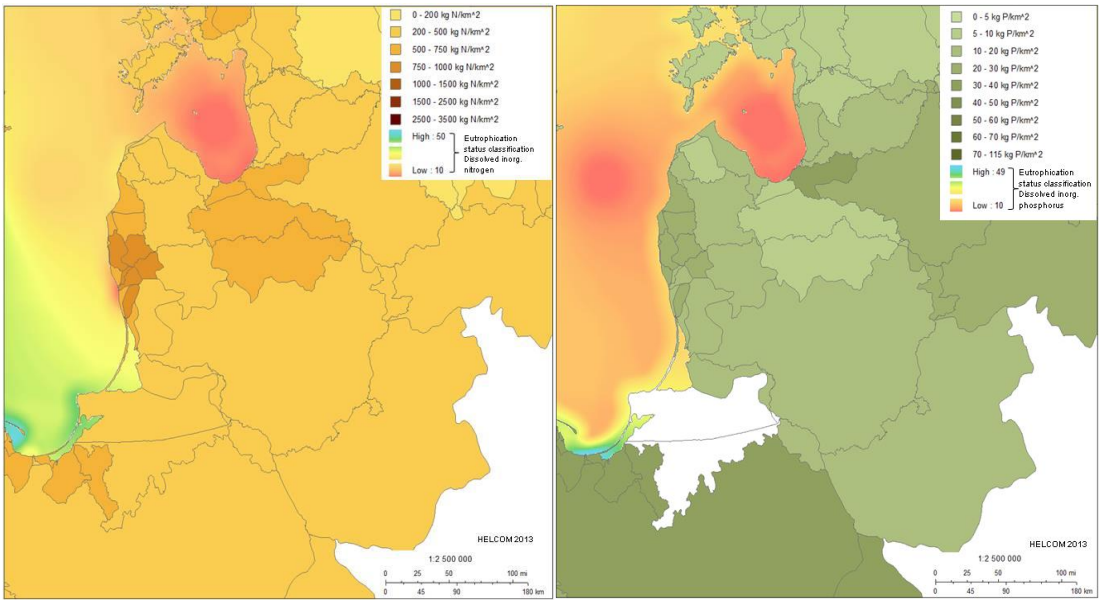


Source: Lithuanian Environmental Protection Agency (2012).

About 48% of the Neman/Nemunas basin is in Lithuania, where the river receives the surface waters – and the pollutants they contain – from several tributaries. As part of the preparation of the River Basin Management Plan for the Neman/Nemunas basin in Lithuania (Government of Lithuania 2010), the rivers in Lithuania's portion of the basin were analysed following the standards set under the EU Water Framework Directive. The analysis found that most rivers within the Neman/Nemunas basin did not qualify for "good ecological status"; for half of those that did not, the problems were attributed to the straightening of rivers; another 24% fell short due to water quality problems, 17% due to both river straightening and water quality problems, 7% due to the impact of hydropower plants, 1.7% due to water quality problems and the impact of hydropower plants, and 0.3% due to all three causes. To reach good ecological status in the Curonian Lagoon, total phosphorus inflow would have to be reduced by 25%, the study found. The analysis also highlighted the need to address transboundary pollution, as half of the total pollution load in the basin is now generated in Belarus.

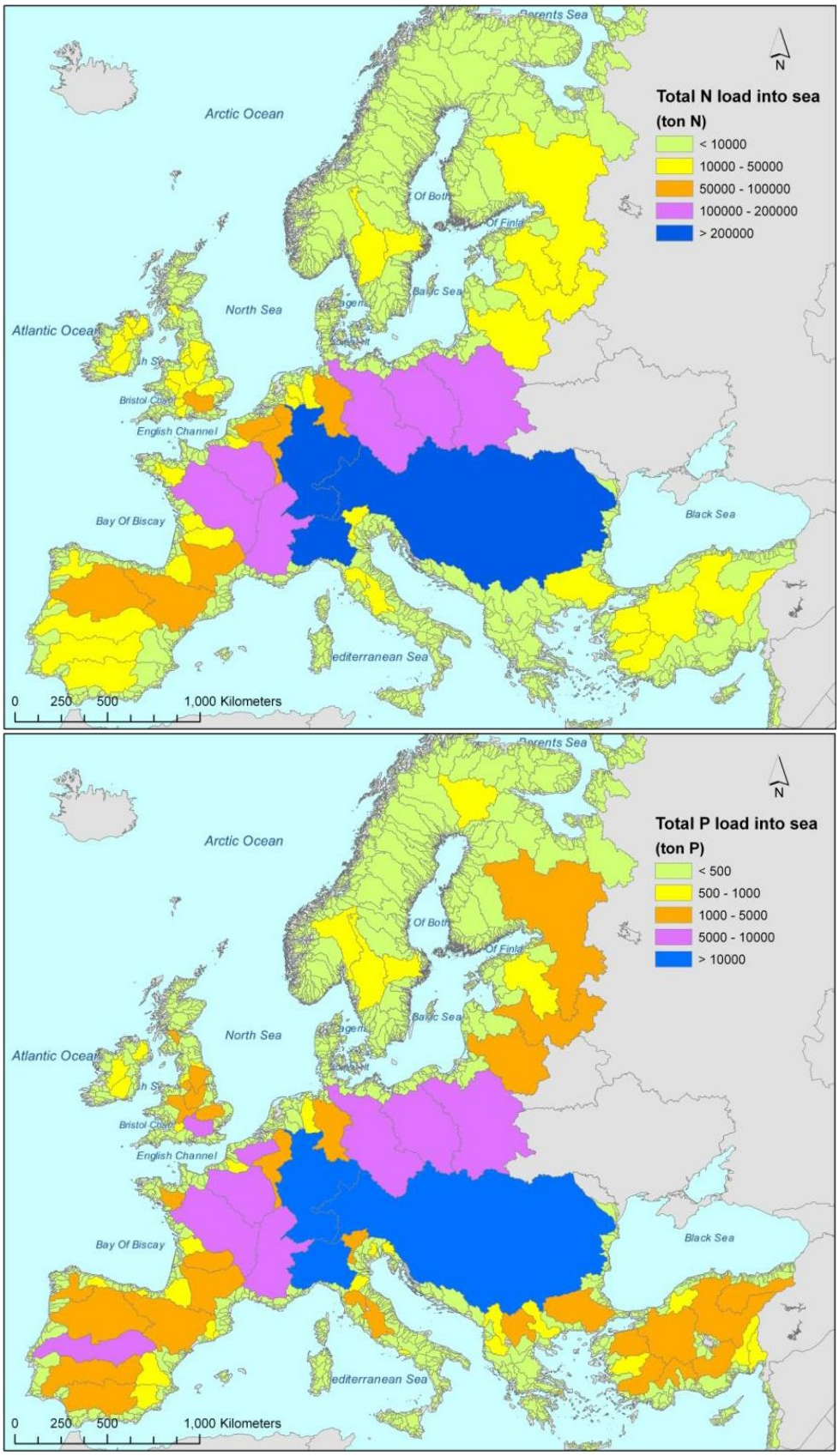
The Lithuanian government found diffuse-source pollution is substantial and comes mainly from agriculture. Diffuse pollution sources account for about 9% of the total organic water pollutant measured as biochemical oxygen demand, or BOD) load, around 17% of ammonium nitrogen, 46% of nitrate nitrogen, and roughly 11% of the total phosphorus transported by rivers into the Curonian Lagoon. Figure 3 shows the contribution of pollutants from the Neman/Nemunas basin to eutrophication of the Baltic Sea, which is considered moderate for both nitrogen and phosphorus. The total nitrogen and phosphorus loads from the Neman/Nemunas basin are 10, 000 to 50,000 and 1,000 to 5,000 tonnes, respectively, as shown in Figure 4 (area-specific load is displayed in Figure 3).

Figure 3: Baltic Sea area-specific load of nitrogen (left) and phosphorus (right) and eutrophication status, 2006



Source: HELCOM (2013).

Figure 4: Total load of nitrogen (above) and phosphorus (below) per river basin in 2000, in tonnes



Source: Bouraoui et al (2009).

3. TRANSBOUNDARY COLLABORATION

Given that water pollution in the Neman/Nemunas basin extends across national boundaries, a key step in addressing water quality – and eutrophication of the Baltic Sea – would be to develop a joint management plan for the basin. In fact, we would argue that a transboundary agreement stipulating appropriate water flows for environment, industry and agriculture is a prerequisite for a sustainable future of the Neman/Nemunas basin. However, there are several reasons why this is challenging, not least of which are the very different development trajectories that the countries have followed since the end of the Soviet Union. Belarus and Lithuania both became separate countries, and Lithuania went on to join the EU.

Environmental policy has also evolved differently in Russia and Belarus than in the EU; for example, the EU has legal requirements for maximum livestock density, manure storage capacity, and obligations to reduce ammonia emissions, but Russia and Belarus do not. At the same time, Belarus and Russia have a rigorous regulatory framework regarding human health that also generates environmental benefits.

Despite the political differences, both Russia and the EU have embraced the concept of managing water resources at the river basin scale. The EU Water Framework Directive (WFD), approved in 2000, requires river basin management plans to be developed to achieve good water status (ecological and chemical) by 2015.[2] In Russia, the Water Code adopted in 2006 includes a river basin approach as a guiding tool for water management;[3] a 2007 decree by the Federal Agency on Water Resources requires "schemes of complex use and protection of water bodies" to be finalized by 2015. Similar policies on basin-level approaches have been adopted in Belarus; the country's Neman/Nemunas river basin scheme of complex use and protection of water was approved in December 2012.

The increased focus on a river basin approach in Russia, Belarus and the EU provides an opportunity to develop a joint transboundary river basin plan for the Neman/Nemunas basin. The governments of the Russian Federation, Belarus and Lithuania have begun to prepare an agreement on cooperation in the use and protection of water bodies within the Neman/Nemunas basin, and a draft has been prepared, but not yet signed. The negotiations were stalled when the EU requested a clause allowing the EU to be a Contracting Party instead of Lithuania.[4] Restarting the negotiations now requires a political will that is not there.

Still, there have been several bilateral collaborations between the different countries, such as:

- An agreement between the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus and the Ministry of Environmental Protection of the Republic of Lithuania about environmental protection cooperation;[5]
- A permanent working group between Belarus and Lithuania that meets annually to discuss the results of surface water quality monitoring; the collaboration also includes the development of a system for prompt exchange of information on pollution accidents in the Neman/Nemunas basin;

[2] See http://ec.europa.eu/environment/water/water-framework/.
[3] The detailed procedure was laid down in the Government Decree of the Russian Federation No. 883, 30 December 2006.
[4] On 27 June 2006 the European Council adopted a decision mandating the European Commission to negotiate the agreement on behalf of the EU and in particular, to include such provision.
[5] Agreement with the EU and, in particular, to include such provision signed on 14 April 1995.

- A 2003 agreement between the Hydrometeorological Service under the Ministry of the Environment of the Republic of Lithuania and the federal Kaliningrad Hydrometeorological and Environmental Monitoring Centre of the Russian Federal Service for Hydrometeorology and Environmental Monitoring for cooperation on monitoring and exchange of data on the status of transboundary surface water bodies;
- A Technical Protocol between the Ministry of the Environment of the Republic of Lithuania and the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus for cooperation on monitoring and exchange of data on the status of transboundary surface water bodies, signed in 2008.

One important limitation of these collaborations is that the countries take different approaches to data-gathering and information management. This has led to disagreements about pollution sources and flows, among other issues. Disputes between tributaries about pollution loads are a common problem in many basins, not just among EU members and non-members (Nilsson 2006). To help address this challenge in the Neman/Nemunas basin, the Commission on Environmental Protection of the Board on Long-term Cooperation of Lithuanian-Russian Regional and Local Authorities has set up a working group to monitor transboundary surface water and groundwater bodies and identify pollution sources.[6] Our analysis suggests that there is a need for greater investments in such collaborative efforts to mitigate nutrient and pollution flows in the basin. Transboundary pollution flows also have implications for the EU's own policies. The EU has invested in agro-environmental measures to mitigate the environmental impact of agricultural production. Unless the programme considers the issues of transboundary basins and develops measures that take a basin-wide approach, the success of measures to mitigate pollution will be limited.

A further challenge is the diversity of interests and perspectives among key actors in the pig farming sector: household farmers, governments and foreign investors whose prime interest to ensure stable production and profitability. In both Russia and the EU, current environmental measures focus on introducing and promoting techniques that reduce pollution. However, our analysis shows that despite technological innovation efforts, little is implemented in practice, often due to limited collaboration between the different stakeholders. Local government, farms, investors and surrounding communities rarely discuss what measures should be employed and how to implement them. That, in turn, has led to conflicts between stakeholders at the local level, as documented in Lithuania and Kaliningrad, and it could escalate to conflicts between the countries. Programmes, regulations and legislation that aim to mitigate the impact of the pig farming sector need to consider the complexity of the sector and the web of different actors with different views and interests. Furthermore, there is a need to encourage transboundary dialogue and exchanges to provide incentives and build political will to support collaboration.

[6] This involves contracts with the Russian Federal Hydrometeorological and Environmental Monitoring Service Kaliningrad Hydrometeorology and Environmental Monitoring Centre, signed in 2002, on cooperation in transboundary water bodies for monitoring the condition and the exchange of field data.

4. PIG FARMING IN THE NEMAN/NEMUNAS RIVER BASIN

As noted above, it is important to acknowledge that the pig farming sector is very diverse, including everything from households with pigs, to large industrial farms. This section provides an overview of pig production in Kaliningrad, Belarus and Lithuania. Our analysis distinguishes between three farm size categories: large-scale farms, small and medium-size farms, and household farms (see Box 1 below for more detailed descriptions). Figure 5 shows the pig population per administrative unit within the Neman/Nemunas River basin.

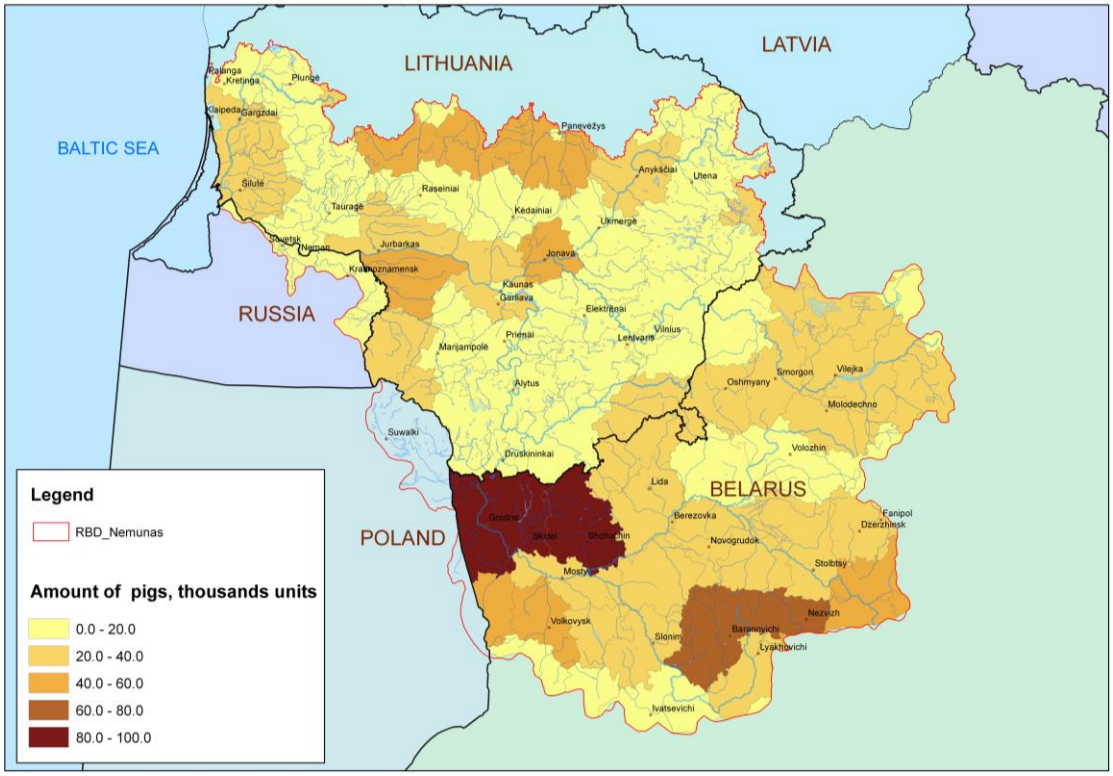
Box 1: Farm size categories

Large-scale farms: These farms are also referred to as pig complexes. Production is based on high stocking density, where a farm operates at an industrial level. In general, farms have more than 2,000 pigs each – some as many as 100,000. Large-scale farms are common in Belarus and Kaliningrad.

Private farms: This category includes small and medium size farms raising pigs for profit. Generally they are run by individuals or families, with herd sizes ranging from 10 to 2,000 pigs.

Household farms: This term originates from socialist countries, where households were allocated small plots of land (0.5 hectares) for subsistence farming attached to a rural residence. Surplus products from the household plot are sold to neighbours, relatives, and often also in farmer markets in nearby towns. The number of pigs is generally below 10 animals.

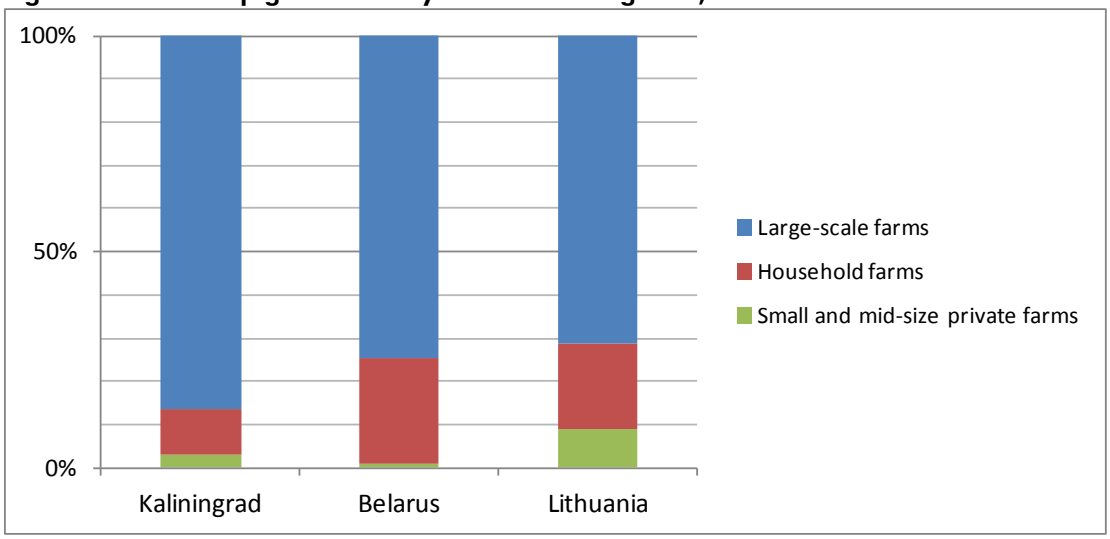
Figure 5: Pig population per administrative unit in the Neman/Nemunas basin, 2010



During the socialist era, the pig farming sector was dominated by large industrial estates responsible for meeting national pork production targets. Belarus was at the time an important pig producer. Since the fall of the Soviet Union, however, the sector has undergone rapid changes. Immediately following the fall of the Soviet Union, the number of small and mid-

size private farms increased in Lithuania. In Belarus the government struggled to operate and maintain the large industrial farms that had previously been heavily subsidized from Moscow. Large-scale pig farms are vulnerable to changes in the economy; in 2008, for example, the financial crisis led to a rapid decline in pig production. Overall, however, pig production is on the rise in Kaliningrad and Belarus, driven in part by tax exemptions for investors, while in Lithuania, the sector continues to decline. Across the region, the number of mid-size farms has declined, and the sector is now again dominated by large industrial farms, along with household farms, in rural areas, that produce mainly for their own consumption. Whereas the big industrial farms are subject to different types of government support schemes, household farms have limited access to extension services or subsidies. See Figure 6 for the production share of the three different pig farm types in Kaliningrad, Belarus and Lithuania.

Figure 6: Share of pig livestock by farm size categories, 2010



4.1 Kaliningrad region

Pig farming is the primary form of livestock production in the Kaliningrad region; in 2011, pork accounted for 50% of meat production, as measured by total slaughter weight. This can partly be explained by favourable local conditions for pork production and recent business initiatives supported by the state.

The fall of the Soviet Union led to a drastic decrease in pig farming in the Kaliningrad region. State-owned farms were abandoned, and overall, meat production in Russia declined for several years. While in 1990, there were 270,500 pigs in the region, by 2000 there were only 68,900, and the decline continued until 2004, when only 38,000 pigs were raised. The main reasons for the decline were the political and economic crisis in the country and also a crisis in agriculture; for years it was much easier to import food than produce it in within the country. More recently, however, the Russian government has been promoting growth in domestic meat production. Measures under the National Priority Project "Development of the Agro-Industrial Complex" 2006–2007 and the State Programme for Development of Agriculture 2008–2012 made it possible to increase domestic pork production to 19.3 million pigs by mid-2012.[7]

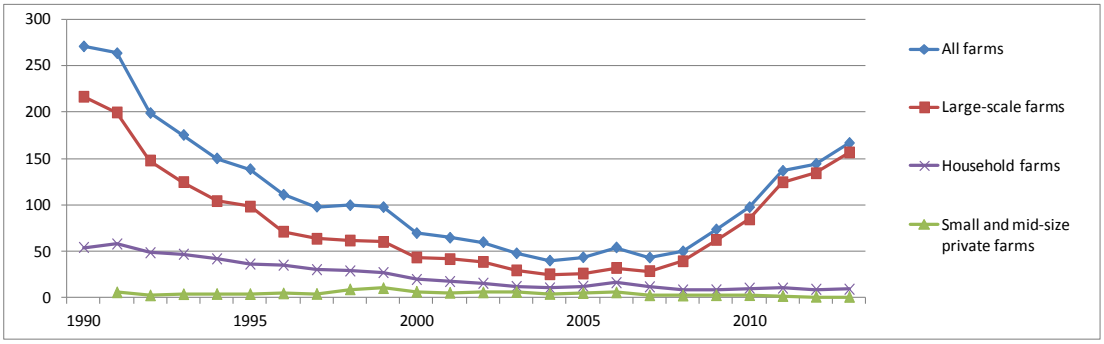
Pig farming in Russia is expected to continue to grow under the State Programme for Development of Agriculture and Regulation of Agricultural Commodities, Raw Materials and Foodstuffs Markets for 2013–2020. The programme does not specifically target the pig industry, but it includes general principles of support for all agricultural producers and some

[7] Federal State Statistics Service, Russian Federation (2012). http://www.gks.ru/.

measures connected with pigs' veterinary care and with the development of the meat processing industry. Furthermore, it should be noted that in January 2017, Russia plans to cancel federal budget subsidies on the new investment loans taken for construction, reconstruction or modernization of pig farms (complexes), provided that by 2018, pork production volumes reach the level required by the country's food security policy. Taking into account these plans, the current market and industry conditions, and World Trade Organization rules, the Ministry of Agriculture (2013) projects that by 2020, Russia will have 25 to 26 million pigs.

Figure 7 shows trends in pig production in the Kaliningrad region. An interesting observation is the small share of small and mid-size private farms. Large-scale pig production, meanwhile, has nearly returned to Soviet-era levels, except that instead of being run by the state, those farms are now dominated by private investors.

Figure 7: Pig livestock in Kaliningrad region (in 1,000s of heads)



Source: Data from Federal State Statistics Service, Russian Federation, Territorial Authority for Kaliningrad (2013).

Although the Kaliningrad region has not had a special programme focused only on pig farming, it has been able to significantly increase pork production by providing state support for substantial private investments. There are now three major industrial-scale pig farms in the Kaliningrad region, representing 93.9% of the production, while the mid-sized private farms and household farms have 0.6% and 5.5%, respectively.

Notably, in the Neman/Nemunas area of Kaliningrad in particular, the share of household farms is higher than average: 56% of the pig population. This highlights the need for policy-makers to pay attention to household-level pig production as well.

4.2 Belarus

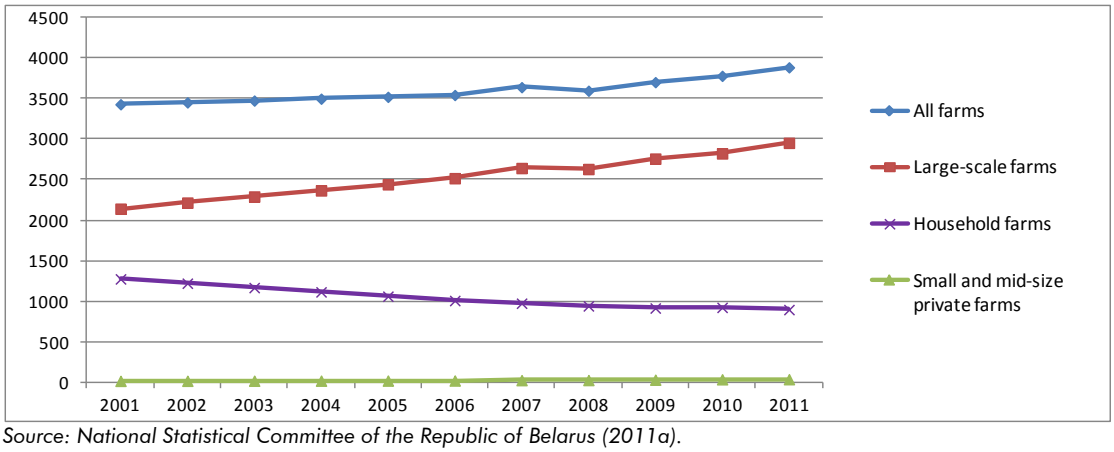
By the early 1990s, Belarus was the second-biggest pig producer (after Estonia) in the former Soviet Union. As in the Kaliningrad region, pig production in Belarus declined after the end of the Soviet era, but it has still remained an important sector that has grown dynamically in recent years. Pig farming is considered a key sector for food security as well as an important industry for socio-economic development in rural areas.

As in Russia, the government of Belarus is committed to supporting an expansion of pig farming. The State Programme on Revitalization and Development of Rural Areas for 2005–2010 supported investments in technological innovations and refurbishment of farms. During this period, the farms' capacity increased by 600,000 pigs, accompanied by a 35% increase in production in large commercial farms.

The programme received continued support for 2011–2015 to establish 21 new large-scale farms. The new plan also included large investments for general improvements of existing

farms to increase productivity and to adopt measures to mitigate environmental impacts. The goal is to increase production in large-scale farms by 60% by 2015. The government sees pig farming as an important employment opportunity and estimates that the current programme will create about 3,000 jobs. Within the Neman/Nemunas river basin in Belarus there are about 40 large industrial pig farms with populations larger than 2,000 pigs.

Figure 8: Pig livestock in Belarus (in 1,000s of heads)



Source: National Statistical Committee of the Republic of Belarus (2011a).

Figure 8 shows pig population by type of farm in Belarus. Household farms accounted for 40% of total production in 2010. Although this is high in comparison with neighbouring countries, it reflects a 20% decrease in household farms' pig production since 2000. Still, it is clear that household pig farming remains an important livelihood activity in the region. Mid-size farms, meanwhile, are a tiny part of the sector, accounting for less than 1% of pig sales. Government measures, foreign investor and subsidy programs support intensive, large-scale production, and they have increased production by almost 50% between 2001 and 2011.

4.3 Lithuania

Like Belarus and Kaliningrad, Lithuania saw a significant drop in pig production after the fall of the Soviet Union – from nearly 1.3 million in 1995 to 936,100 in 2000, a 26% drop.[8] But unlike its neighbours, Lithuania hasn't seen a resurgence in pig farming; the numbers have gone up and down, but at the start of 2012, there were only 790,300 pigs.

Table 1: Number of farms and pigs in Lithuania

Farm size	Number of farms			Number of pigs (1,000s)			% of total pigs		
	2005	2007	2010	2005	2007	2010	2005	2007	2010
1-100	151,586	95,118	62,581	610.8	281.7	205.2	50.9	29.5	23.9
100-2,000	203	120	91	71.6	51.6	40.9	6.0	5,4	4.8
>2,000	46	49	37	517.8	622.8	614.2	43.1	65.1	71.4
Total	**151,835**	**95,287**	**62,709**	**1200.2**	**956.1**	**860.3**	**100**	**100**	**100**

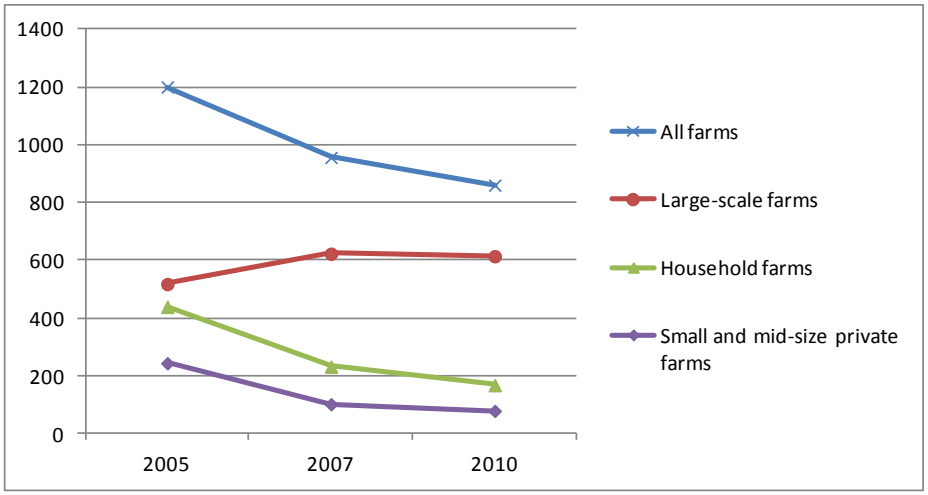
Source: Lithuanian Department of Statistics.

Small- and medium-scale pig production in Lithuania has declined dramatically in recent years. As shown in Table 1, the number of farms with 100 or fewer pigs dropped by 59% from 2005 to 2010, while the number of pigs in those farms dropped by 66%. As in Belarus

[8] Statistics Lithuania, *Number of livestock and poultry by kind, period*. M5010401. http://db1.stat.gov.lt/statbank/SelectVarVal/define.asp?MainTable=M5010401&PLanguage=1&PXSId=4361&ST=ST. Accessed 14 March 2012.

and Kaliningrad, the role of mid-size farms is limited; see Figure 9. Industrial-scale production has increased at the same time, though not enough to offset the sharp drop in smaller farms. This trend roughly corresponds to when Lithuania became an EU member. The number of pigs in large-scale farms increased by 18% from 2005 to 2010, but the increase in share of pigs in large farms rose from 43.1% to 71.4%. In the current system it is less viable to raise pigs on a small scale.

Figure 9: Pig livestock in Lithuania (in 1,000s of heads)



Source: Data from Lithuanian Department of Statistics.

5. ROLE OF PUBLIC AND PRIVATE SECTORS IN THE PIG FARMING SECTOR

Global meat production and consumption have more than quadrupled in the last half-century, from 70 million tonnes in 1961[9] to an estimated 304.1 million tonnes in 2012, and they continue to grow steadily, driven primarily by fast-rising demand in developing countries (FAO 2013). Pork is the most consumed meat from a terrestrial animal, accounting for 112.7 million tonnes of 2012 consumption (followed closely by poultry, at 104.9 million tonnes).

This section focuses on the interplay between public and private sectors and their respective influence on the pig farming sector. Since agriculture is heavily subsidized around the world, the public sector plays a critical role in shaping the industry through economic incentives and other supportive measures. As noted in earlier sections, pig farming in the Neman/Nemunas basin was driven by the state during the Soviet era and declined sharply after the fall of the Soviet Union. The recovery seen in recent years in Kaliningrad and Belarus has been driven by a combination of government incentives and private investment, which we describe in more detail below.

5.1 Kaliningrad region

The resurgence of pig farming in Russia, including the Kaliningrad region, started in 2006, mainly due to state support of investment activity in agriculture under the National Priority Project "Development of the Agro-Industrial Complex" in 2006–2007. In 2006, after a competitive process, the Ministry of Agriculture of the Russian Federation chose four enterprises, deemed to have the most efficient business plans for pig production in the region, to participate in the National Priority Project. These companies built large pig complexes in Kaliningrad region, and within three years were working at full capacity. They subsequently

[9] Data from the International Assessment of Agricultural Knowledge, Science and Technology for Development (IIASTD); for a summary, see http://www.globalagriculture.org/report-topics/meat.html.

built and began operating new facilities, with continued state support for their investments under the State Programme for Development of Agriculture for 2008–2012. The latter included sub-project "Accelerated Development of Livestock Farming", focused on the following activities:

1. Enhancing the availability of credit resources for agricultural producers. The main tool for implementing the activity was subsidizing interest rates on loans, with terms up to 8 years, for construction and modernization of livestock facilities; two-thirds of the subsidy came from the federal budget, and one-third from the regional budget.
2. Developing subsidies for leasing machinery, equipment and breeding stock.

Interest rates subsidies have become the major incentive for modernization and construction of pig breeding complexes in the Kaliningrad region, but other types of support from regional and federal authorities have also contributed to accelerated growth. The regional programme "Main Directions for the Development of the Agro-industrial Complex in the Kaliningrad region for 2007–2016", for example, sets a goal of increasing pork production by up to 80,000 tonnes per year. (Few people interviewed for this study were confident that the targets would be met, however.) In 2012, the Kaliningrad region produced 28,900 tonnes of pork,[10] and production was expected to increase in 2013 due to an increase in the number of pigs in industrial facilities.

The Russian Ministry of Agriculture also budgeted 5.7 billion rubles (113.2 million euro)[11] for loans to support the Russian pig farming in 2013. It is a part of additional allocation of 42 billion rubles (932.2 million euro) to Russian agriculture in 2013. This additional support will be distributed in different forms, for example per litre of first-class milk, but mostly for payment of interest rates on loans that have had to be extended because of the low efficiency of business projects in agriculture. Part of the funds will be used to cover the cost of increases in the price of animal feed. The Ministry of Agriculture is working with the Ministry of Economic Development to establish a medium-term programme (for three to four years) that will focus on state support for poultry and pork producers.[12]

Pig farmers will also receive assistance to improve breeding methods to select high-production breeds and animals that are able to adapt to industrial-scale housing conditions; to establish a centre for selective breeding and cross-breeding; and to house and increase breeding stock, with breeding sows to make up 15% of the total number of sows (Target Programme of Kaliningrad region, 2007–2016).

According to expert estimates (Surovtsev and Sergeev 2013), despite the overall increase in pig numbers, it is not likely that pork production and the number of pigs in the Kaliningrad region will increase within the next five years, since no large investment projects are currently being implemented or planned. Interviews with the private sector conducted as part of this study found that uncertainty about the future of government support for large complexes has directly affected the private sector, making foreign investors in particular more hesitant to invest in new technology. Lack of clarity about the environmental regulatory framework has also led to hesitation about investing in environmental measures. As a result, foreign

[10] Ministry of Agriculture of the Kaliningrad Region (2013), http://mcx39.ru/wp-content/plugins/download-monitor/download.php?id=83.

[11] One Russian ruble corresponds to approx. 0.022 euro (29 November, 2013, www.xe.com).

[12] Korobitsyna, O. (2013). Министр сельского хозяйства Фёдоров: Россия может себя прокормить! (Agriculture Minister Fyodorov: Russia cannot feed itself!). *Argumenty i Fakty*, No. 20, 15 May, page 14. http://www.aif.ru/money/43370.

investors, including companies from EU Member States, have made only limited investments in environmental measures.

5.2 Belarus

In 1988, Belarus produced 458,000 tonnes of pork. At the time the profitability of the pig farming sector exceeded 30% (Pestis et al. 2006). In the first years of the post-Soviet era, amid a transition to a mixed economy, the pig farming sector experienced a rapid decline. There were shortages of feed, animals had unbalanced diets, and fuel and electricity costs rose. The government decided to support the expansion of pig farming, and the State Programme on Revilatization and Development of Rural Areas 2005–2010 supported investments in technological innovations and reconstructions of old Soviet farms. During this period the capacity increased by 600,000 pigs, leading to a 35% increase in production at commercial farms. The development of pig farming is of high strategic importance for Belarus in terms of food security. There are currently pig-breeding facilities in all the regions, 96% of them owned by the government. The meat is sold domestically and abroad.

Pork qualifies as a "socially important" good, which means prices are highly regulated, with fixed prices, price ceilings and capping of trade margins. At the farm gate level, the Ministry of Agriculture and Food of Belarus determines the prices for agricultural products sold to state procurement organizations, and these account for the majority of agricultural sales in Belarus. The state also sets industrial pig farms' production targets, supplies agricultural inputs at subsidized prices, and controls wages.

Production costs have been rising over the past years due to price increases for fertilizers and other farm inputs, so price controls and artificially low farm gate prices have had a negative impact on farm revenues. Profit margins in the agricultural value chain have thus shifted to the processing sector. Some agricultural industrial pig farms have processing units within their organizational structure, which enables them to gain some profits.

State-owned industrial pig farms sorely lack funds to make their own investments. Almost all investments for modernization and expansion of pig farms are planned at the national level, as part of several nationwide and regional development programmes. The Republican Programme for Reconstruction, Technical Requirements and Construction of New Pig Complexes for 2011–2015 aims to increase production and improve the efficiency of industrial pig farms. The plan is to introduce modern technologies and energy-saving equipment, rebuild old facilities, and build new facilities. In addition to technological innovations, the government is also focusing on how to improve the regulatory framework and improve current economic policies to attract more investors. The government foresees pork production to increase by 87% by 2015 from 2009 levels. The Ministry of Agriculture and Food has been given the mandate to fulfil the goal.

Also as part of the programme, 72 pig breeding complexes are to be built, with complete production cycles, and 38 new reproduction workshops are to be held at existing complexes (to increase production capacity by 39% by 2015 from 2009 levels). In addition, five breeding farms and six pedigree breeding reproducers are to be set up. At full capacity the new liveweight pig reproduction facilities are expected to reach 650 tonnes per year by 2018. Reconstruction and technical re-equipment are also planned for all 107 existing pig farms.

The total planned investment in reconstruction, technical re-equipment and new farms for pigs breeding is 10 trillion Belarusian rubles (787.2 million euro).[13]. Almost all of this will

[13] One Belarusian ruble is 0.0000787249 euro (29 November 2013, www.xe.com).

come from private bank funds, investors and foreign credit lines; 103.3 billion rubles (8.1 million euro) is to come from pig farms' and complexes' own funds. The funds for the implementation of such investment programmes are provided by state-owned banks via loans under governmental guarantees (it is not unusual for government to have to pay off farms' bad debts). Government also subsidizes (fully or partly) the interest rates on modernization loans to agricultural producers.

5.3 Lithuania

Whereas Kaliningrad and Belarus have experienced an increase in the pig production in recent years, in Lithuania, the decline that began with the end of the Soviet era has continued. In 2003 the share of income from pigs in the total livestock economy was 23%, and by 2010 that had dropped to 12% (Lithuanian Department of Statistics, 2012). Despite optimistic prognoses issued by the Lithuanian Institute for Agrarian Economics, which estimated an increase of 40% by 2020 (based on results from 2009), the sector is shrinking, and foreign investors are seeking opportunities in Kaliningrad instead of Lithuania. The reasons for the decrease are multifold, including demographic changes linked to urbanization as well as stricter environmental policies in the EU. Thus, while in Belarus and Kaliningrad, pig farming has been given priority, in Lithuania, the Ministry of Agriculture has a neutral position with regard to pig farming.

The Development Plan of 2012 sets a goal of increasing meat production (including pork) by 3%. However, in Lithuania as in some parts of Kaliningrad, there is strong local opposition to industrial pig farming, led by environmental NGOs. The Ministry of Environment considers management of smell as a key problem, since smell is not comprehensively controlled, and there have been numerous complaints. Measures are now being taken, through a smell monitoring programme, and the Public Health Services are investing in equipment for smell control. The environmental NGOs in Lithuania argue that the Danish investors that control the majority of large industrial farms do not meet the same environmental standards in Lithuania as in Denmark. The pig farming association claims that the authorities may be biased in favour of the NGOs and local communities.

A similarity between the three case studies is that the public sector plays a key role in providing necessary subsidies and incentives that the sector relies on. In all three countries, small-scale household production remains an important part of the sector. In Kaliningrad, efforts to promote private farms are promoted in the current regional development plan, but measures on how to facilitate the implementation are still being developed. In Belarus and Lithuania, limited attention is paid to small-scale household production. There is a lack of extension services and public-sector attention to how to improve small-scale production and mitigate its environmental impacts.

6. ROLE OF TRADE IN THE PIG FARMING SECTOR

Pig farming sector has been transformed from a traditional rural activity to an activity driven by global commodity markets. This transformation is of high importance when trying to encourage more environmentally friendly management practices, since the actors leading the change process are not only governments, but also the private sector – and foreign investors in particular. In Belarus, trade in pigs mean access to hard currency. Cheaper meat from Poland is imported to meet domestic needs. A prime motivator for countries promotion of pig farming in the Neman/Nemunas basin is to attract foreign investments.

In 2012, Russia produced an estimated 2.6 million tonnes of pork and imported an estimated 1.1 million tonnes. The Kaliningrad region could be self-sufficient in pork, and production even exceeds consumption, but the current market situation is such that domestic production constitutes only about 20% of the local pork market. The rest is imported as chilled and frozen pork mostly (127,000 tonnes in 2012, per the Federal State Statistics Service, 2013). At the same time, a considerable amount of pork is exported from the Kaliningrad region to other parts of Russia – both locally produced meat and imported pork.

The situation in Lithuania is similar: almost the same amount that is imported is also exported. The key country for exports from Lithuania is the Russian Federation, and the main country for import is Poland. According to the Lithuanian Pig Farming Association, this is due to the fact that Lithuanian farmers receive higher prices for pigs on the Russian market. Fluctuations in the revenues of the pig farms are linked to trade and markets.

In Belarus the import of pork exceeds the export of pork by 42% (see Table 2). Given the recent fluctuations in financial markets, exports from industrial farms represent an important source of income for the national economy. Inflation and currency fluctuations have led to a need for increased export of pork from Belarus to Russia, which in turn requires an increase of imports from Poland for domestic consumption. According to the National Statistical Committee of the Republic of Belarus (2011b), in 45,000 tonnes of pork from Belarus (9% of total production) went to the Russian market in 2011.

Table 2: Export and import of pork in Belarus

Commodity country of origin	2008		2009		2010	
	Quantity (1,000 tonnes)	Value (1,000 USD)	Quantity (1,000 tonnes)	Value (1,000 USD)	Quantity (1,000 tonnes)	Value (1,000 USD)
Export:						
CIS countries	31.2	104,592	17.1	47,462	38.7	119,029
Import:						
Total import	***49.9***	***138,277***	***22.6***	***61,593***	***72.6***	***171,698***
CIS countries:	0.1	244	-	-	0.0	101
Non-CIS countries:	49.8	138,033	22.6	61,593	72.6	171,597

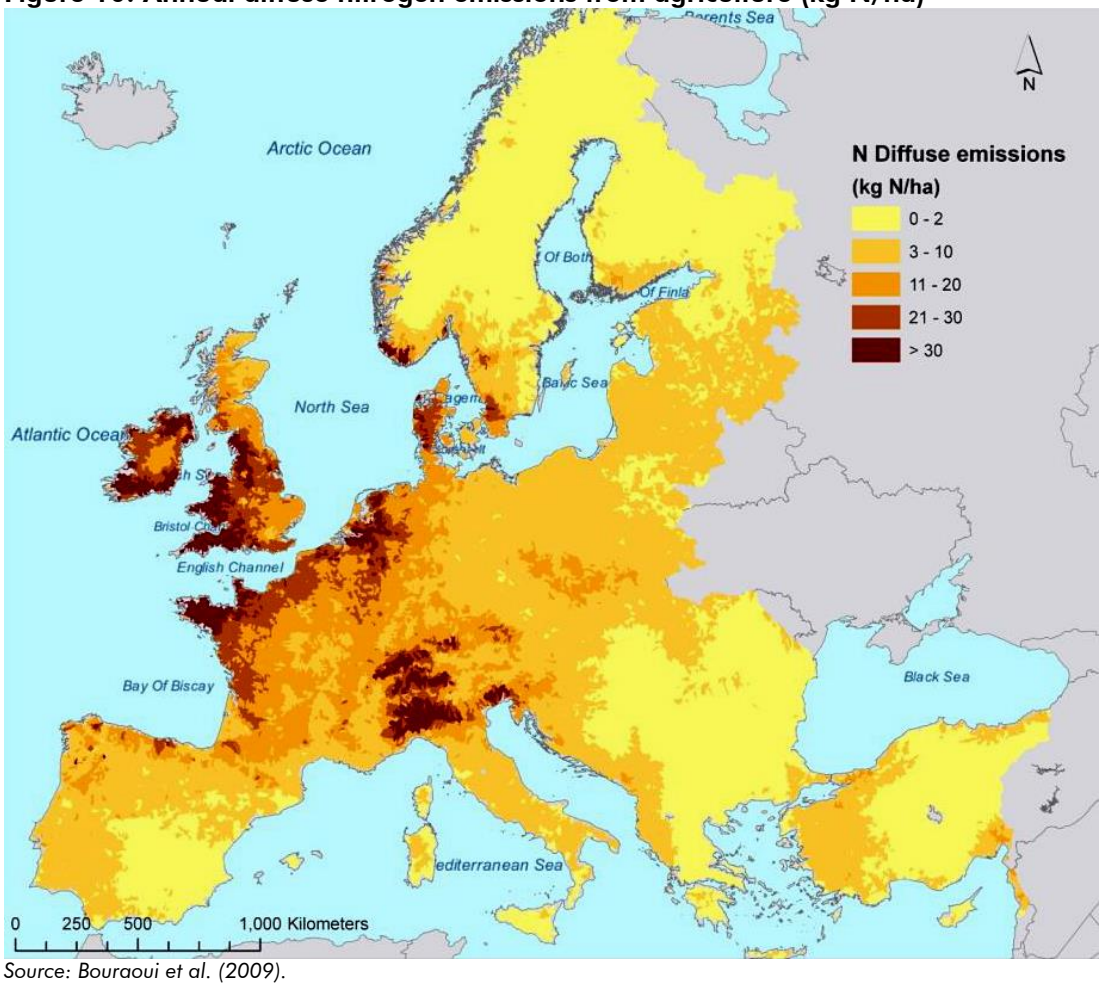
Source: National Statistical Committee of the Republic of Belarus (2011b).

7. ENVIRONMENTAL IMPACTS AND BIOSECURITY IN PIG FARMING

The impact of agricultural activities on the water bodies of the Neman/Nemunas basin varies, depending mainly on the intensiveness of agricultural activities. Water pollution sources are usually classified as either diffuse or point-source, and agriculture is a major source of diffuse-source pollution in the Neman/Nemunas basin. Manure management in the pig sector is one of the sources of that pollution (see Figure 10). The Nemunas River Basin Management Plan in Lithuania estimates that diffuse agricultural pollution accounts for 45-80% of the nitrate-nitrogen loads entering water bodies (Government of Lithuania 2010).

The pig farming sector is also associated with point-source pollution from wastewater discharge and runoff from manure storage sites. Table 3 shows wastewater generation and its contribution of pollutants by point sources from agriculture, forestry and fishing in Lithuania. According to data from Eurostat, the volumes of wastewater are not decreasing, but there has been a reduction in the actual contaminant load.

Figure 10: Annual diffuse nitrogen emissions from agriculture (kg N/ha)



Source: Bouraoui et al. (2009).

Table 3: Wastewater generated by agriculture, forestry and fishing (point source) in Lithuania

Parameters	2006	2007	2008	2009
Volume wastewater (million m3/year)	57.23	63.83	63.55	62.92
BOD (tonnes 0_2/day)	15.89	14.61	14.14	13.55
N-total (tonnes/day)	1.49	1.43	1.24	1.15
P-total (tonnes/day)	0.26	0.28	0.24	0.21

Source: Eurostat, 2013

Major point-source pollution is mainly derived from intensive pig production systems, which generally involve large numbers of animals concentrated in relatively small areas. The impacts on water resources depend on the management system and show great variations in the farms, both between and within the countries studied here. Diffuse or non-point pollution associated with pig farming can be linked to three main sources: livestock wastes and, in particular, manure applied on land; run-off and subsurface flow in cases where manure is deposited on soil; and high demand for feed and forage resources that often require additional inputs of mineral fertilizers and pesticides to arable land, with increased risks for generating water contamination (Steinfeld et al. 2006).

The major negative impact of over-fertilization or leakage of nutrients and organic matter is the eutrophication of inland and sea waters. Over-fertilization of soils can also contribute to

the formation of acid rain and increase the greenhouse effect. Apart from odour generation, the decomposition of manure can cause air pollution with gases such as ammonia, methane, hydrogen sulphides, carbonyl compounds, amines, etc. The content of organic compounds in the atmospheric air on the territory of a pig farm can be 40-50 mg/m^3, and within a 1 km radius, 18.6 mg/m^3, and the offensive odours can spread as far as 5 to 7 km (Łysko and Cyglicki 2002). For example, in Lithuania, where a majority of farms lack proper manure storage procedures, the methane and ammonia emissions from pig farming are significant.

The waste streams from the pig production are also a source of biological contamination, which can create health hazards. Livestock excrete many different parasites of relevance to human health. Pathogenic micro-organisms can be water-borne or food-borne, especially if the food crops are irrigated with contaminated water. The use of trace (heavy) metals in feed additives is also a source of water contamination. For example, copper and zinc are added to reduce risks for stomach diseases in pigs. Most of these ingested heavy metals are excreted again and return to the environment (Steinfeld et al. 2006).

Biological contamination can also be a direct hazard for the industry itself, as in the case with the African swine fever (ASF), which has caused a decline in pig production in Belarus. The risk increases with large-scale farms, since the impact of failure can be enormous. Effective July 2013, Belarus no longer allows private homes or farms to keep pigs within a 5 km radius of industrial pig farms.

The risk of ASF is also affecting pig farms in the Kaliningrad region. Some regions of Russia have already registered cases of this disease, and there are concerns that ASF could come to Kaliningrad via Belarus. Serious measures are being undertaken, and there are recommendations by the state veterinary controlling authorities: vaccination, keeping pigs in closed sheds, border control, fodder and raw material for mixed fodder control, avoiding visitors on farms. The Russian ban on import of live pigs is connected with this problem as well. The ban was enforced in 2012 and has been heavily criticized by the EU. Lithuania has also taken actions to avoid the spreading of this disease.

8. ENVIRONMENTAL MEASURES AND NUTRIENT MANAGEMENT IN PIG FARMS

8.1 Nutrient management in the pig farming sector

An important way to manage nutrients from livestock production is to link them to fertilizer application in the fields. A pig in a production unit produces close to four times as much excrement as a human being. Hence, large-scale farms can be compared to large cities when it comes to the generation of excreta, which explains the need for appropriate management. If the manure can be brought back to the fields instead of deposited, this will reduce risk for leakage and will also reduce the input of mineral fertilizers. An increasing issue in areas with high-density pig farming is that the available land areas for manure application are limited; hence there will be a surplus of manure.

Inadequate organic fertilizer application methods to fields may cause additional pressure on the environment. For example, with surface runoff during snow melt or intense rainfall, a lot of the organic compounds enter surface water bodies. In addition, if large amounts of organic fertilizers are applied annually to the same plots, this can lead to excessive levels of nitrate in the soil and increase the risk of leakage and water contamination.

An important reason for the current environmental challenges in the agricultural sector in the Neman/Nemunas River basin is the changing composition of the farms. A few decades ago it was more common to have a combination of livestock and food crop/vegetable production.

These combined farming systems allow farmers to use manure to fertilize arable lands and pastures. Farms today, however, typically specialize in one or the other, and due to a lack of collaboration among farmers, relatively little manure is used to fertilize cropland, while a large share is deposited on limited land areas. This leads to inadequate nutrient management and excessive nutrient input to the soil, with severe negative impacts on water quality. Figures 11 and 12 show the average mineral and organic fertilizer application rates for the three countries.

Figure 11: Mineral fertilizer NPK application rates, Neman/Nemunas basin, 2010

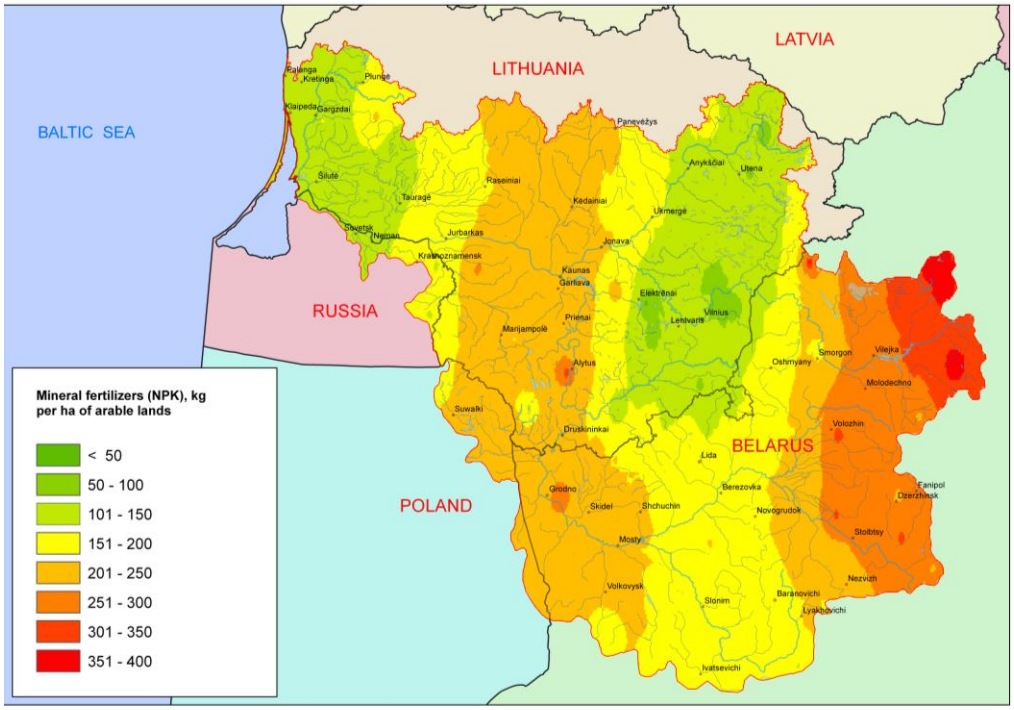
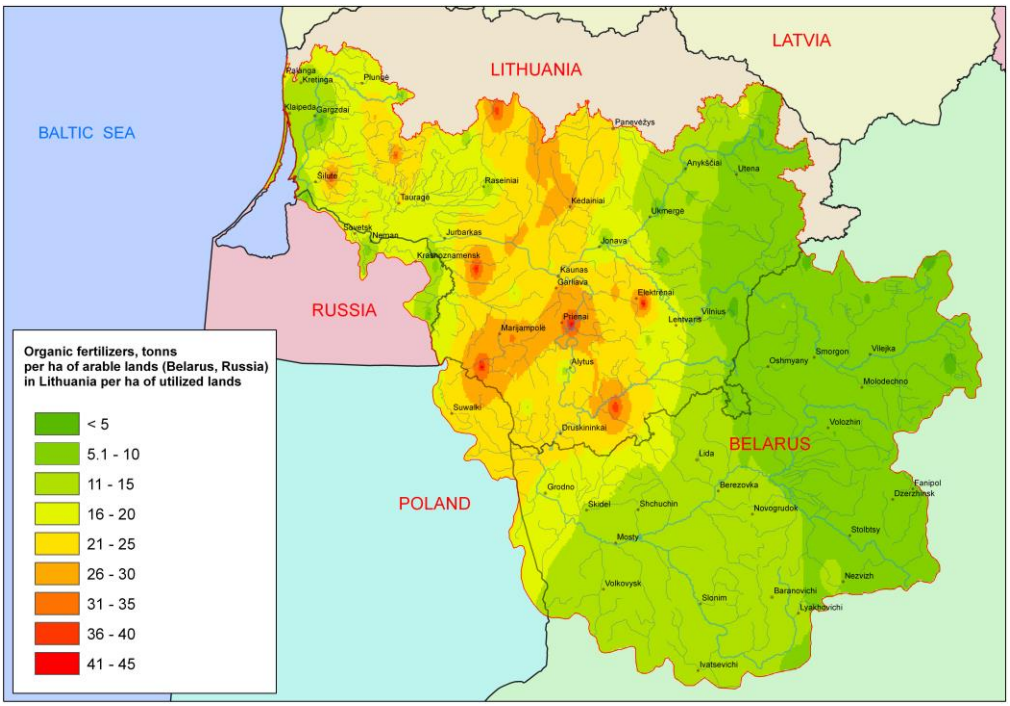


Figure 12: Organic fertilizer application rates, Neman/Nemunas basin, 2010



8.2 Supply of feed in pig farming

Animal feed is another important component of pig production to consider when analysing the sustainability of the sector. Worldwide, animal feed production takes up an estimated 33% of agricultural crop land (Steinfeld et al. 2006). The increasing demand for food and feed products, combined with declining natural fertility of agricultural lands resulting from increased erosion, has led to an increased use of chemical and organic inputs (including fertilizers and pesticides) to maintain high agricultural yields. This increase, in turn, contributes to a widespread pollution of freshwater resources.

The feed supply can be distinguished between local, regional and imported feed. For the large-scale farms in Kaliningrad, most of the feed is purchased locally, from central Russia, or imported from abroad, as the case with soy meal. One of the pig complexes produces 25% of its own feed, while the other two large complexes purchase all of their feed.

The situation in Belarus is similar, with most large-scale farms dependent on external feed producers. It is common for 80-95% of the feed to be purchased, mainly from domestic producers. About 5% of this feed is imported from other countries, e.g. soybean meal (Moldova, Ukraine, Brazil, and Latvia) and sunflower meal (Ukraine, Moldova, and Russia). The forage supply in household pig farms is mixed, combining own crop production (20%) with purchased feed (feed, grain) from agricultural enterprises (80%).

Lithuania also shares a similar situation as the other countries; a majority of farms are dependent on external feed producers. Soybeans and additives are imported from global markets, depending on market prices.

Since only a limited share of the feed used in pig farms in the Neman/Nemunas basin is produced locally, this sector not only contributes not only to local environmental pressures, but also to pressure on other land areas and water bodies both inside and outside the three countries.

8.3 Environmental measures in pig farms in the Neman/Nemunas basin

This study highlights the need for a diverse set of measures to address the environmental and social factors linked to different types of pig farms in the Neman/Nemunas basin. In the section below we describe some measures that are already being employed in the basin.

Kaliningrad region

The Kaliningrad region is promoting the development of the agricultural sector, partly focusing on environmental protection and promotion eco-friendly food production, through the regional target programme “Development of Agriculture and Regulation of Agricultural Commodities, Raw Materials and Foodstuffs Markets for 2013–2020”. There is no direct support for environmental measures or investments in the programmes, but if a measure, such as utilization of livestock wastes, is a part of a new investment project, it could be subsidized within the project on a regular basis.

Achieving the goals regarding manure management will require significant investments. Some of the technical measures employed today to obtain manure of reduced moisture content in Kaliningrad are:

- Arrangement of manure collectors and storage facilities above the subsoil water level;
- Dry cleaning of stalls and service alleyways;
- Arrangement of strict recording and control of water flow and manure discharge;
- Application of high-pressure equipment for periodical flashing the stalls.

One of the large-scale farms has studied various manure treatment technologies, including manure separation, composting, biogas production and others, and it has determined that introduction of environmental measures is currently not cost-effective. If a new technology – effective and profitable under current market conditions – appeared, the company expressed a willingness to use it.

A regulatory instrument to address some of the environmental issues associated with pig farming in Kaliningrad is the "Sanitary protection zones", which new pig farming activities needs to comply with. This regulation divides pig farming into five hazard classes depending on farm size, activities and design of installations, as shown in Box 2.

Box 2: Sanitary protection zones and sanitary classification of constructions, enterprises and other facilities

CLASS I – 1000 metre protection zone 1. Pig complexes. 2. Open manure storages. **CLASS II – 500 metre protection zone** 1. Pig farms with 4,000–12,000 pigs. 2. Open manure storages for biologically treated liquid fraction. 3. Covered manure storages. **CLASS III – 300 metre protection zone** 1. Pig farms with up to 4,000 pigs. 2. Sites for manure heaps. 3. Facilities (garages and sites) for maintenance and storage of trucks and agricultural machinery.	**CLASS IV – 100 metre protection zone** 1. Reclamation facilities using livestock wastes. 2. Facilities for fodder preparation, including use of food wastes. 3. Farms with a number of animals (piggeries, barns, stables, fur farms) of up to 100. 4. Fuel and lubricant warehouses. **CLASS V – 50 metre protection zone** 1. Farms with up to 50 animals (piggeries, barns, stables, fur farms). .

Note: The size of a sanitary protection zone for operating pig farms and pig complexes can be increased or decreased, depending on the pollution level, confirmed by measurements or laboratory observations. Source: State Sanitary Rules – SanPiN 2.2.1./2.1.1.1200-3 – paragraph 1.8.

Market conditions and competition with foreign farms create challenges, however. Most European farms are done making investments in environmental technologies, which were highly supported by their governments when they made them. Russian farms cannot afford to make environmental investments now, as the cost could undermine their competitiveness, and there is no direct support of environmental technologies in agriculture by the state.

In addition, the case study showed that household production remains an important producer of pigs and represent an important source of food in rural areas, but these farms are not subjected to any formal management regulations.

Belarus

Belarus has introduced measures to reduce risks to human health and the environment from large-scale farms, including:

- Reconstruction of system for manure sediment storage;
- Modernization of water supply and water disposal systems;
- Construction of a biogas plant;
- Construction of biological ponds.

At the same time, many pig farms still use technologies from the 1980s. A majority of the pig farms included in the country's 2011–2015 reconstruction and upgrading programme are not profitable without direct state support. Currently, the lack of available funds is resulting in further deterioration of large-scale pig farms. Consequently, any improvements in manure management will require state funds or international support. The majority of farm representatives are familiar with modern measures to protect the environment (water protection zones, organic farming and bio-ponds, biogas plants, etc.).

Only a few private and household pig farms have installed protected storage sites (concrete collectors), while a majority store the manure directly on the ground. Only a limited number of interviewees were aware of the risk for ground- and surface-water contamination.

Belarus has also regulations concerning sanitary protection zones – comparable to those in the Kaliningrad region – to protect the local environment and human health from the negative impacts of pig farming activities.

Lithuania

According to the Lithuanian Rural Development Programme 2007–2013, the reduction of methane and ammonia emissions from inappropriate storage and use of fertilizers and liquid manure is one of the key objectives in implementing the Lithuanian Action Programme within the framework of the EU Nitrate Directive. As the majority of farms lack proper manure storage capacities, methane and ammonia emissions and outdoor pollution from pig farming are significant. Today the large-scale pig farms dispose of liquid and solid manure on the plots of the farms, often to areas without crop production, contributing to substantial contamination.

In Lithuania, national regulations set the basic technological requirements for the design of pig farms, depending on the farm size, as shown in Table 4. It should be noted that these regulations apply to both existing and new farms; only in the case of small-scale farms does this requirement only apply to new farms. For example, pig farms with 2,000 and more pigs have to submit documents for Integrated Pollution Prevention and Control (IPCC) permits; 30 permits have been issued in the Nemunas basin. The IPPC permits should have information on what Best Available Techniques (BAT) have been implemented or will be applied during the validation period of the permit.

Table 4: Key environmental requirement for different pig farm sizes in Lithuania

Farm size class	Summary of the key environmental requirements
1-100	For farms constructed up to 2004 there are no requirements for construction of dung yards, but requirements on proper field fertilization apply. Farms constructed after 2004 must comply with regulations concerning manure and wastewater management.
100-2,000 (and 1-100 when initiated after 2004)	Obligation to have dung yards set up according to environmental standards as well as requirements on proper fertilization of fields. For new farms with 700 pigs or more, an environmental impact assessment is obligatory.
>2,000	Obligations to apply for IPPC (Integrated Pollution Prevention and Control) permit as well as to comply with requirements for groundwater monitoring and proper fertilization of fields. For new farms, environmental impact assessments are obligatory.

According to the national IPCC register, the large-scale farms generally declare that they are using BAT for Intensive Rearing of Poultry and Pigs (July 2003). These measures are mainly the same for all farms because of a limited number of consulting companies on the Lithuanian market providing IPPC permits development service. This has led to an almost standardized procedure, where the majority of the environmental measures (also including those not

obligatory by legislation) are implemented formally. The implemented measures include: water saving (e.g. high pressure cleaning systems); energy saving (e.g. natural ventilation); biogenetical pollution (e.g. protein content regulation in fodder); smell management (e.g. cleaning of stalls, covering of slurry storage); and waste management (e.g. waste separation).

Implementation of biogas plants has not been very successful in Lithuania. Two farms installed biogas plants; one plant had a fire and has not been restored, and the other stopped working after a change of ownership. Apart from this, another farm considered installing a biogas plant, but the plan was cancelled because of it was too complicated and because of the bureaucratic procedures involved.

8.4 Implications of current manure production and nutrient management

The amount and type of manure produced is determined by the amount and type of livestock and methods for collecting and handling the manure. According to interviews conducted in the three countries, the main issues related to manure handling are:

- Pollution of drinking water sources, according to representatives of large-scale pig farms in Belarus;
- Strong odours during manure spreading period, according to complaints from local populations;
- Sewage overflow or breakdown of wastewater systems generate leakage to ground- and surface waters;
- Use of water for cleaning (instead of bedding with straw), a method that generates low fertilizing quality of manure and more liquid manure fractions, which leads to faster filtration to ground- and surface waters.

Apart from issues directly related to manure, a farm manager in Kaliningrad pointed out that the improper handling of dead animals and slaughterhouse wastes can become even more hazardous for the environment and public health compared to the manure handling.

Kaliningrad Region

In the large-scale farms, manure is generally mixed with cleaning water. In one of the pig complexes, manure is stored for 10 months to reduce biohazard before it is spread on available fields. One crop production enterprise purchases a part of the manure from this pig complex for spreading on its fields.

Another pig complex has a yearly manure production of 176,000 tonnes. The liquid fraction is pumped into storage lagoons (160,000 tonnes), while the solid fraction is stored on-site (16,000 tonnes). Manure is spread to an area of 5,000 hectares. Manure is pumped through the pipes around the complex and applied by special machinery with hoses (see Figure 13). Since the farm does not have enough fields nearby, it uses its available land to a maximum. That results in constant complaints of the local population about the odour coming from manure transportation and spreading. Liquid fraction application rate is as high as 40 t/ha. As a reference data for Kaliningrad region, the average manure production is estimated to 4.8 kg per animal, while the average nutrient value (on the dry weight basis) of pig manure as a fertilizer is given in Table 5.

Figure 13: Spreading of liquid pig manure in Kaliningrad

Photo by pig farm staff.

The third large-scale farm does not have its own lands available for manure application. Instead, it has contracts with crop producers for manure supply. The farm has to pay for manure removal (approx. 1 euro/tonne). Estimated manure production is 34,000 tonnes/ year, implying an annual disposal cost for the liquid fraction of about 34,000 euros.

These three large-scale pig producers hold more than 90% of total pigs in the Kaliningrad region.

Table 5: Value of pig manure as a fertilizer on dry weight basis

Pig manure	Content in the dry weight, %		
	Total nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
Liquid fraction	3.3	0.32	1.25
Solid fraction	2.7	2.88	1.25
Total content	6.0	3.2	2.5

Source: Methodical recommendations for design of manure effluents removal and processing systems at industrial type pig complexes. Ministry of Agriculture of the Russian Federation (2009).

Many small and medium-sized pig companies are facing manure handling problems. Many farms have not modernized their production and continue to use antiquated technologies and equipment. Since the manure produced on the farms is mainly slurry, it is difficult to store, transport and spread without special machinery and equipment. Usually, manure is transported to the fields and incorporated by plowing. Household plots remove manure manually and store it in piles. Small amount of produced manure are used as organic fertilizer for potatoes and vegetables.

In Kaliningrad there are only recommendations specified for spreading of pig manure, but no official regulations currently exist, which is a problem for farms, surrounding communities and official supervisory authorities (See Annex 1 for Russian manure recommendations). New regulations based on European solutions, modern technologies, relevant experience and environmental requirements have to be developed and issued. Another detected problem was the ineffective production control and penalty system for the violation of rules and environment pollution.

An increase in prices for mineral fertilizers and drastic changes to the structure of support given to agricultural producers have led to increased efficiency in the use of manure as a fertilizer. Before 2013, subsidies were available to purchase mineral fertilizers (up to 79% of the value), but in 2013 these subsidies were removed and green-box subsidies were introduced, meaning they are not connected with a particular product, and include direct support for farmers per hectare of arable land. However, there are no specific regulations on manure application. Normative documents (e.g. State Standards – GOST, Industry Standards – OST, State Sanitary Rules –SanPiN) do not consider new technologies and need to be

updated, according to interviewees. Intensive crop production in the Kaliningrad region contributes to ensuring favourable conditions for the development of forage and fodder production, and also for environmentally safe manure utilization, allowing the recycling of waste into organic fertilizers to be used in crop production.

Belarus

Manure management in Belarus can be differentiated according to farm size:

Large-scale farms: Large industrial pig farms in Belarus are employing different methods of manure management, starting from direct storage on agricultural fields to advanced technological processes, including biogas production. Of the 27 industrial farms covered in this study, two have biogas plants in operation, and another is planning to install one. A common feature in the large-scale pig farms is a separate handling of liquid and solid manure. After storage in open ponds or closed tanks, the liquid fraction of manure is used as organic fertilizer for row crops on arable land belonging to the agricultural large-scale farms.

In the case of Belarus, the manure management in industrial pig farms has been identified as one of the major potential sources of negative environmental impacts in the Neman/Nemunas basin. The main sources of pollution of surface and groundwater are manure sedimentation tanks, liquid manure storage ponds, and the crop fields where manure is applied as organic fertilizer.

Historically, farms in the Neman/Nemunas River basin in Belarus have had high fertilizer application rates. In the main southwestern part of the Belarusian section of the basin, the application to soils is an average of 11.1 tonnes of organic and 184 kg of mineral fertilizers (NPK) per 1 hectare of arable land,, including 73 kg/ha of nitrogen, 17 kg/ha of phosphorus, and 94 kg/ha of potassium (see Figures 11 and 12). The application rate in the northeastern part is lower, less than 6.2 tonnes of organic fertilizers per hectare, while the mineral fertilizer application in that area can reach extremely high levels, above 335 kg/ha.

Mid-size farms: The maintenance of pig manure is mainly done with straw, so there is no liquid residue generated. It is estimated that a farm with 30 to 150 pigs can produce 0.2 to 0.8 tonnes of solid manure per day, or 40 to 210 tonnes per year, according to interviews with farm representatives in Belarus. In general, all manure is used as organic fertilizer in crop production. A small part of the manure can be sold as a fertilizer to private households that are engaged in agriculture. There is a potential risk for leakage and water pollution if storage facilities do not have the capacity to store manure during periods when spreading is not allowed.

Small-scale farms: Again, manure is mostly disposed of with straw litter, so no liquid manure is formed. The solid manure is carried out mechanically, as a rule, without special equipment for this. In one year a household produces three or four tonnes of manure, which is used as organic fertilizer to grow crops in the own field or transported to other plots. In households there are no special systems for the collection, disposal and treatment of manure (see Figure 14), with high risk for leakage and spreading of contamination to both the atmosphere and water bodies.

Figure 14: Typical manure handling in small-scale pig farms

Photo by: Lubov Hertman, CRICUWR.

National legislation in Belarus does not require a reduction of ammonia emissions from storage and utilized manure. There are no requirements on maximum livestock density and required capacity of manure storage, and the annual allowed nitrogen application rate through manure fertilization is very high (200 kgN/ha for solid manure and 300kgN/ha for liquid manure). In addition, there is no regulation to prevent spreading of the manure during wintertime; this is only specified in technical recommendations.

Lithuania

The majority of the large-scale farms in Lithuania are applying minimum environmental standards according to national legislation. For manure management this generally means waste separation and covering of slurry storage. The environmental impact of small private farms, with about 24% share of the pig population in Lithuania, is significant. Visits to more than 50 small-scale farms that have been in business since before 2004 (the EU accession date) showed that the farms do not have adequate manure storage or facilities to handle liquid residues. The current manure management is not protecting the groundwater from uncontrolled infiltration of polluted runoff. Many mid-size modern farms only have a capacity of up to 699 pigs, since below this size the farmers do not need to apply Environmental Impact Assessment procedures.

Today the large-scale pig farms dispose of liquid and solid manure in the plots of the farms, but only in very rare cases are these lands used for growing crops. On the other hand, the crop farms are buying and applying mineral fertilizers, which in Lithuania is incentivized by the EU direct payment policy.

Per the EU Nitrate Directive, livestock density should not exceed 1.7 livestock units[14] per hectare of agricultural land; otherwise there is a need to have an agreement with other farms. The directive also stipulates that the fertilizer input should not exceed 170 kg N/ha. An

[14] Livestock units in Lithuania are counted thus: sow (including suckling pigs); 0.35; piglets from 7 kg to 32 kg: 0.01; pigs from 7 to 8 months: 0.1; pigs from 8 months: 0.11.

analysis by the Baltic Environment Forum, based on data from the Nemunas River Basin Management Plan and data from the Agricultural Information and Rural Business Centre, shows that the theoretical nitrogen load from all agricultural sectors in the basin is 30.4 kg/ha; the load from pig raising is 1.07 kg/ha, or 3.75% of the total nitrogen load.

9. KEY FINDINGS

This report shows that efficient nutrient management strategies for pig farming need to consider the dynamic changes of the sector. In the Neman/Nemunas basin, large integrated farms dominated during Soviet times. After the fall of the Soviet Union, a diverse sector emerged, with a combination of small and large farms. Today large industrial intensive farms have come to make up 70-85% of the sector, and there has been a constant decrease in small farms. Still, household farms remain an important production unit that is often disregarded in policy analyses, since it is not commercial. The transformation to commercial industrial units calls for a new regulatory framework to ensure more sustainable production.

This report also shows that there are multiple actors with different roles and responsibilities in this sector. It is important to consider that when setting new regulations. For example, household farms in Belarus and Kaliningrad have different abilities and means to take actions for sustainable management than large industrial farms, which use different techniques and pursue a single goal, to maximize production. That implies the need for thorough stakeholder analysis and the promotion of dialogues among stakeholders. This study shows that the private and public sector are far apart. The private sector plays an important role in ensuring that proper environmental measures are taken and suggests that greater emphasis on the private sector is needed. The private sector is not limited by national boundaries, and the regulatory framework needs to be adjusted accordingly.

Furthermore, the study shows that effective nutrient management in the Neman/Nemunas basin will depend on a combination of effective nutrient management and setting a ceiling on the level of nutrients that the system can cope with. That, in turn, requires improved engagement between the riparian states, recognizing that it is important to consider not only hard measures, such as technical tools to mitigate impact, but also soft measures such as stakeholder engagement and dialogues between the public and private sectors.

Our analysis identified several opportunities to reduce water pollution associated with pig farms in the Neman/Nemunas River Basin. They include:

Promote nutrient reuse by connecting pig farms with crop farms that need fertilizer

A majority of large-scale farms specialize in either pig farming or crop production, but not both. This specialization generates an environmental issue, since in many cases, there is no link between manure generation and the fertilization of crops. The pig farms are spreading manure on their own often limited farmland or, in the worst case, just depositing it, while the crop-producing farms purchase mineral fertilizers. This inadequate management of resources leads to higher pressure on water bodies. Strategies are needed to facilitate the reuse of manure; economic instruments may be one way forward to promote collaboration between animal and crop farms.

Pig farms in the Neman/Nemunas basin now depend heavily on external inputs for their animal feed, including imports from other parts of the world, which does not facilitate nutrient reuse. To achieve sustainable production and trade, from both a general environmental and nutrient management perspective, investments in research must be made.

Promote improved manure handling

This study shows that improving manure handling is not only a matter of getting the manure back to the field as a fertilizer, but also of ensuring the manure is handled properly from the stable to the application on the field. For example, the characteristics of the produced manure are greatly affected by collection methods used and the amount of water added. Hence, the type of flooring, cleaning methods, and the collection system are key factors to control undesirable dilution and runoff. An alternative that may be feasible and generate multiple benefits – even in large-scale production – is litter bedding or deep-litter housing. Litter bedding generates very little or no liquid effluent, can reduce odour, and provides benefits to animal health (Kruger et al. 2006). The used litter is suitable for composting, providing an enhanced fertilizer product.

For liquid manure management the use of anaerobic digestion in a biogas plant is an appealing processing technique that will support the hygienization of the manure at the same time as energy is produced. The process will also reduce the organic matter content. Compared with raw slurry, a larger share of the total nitrogen will be in the form of ammonium-nitrogen in the digestate, which facilitates a higher uptake of the nitrogen by the crops; less nitrogen is lost, assuming that there is a need for nitrogen by the plants (Frandsen et al. 2011). At the same time, industrial biogas plants needs to reach a certain scale to become sustainable (Larsen 2012), which indicates that they may be more viable in large-scale farms.

Finally, effective reuse of manure requires improved field management. To avoid nutrient leakage to ground- and surface waters, improved field practices are required, including ensuring adequate fertilizer application rates and periods, tilling, and maintaining buffer distances to water bodies, among others. Improved field management will also have a positive impact from a climate change perspective, since nitrous oxide emissions from agricultural soils depend directly on the amount of application of synthetic fertilizers and manure, the cultivation of nitrogen-fixing crops, the introduction of crop residues into soils, and soil nitrogen mineralization due to cultivation of organic soils.

Strengthen the regulatory framework and remove bureaucratic hurdles

There is a need for a common regulatory framework in the region to ensure compliance with a minimum of environmental requirements. For example, national legislation in Belarus does not set any special management requirements to reduce ammonia emissions from storage and utilized manure. Furthermore, there are no requirements regarding maximum livestock density, and the allowed annual nitrogen application rate through manure fertilization is very high (200 kgN/ha for solid manure and 300kgN/ha for liquid manure).

The country studies that form the basis of this paper found that it is not only lack of interest or funds that prevents pig farmers from investing in environment-friendly technologies. In interviews, farm representatives said that complicated bureaucratic procedures for such technology implementation represent a significant barrier.

Embrace a diverse set of strategies and agri-environmental measures

This study clearly shows the diversity in the pig farming sector between large- and small-scale producers. Small farms account for 15% to 30% of production among all pig farms in the Neman/Nemunas basin. Hence, national environmental strategies for the pig farming sector must also address these small farms to ensure proper manure and waste management. The high diversity of farm types and scales of farming require different solutions, both soft and hard measures.

To improve the environmental and veterinary safety of pig production in large-scale farms it is necessary to develop and adopt new regulations on collection, storage and utilization of organic waste, according to current situation, potentials of innovative technologies and international requirements for environmental protection. For example, installation of biogas plants may have high potential to achieve improved resource management. However, the challenge of ensuring the reuse of the processed manure will still remain, to avoid direct disposal or excessively high nutrient application rates to the field. It is important to ensure accountability among foreign investors. The control function to mitigate environmental and social impact is linked to the way private investors choose to operate. New ways to ensure corporate accountability are important and needed to ensure sustainable pig production. The responsibility cannot be limited to the public sector only. The EU is committed to reducing eutrophication in the Baltic Sea, and if it wants to do so effectively, it must develop a regulatory framework that promotes regional actions to effectively address the environmental concerns of the Baltic Sea. That in turn will require active involvement of the private sector to ensure that pollution is not "exported" to neighbouring countries. The pig farming sector is a good example of how the private sector does not live up to the same environmental practices in its home country as outside national boundaries. This is evident from the farms in Kaliningrad and Belarus included in this study.

Environmental measures adapted for small-scale farming should be implemented, not only for new farms but also in existing ones. For small-scale farming systems, mainly low-cost and low-tech measures will be feasible. In most cases, information campaigns and advisory services will be instrumental. Local governments may play a key role in providing this support and in monitoring the environmental performance of small-scale farms.

Include household pig farms in environmental measures and raise farmers' awareness

As noted earlier, household pig production in the Neman/Nemunas basin is declining, but remains a factor contributing to water pollution. The lack of support for small-scale manure handling measures may lead to negative impacts. Information and awareness-raising campaigns are needed to address this problem, and environmental measures for pig farming must also cover small farms. Most private peasant and household farms are excluded from government extension services as well as from measures linked to the environmental control system; the institutional and regulatory systems have to be adapted to deal with this situation.

Invite international support

International organizations could help enhance the environmental safety of pig production by providing information on innovative technologies of manure storage and utilization in different size agricultural farms: large pig complexes up to 100,000 pigs; medium-size producers with up to 1000 pigs (diversified agricultural enterprises, large peasant farms); and small producers with up to 10 pigs (household farms, including growing pigs for self-sufficiency). For instance, stakeholders in the Kaliningrad region (pig producers, heads of district departments of agriculture, representatives of research and educational institutions) said they would be willing to discuss with international partners how to address problems of environmental and biological safety in agriculture, and that they are interested in participating in joint meetings and seminars on specific issues and best practices.

Introduce joint monitoring of water bodies

There is a need to improve monitoring of water bodies. The current system is based on national monitoring systems that differ between tributaries. There is a need to improve the monitoring systems to more accurately detect the main pollution sources from the agriculture sector. To achieve this it will be necessary to agree on assessment criteria as well as to select

pilot areas where in-depth assessment should be done, including monitoring of groundwater around pig farms and arable land.

The pig farming industry can do much more on its own

The pig farming industry needs to ensure transparency in the production chain, improve its environmental management practices, and make its own voluntary investments in environmental measures, rather than depend on external financial support and legal demands.

The industry also needs to engage in dialogues with relevant stakeholders. Public opinion is generally not positive towards pig farming, and admittedly, the current situation, in which developers by default are considered "bad guys", may not encourage constructive dialogue. Political leaders also will not gain popularity from engaging with pig farmers. However, visible and concrete efforts to support modern and environmentally friendly technologies could improve public perceptions of the industry – and yield real benefits.

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ANNEX 1: APPLICATION METHODS FOR PIG SLURRY MANURE

Agricultural crop	Year application rate		Time of spreading	Soil incorporation method
	Nitrogen, kg/ha	Manure, t/ha		
Winter grain crops	120–140	30–35*	Before main tillage (ploughing)	Under plough
Potatoes	120–200	38–50*	In autumn under winter ploughing or in spring before ploughing	Under plough
Maize for forage and silage	240–400	60–100	In autumn before under-winter ploughing or in spring before presowing tillage	Under plough, disk hoeing plough
Sugar beet	200–300	50–75	The same	The same
Beet and sugar beet for cattle forage	200–400	50–100	–/–	–/–
Perennial grain and grain-legumes grasses for hay and green forage	240–320**	60–80	Before sowing and after cut as fertilizing watering or spraying on soil surface	Harrowing after cuts
Natural grassland and pastures	200–240**	50–60	Early spring and after cut or pasturing, scattering or subsoil, as fertilizing watering	The same
Irrigated cultivated pastures	300–360**	75–90	The same	–/–
Annual grasses	120–180	30–45	In autumn under winter tillage or in spring under presowing tillage	Under plough, disk hoeing plough
Winter intermediate crops	140–180	35–45	Under main or presowing tillage	The same

** Manure application rates are calculated with nitrogen content 0.4%. ** The year amount is separated by equal parts for 2–4 time spread. Source: Ministry of Agriculture of the Russian Federation (2009).*

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