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# Best available techniques (BAT) for intensive livestock farming in the Russian Federation

**Support for implementation of the Gothenburg Protocol to the UNECE Convention on Long-range Transboundary Air Pollution and of environmentally friendly techniques in accordance with the EU Industrial Emissions Directive (IED)**

by

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**Abstract: Best available techniques (BAT) for intensive livestock farming in the Russian Federation Support for implementation of the Gothenburg Protocol to the UNECE Convention on Long-range Transboundary Air Pollution and of environmentally friendly techniques in accordance with the EU Industrial Emissions Directive (IED)**

With the environmental legislation reforms in 2015, the Russian Federation aims at the improvement and harmonisation of Russian legislation with International (CLRTAP) and European (IE-RL) laws and regulations. These reforms also are intended to introduce more precisely defined environmental protection standards by identifying best available techniques (BAT) in all industrial sectors.

The Russian BAT Secretariat envisaged one year for the elaboration and finalisation of the Russian BREF, which should be completed by the end of 2017. Therefore, phase 2 of the project (2016 - 2018) was aiming to support the exchange of information on the description of BAT candidates, the development of methods for the assessment of environmental protection techniques and the description of the techniques with defined criteria in the Russian reference documents using the experiences and results of project phase 1 (2014 - 2016) as well as the experiences from the Seville Process of the EU. The reference documents were completed in December 2017 and entered into force on 1st of June 2018.

The information transfer from the advisory assistance project to the technical working groups for the compilation of the BAT reference documents for pigs and poultry was done by the partner institute IEEP, which was represented by several experts in both technical working groups. The transfer of knowledge from IEEP to other experts (universities, ministries etc.) took place, besides the exchange within the technical working groups, also through two workshops.

As an important result of the project, it was established that the production standards in intensive animal livestock farming in Russia are at a high level, that measures to protect the environment, in particular measures to reduce emissions from livestock houses and measures for the environmentally sound management of livestock manures have not yet been sufficiently implemented.

**Zusammenfassung: Beste verfügbare Techniken in der Intensivtierhaltung in der Russischen Föderation – Förderung der Umsetzung des Göteborg-Protokolls der UNECE-Luftreinhaltekonvention und umweltverträglicher Techniken entsprechend der EU-Industrieemissionsrichtlinie (IED)**

Mit den Reformen der Umweltgesetzgebung im Jahr 2015 zielt die Russische Föderation auf die Verbesserung und Harmonisierung der russischen Gesetzgebung mit den internationalen (CLRTAP) und europäischen (IE-RL) Gesetzen und Verordnungen ab. Mit diesen Reformen sollen auch genauer definierte Umweltschutzstandards mit der Identifizierung der Besten verfügbaren Techniken (BVT) in allen Industriebereichen eingeführt werden.

Das BVT-Sekretariat sah für die Erarbeitung und Fertigstellung des russischen BREF ein Jahr vor, die Fertigstellung sollte Ende 2017 erfolgen. Ziel der Phase 2 des Projektes (2016 – 2018) war daher die Unterstützung des Informationsaustauschs zur Beschreibung von BAT Kandidaten, der Entwicklung von Methoden zur Beurteilung von Umweltschutztechniken und der Beschreibung der Techniken mit festgelegten Kriterien in den russischen Referenzdokumenten unter Nutzung der Erfahrungen und Ergebnisse in der Projektphase 1 (2014 – 2018) sowie der Erfahrungen aus dem Sevilla Prozess der EU.

Der Informationstransfer aus dem Beratungshilfeprojekt in die technischen Arbeitsgruppen zur Erstellung der BVT-Referenzdokumente für Schweine und Geflügel erfolgte über das

Partnerinstitut IEEP, welches in beiden technischen Arbeitsgruppen mit mehreren Fachleuten vertreten war. Der Wissenstransfer vom IEEP zu anderen Experten (Universitäten, Ministerium, etc.) fand, neben dem Austausch innerhalb der technischen Arbeitsgruppen, auch durch zwei Workshops statt. Als wichtiges Ergebnis wurde im Rahmen des Vorhabens festgestellt, dass die Produktionsstandards in der Intensivtierhaltung Russlands sich auf hohem Niveau befinden, Maßnahmen zum Schutz der Umwelt, hier insbesondere Emissionsminderungsmaßnahmen im Stall und Maßnahmen zum umweltverträglichen Management von Exkrementen tierischer Herkunft noch nicht ausreichend umgesetzt werden.

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| | |
|---|---|
| **AEL** | Ammoniak Emission Level |
| **approx.** | approximately |
| **BAT** | Best Available Techniques |
| **BREF** | Reference Document on Best Available Techniques (BAT) for Intensive Rearing of Poultry and Pigs |
| **CLRTAP** | Convention of Long-Range Transboundary Air Pollution |
| **CO2** | Carbon dioxide |
| **e.g.** | exempli gratia, for example |
| **etc.** | et cetera |
| **IED** | European Industrial Emissions Directive |
| **IEEP** | Institution for Engineering and Environmental Problems in Agricultural Production – branch of Federal State Budgetary Scientific Institution “Federal Scientific Agroengineering Centre VIM” |
| **i.p.** | in particular |
| **kg** | kilogram |
| **N** | Nitrogen |
| **No.** | number |
| **NOx** | Nitrogen oxide |
| **P** | Phosphorous |
| **PM** | Particulate Matter |
| **t** | ton |
| **TWG** | Technical working group |

# 1 Introduction and background

Emissions of pollutants (e.g. ammonia and nitrate) from intensive live-stock farming endanger the quality of air, soil, inland and marine water bodies. The current reforms of environmental legislation of the Russian Federation aim at improving and harmonising Russian legislation with international conventions (Geneva Convention on Long-Range Transboundary Air Pollution, CLRTAP) and the European Industrial Emissions Directive (IED), including the establishment of Best Available Techniques (BAT).

The process to prepare and substantiate the conditions of Russia's ratification of the protocols of UNECE Convention of Long-Range Transboundary Air Pollution (CLRTAP) is going on. The Gothenburg Protocol of the UNECE-CLRTAP provides for initiation of abatement measures of ammonia emissions from agricultural sources.

In particular, the application of BAT criteria is one of the core harmonization elements of Russian and European environmental policies. Nearly all measures identified in the CLRTAP "Guidance Document for Preventing and Abating Ammonia Emissions from Agricultural Sources" are in line with the provisions of the European "Reference Document on Best Available Techniques (BAT) for Intensive Rearing of Poultry and Pigs" (BREF).

On 1 January, 2015, the Federal Law of the Russian Federation № 219-FZ "Concerning the Introduction of Amendments to the Federal Law "On Environmental Protection" and Certain Legislative Acts of the Russian Federation" came into force (previously adopted on 21 July, 2014). This Law provides for the introduction of Best Available Techniques – BATs.

# 2 Project objectives

Within the frame of the Advisory Assistance Programme (AAP) for environmental protection in the countries of Central and Eastern Europe, the Caucasus and Central Asia and other countries neighbouring the European Union (a programme of the Federal Ministry for Environment, Nature Conservation and Nuclear Safety) and by cooperation between the German and Russian partners several Russian technical institutes, authorities and ministries (esp. Ministry of Agriculture and Ministry of Natural Resources and Environment of the Russian Federation) were supported on their way to an ecologically more efficient intensive livestock farming. The overall objective of the advisory assistance project "Best available techniques (BAT) for intensive livestock farming in the Russian Federation" was to support and to develop an information exchange on the integrated and specific methodology for the classification of livestock housing systems, and of the storage, treatment and spreading of manure produced, in terms of "Best Available Techniques (BAT)" accordingly to the IED information exchange in Central Europe.

Within the scope of the Russian-German project the German Partner DöhlerAgrar business consultancy was designated to transfer knowledges, methodological approaches and experiences from the process of elaborating the Best Available Techniques (BAT) Reference Document for the Intensive Rearing of Poultry and Pigs to the Russian partner IEEP.

DöhlerAgrar is an independent, privately-held company that focuses on consulting, research and development in the field of sustainable agriculture. Clients are farmers, agribusiness, public authorities, scientific and government institutions.

IEEP is a branch of the Federal State Budget Scientific Institution "Federal Scientific Agroengineering Center VIM" (FSAC VIM), which is a state-financed, non-profit scientific institution under the Ministry of Science and Higher Education of the Russian Federation and the Russian Academy of Sciences (RAS). The institute is engaged in fundamental, exploratory and applied research contributing to the technological, economic and social development of agriculture.

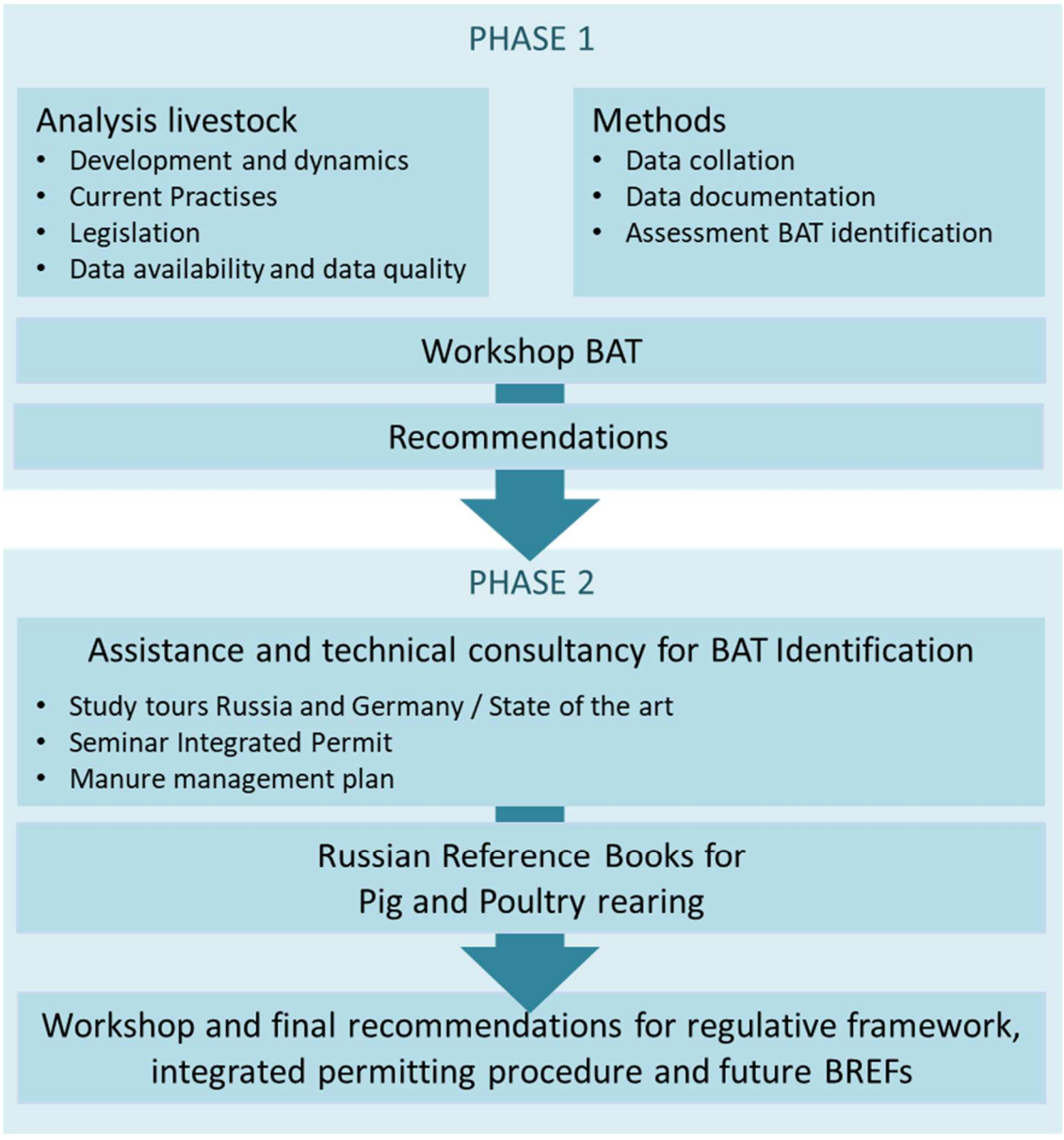
On the basis of the intensive cooperation of the project partners, both the methodological preparation up to the method development for the identification of BAT, the information transfer about common practice of the animal husbandry facilities and their authorisation, as well as the technical accompaniment of the process for the development of the Russian reference documents on intensive animal husbandry were supported.

In phase 1 (2014-2016) the project was meant to draft proposals on introduction of BATs for intensive livestock farming in the Russian Federation based on the European experience by acquiring and analyzing the information on the European procedure of identification, selection and implementation of Best Available Techniques for the intensive rearing of livestock (including pig and poultry rearing according to the EU IED Directive). Based on that scheme for the assessment of IRPP BAT suitable for the Russian Federation have been identified and adopted. The information resulting from these first steps were disseminated and discussed in the Russian Federation's intensive livestock sector, namely scientists, advisors, farm managers, politicians, and administration staff. Conclusions were summarized in proposals for BAT introduction system in the intensive livestock farming sector in Russia including a regular update of the BAT identification procedure.

Phase 2 (2016-2018) was initially devoted to refining the methodology from Phase 1, which could be used for a transparent evaluation of the environmental and economic performance of different techniques and processes in intensive livestock farming, including calculation of the

costs and benefits of emission control measures. The focal phase was sought to make a substantial technical contribution to the consolidation of the process of identifying and developing BATs for the relevant pig and poultry categories in intensive livestock farming, in order to achieve high technical standards on the basis of the approach applied in the EU. It served further as a methodical and knowledge-based contribution to the process of developing Russian BAT reference documents for intensive livestock rearing through the participation of the Russian partner representatives in the activities of relevant Russian BAT Working Groups. The German project partner as the technical advisor provided support to IEEP in argumentation and dissemination of information forwarded to the Technical Working Groups on developing BAT reference documents for intensive livestock rearing.

**Figure 1: Project tasks overview**



# 3 Elaboration of principles and recommendations for the drafting of Russian Federations reference documents for the intensive pig and poultry sector

## 3.1 Development of agriculture and livestock farming in the Russian Federation and future perspectives

**Cereal production as the basis for pig and poultry farming**

Already at the turn of the millennium Russia began to export wheat. Favoured by the strong devaluation of the Russian Rouble, the abandonment of the exchange rate fixation and the transition to a free exchange rate regime at the beginning of 2015, Russian wheat exports exceeded those of the USA and Russia finally advanced to become the world's largest wheat exporter. The protectionist policy leads to low market prices for grain, from which the meat producers profit with the consequence of low production costs.

It can be expected that Russian grain production will continue to rise in the future as a result of technological improvements in machinery and an increase in yields. In addition, Russia has unused fallow land that was cultivated during the Soviet Union and removed from cultivation in the course of transformation. According to scientific estimates, grain yields in Russia can be increased from the current average of 2 tons per hectare to an average of 3 to 5 tons per hectare in the future. The used arable land could thus increase from approx. 80 million hectares by approx. 42.5 million hectares to a total of 122.5 million hectares through the reutilization of abandoned arable land. This results in a total grain production potential of between 120 and 160 million tons, which corresponds to roughly doubling grain production in 2017/18.

**Pork sector**

In the pig meat sector, the agricultural policy goal of increasing the self-sufficiency rate for pig meat to 85% was already achieved by 2015. It can be seen that this is indeed the result of an increase in domestic production and a simultaneous decline in imports of pork. The expansion of domestic pork production was accompanied by extensive regional shifts from the Southern Region to the Central Region. Since 2006, pork production has been increasingly concentrated in Belgorod. Today, this oblast accounts for almost 20% of Russia's total pork production. On the other hand, production in the formerly leading pork production regions Krasnodar and Rostov in the Southern Region has declined significantly.

This development is accompanied by a strong expansion of highly integrated agroholdings. Agroholdings control several stages of the value chain, from feed production to pig fattening, slaughterhouses, meat processors and sometimes even distribution to end consumers via their own supermarket chains. The share of agroholdings in Russian pork production has risen on average from 31% in 2002 to just under 70% in 2016.

Therefore, it can be expected that the holding companies will increasingly act as exporters of pork on the international markets in the future and above all supply markets in Southeast Asia.

**Poultry sector**

Currently poultry farming is the most dynamic branch of economy. In Russia, the largest decline in egg production was recorded in 1996. Since 1998, 90 new poultry farms were commissioned and 143 poultry farms were upgraded over the five years (2010-2016). In 2016, 43.6 billion eggs were produced on poultry farms of all categories. 139.3 million market eggs were exported from Russia over the nine months of 2015. The poultry meat production in the country at the end of

2016 reached 4620.8 thousand tons. Per capita consumption of poultry meat in 2016 amounted to 31.5 kg, dominating other types of meat. In addition to traditional broiler production, Russia is gradually developing alternative types of poultry – turkey, duck and others, although their share in the total poultry market is small – about 6-8%.

Poultry farming is characterized by uneven distribution in the country. In 2015 the share of the Central Federal District amounted to 35.9% in the total volume of poultry for slaughter, while the share of the Far Eastern Federal District accounted for only 1%. Egg production shows the similar pattern, the bulk of production is concentrated in the Volga Federal District – 25.1% of the total eggs. The leaders in the growth of egg production are Leningrad, Yaroslavl, Tyumen, and Belgorod Regions, as well as the Republic of Mordovia. In fact, these regions are the main egg suppliers to the Russian market.

**Milk sector**

Following the collapse of the Soviet Union, the number of dairy cows in Russia has fallen dramatically and has not risen substantially until now. Milk production in 2016 amounted to 30 million tons. A characteristic feature of milk production in Russia is that, although declining, the household economies are still of great importance. In 2016, they still produced an average of 5 cows per agricultural household, or about 44% of the total milk produced in Russia.

Agroholdings accounted for about 48% of milk production in 2016. Although the share of farms and individual enterprises with an average of about 60 cows in total production is small, this is the only type of enterprise whose importance for Russian milk production has increased. The share of the 10 largest milk-producing companies in 2016 was about 7%. The shares of large farms will continue to increase in the future and will be stimulated by appropriate financial incentives.

The Volga region comprises the largest milk and butter production, cheese production is concentrated in central Russia, and the stabilisation of the dairy centres in the metropolises of Moscow and Sverdlovsk is to be expected.

## 3.2 The Russian Federation activities for identifying BAT in livestock farming

The current Russian regulatory and legal framework on environmental issues in designing, construction and operation of pig, cattle and poultry farms has a complex hierarchical structure. It includes federal laws and codes, regulations of the federal and regional level, guidance documents, sanitary and veterinary standards, state standards and others documents.

The main weak point of the current system is that enterprises may carry out the economic activities, which have an adverse environmental impact. This is possible through temporary permits being issued for excessive emissions and discharge of pollutants. In this case, the penalty fee for an adverse environmental impact is negligible and fails to promote introduction of environmentally friendly techniques.

Federal Agency on Technical Regulating and Metrology – Rosstandart – has been assigned responsible to develop the regulatory documents concerning BAT implementation

Following the Resolution of the Russian Government № 1029 of 28 September 2015 “On establishment of criteria, by which the objects with the impact on the environment are rated as the objects of I, II, III and IV category” the categories of agricultural enterprises requiring the transition to BAT are defined, namely,

- Facilities for poultry breeding with the design capacity of 40000 bird places and more.

- Facilities for pig fattening with the design capacity of 2000 animal places and more; facilities for sows with the design capacity of 750 animal places and more.
- Facilities for storing the waste of IV-V class of hazard with the design throughput of 50 t/day and more

The Ministry of Industry and Trade of the Russian Federation by Order № 665 of 31 March, 2015, approved the general sectoral "Methodological recommendations on identification of a technology as BAT". They describe the general approach and algorithm of selecting technologies. While the above documents are the basis to organize the work on BAT introduction in all the industry sectors, the Russian German project is aiming at the development of Methodologies for data acquisition and BAT assessment resp. identification for intensive livestock rearing.

## 3.3 Current practice and technical standards in livestock farming

The main characteristics, indicators, and requirements to animal housing and manure management practices are governed by the existing regulatory and legal framework concerning the construction and operation of livestock enterprises. It includes federal laws and codes, regulations of the federal and regional level, guidance documents, sanitary and veterinary standards, state standards and others documents.

In general all directions of animal and poultry farming feature the tendency to large-scale enterprises and concentration of livestock on separate sites. This results in lower production expenses but higher environmental risks. For example, pig enterprises in Leningrad and Kaliningrad regions are large-scale complexes with the capacity of 15, 30, 60 and 100 thousand head; poultry farms have 1milion and more head; cattle farms have from 800 to 1000 head.

Modern livestock enterprises use state-of-the-art West European machinery and equipment in the animal houses. Their designing, construction and operation in accordance with current Russian norms and regulations ensure their compliance with international standards.

It follows from the analysis of the questionnaires filled in by the agricultural enterprises in the process of Russian BAT reference books development that agricultural enterprises in the Russian Federation use technological equipment manufactured and supplied by various foreign companies. The feedback of the pig farms is that serial (commercial) national and foreign equipment manufactured in 70-ies or 80-ies of the last century account for 5.4%. Most farms (94.6%) are equipped with foreign machines of the following companies/suppliers A similar picture is found in poultry enterprises.

The top-priority environmental problem in animal and poultry farming is manure utilization on large-scale farms with substantial animal/poultry manure output. According to statistical data, in the North-West Federal District of the Russian Federation only 30% of overall produced animal/poultry manure are processes and applied. The main reasons for that are:

- lack of sufficient amount of land for manure application, primarily on pig farms and poultry factories;
- poor coordination by the executive authorities the issues of new farms siting and operating farms upgrading in terms of their environmental impact, especially those having not enough land for manure application;

- poor awareness of agricultural producers on BATs for animal/poultry manure processing and use;
- failure to comply with technological regulations for environmentally sound animal and poultry manure processing and fertilizing application;
- the main obstacle – no applicable economic incentives for farmers to introduce the environmental measures on their farms.

Lowering of environmental effect of large-scale livestock enterprises may be achieved through introduction of BAT for manure processing, storage and application. The developed Russian BAT reference books should give a clear legal status to such indicators as correspondence of manure storage size to the amount of animal/poultry manure produced, correspondence of the farm animal stock in the agricultural enterprise to agricultural land area (own or rented) sufficient for produced manure application, and the specific costs of nutrients control along with indices of resource and energy consumption and the levels of emissions and discharges

To reduce emissions on the farm level is possible not only by the use of most suited technologies but also by the uniform ecological management of plant and livestock production departments of the enterprise. More strict control is needed on the Federal level over the compliance of the farm size and animal stock to the farmland available for produced manure application.

## 3.4 Existing data and data availability

At present, the regularly collected open source data includes general indicators of agricultural production efficiency (land area, animal stock, productivity, gross production, availability of machines and equipment by aggregate groups, etc.). Detailed data on technologies, machines and equipment used are not publicly available but are accessible to only a limited group of specialists from branch departments and supervisory agencies.

One of the most important tasks for the effective introduction of BAT is to improve the state system of environmental monitoring of agricultural enterprises (to set the monitoring indicators, regularity and accuracy of information, accessibility), which allows for a comprehensive assessment of the technological solutions used in agricultural production.

## 3.5 Recommendations for the Russian BREF for intensive rearing of pigs and poultry

Recommendations were developed to be submitted to the legal and regulatory bodies responsible for issuing the reference documents on intensive livestock farming. They were intended, to describe the methods of BAT identification for intensive livestock farming and the list of recommended methods and technologies to be included in the Russian reference books for intensive pig and poultry rearing.

Recommendations were shared with Russian experts and discussed during a workshop on BAT in intensive livestock farming, which was held in February 2016 on the premises of IEEP. The main purpose of the workshop was dissemination of information obtained in the course of project work and discussion of elaborated Recommendations, which was finally agreed by the 54 participants (researchers and other specialists).

The most relevant issues of the recommendations were to describe the methods of BAT identification for intensive livestock farming and the list of recommended methods and

technologies to be included in the Russian reference books for agricultural enterprises on pig and poultry rearing.

Based on the results obtained by questionnaires and the interviews with livestock enterprises in the North-West Federal District of Russia, the most relevant techniques and practices were identified and a recommendation list for the Russian BREFs was drawn up (see table 1).

**Table 1: Recommended Technique and Management Categories to be considered as BAT for the Russian intensive livestock farming sector**

| | Recommended BAT Categories |
|---|---|
| Environmental management systems | ISO 14001<br>Added:<br>noise management plan<br>odour management plan |
| Good housekeeping | Proper location of the plant/farm and spatial arrangements of the activities<br>Educate and train staff<br>Prepare an emergency plan for dealing with unexpected emissions and incidents such as pollution of water bodies.<br>Regularly check, repair and maintain structures and equipment. Store dead animals in such a way as to prevent or reduce emissions |
| Nutritional management | Multiphase feeding with a diet formulation adapted to the specific requirements of the production period |
| Efficient use of water | Keep a record of water use |
| | Detect and repair water leakages |
| | Use high-pressure cleaners for cleaning animal housing and equipment |
| | Select suitable equipment (e.g. nipple drinkers, round drinkers, water troughs) for the specific animal category while ensuring water availability (ad libitum) |
| | Verify and (if necessary) adjust on a regular basis the calibration of the drinking water equipment |
| | Reuse uncontaminated rainwater as cleaning water |
| Techniques for reducing emissions from waste water | Minimise the use of water<br><br>Segregate rainwater from waste water streams that require treatment |
| Techniques for efficient use of energy | Optimisation of heating/cooling and ventilation systems and management |
| | Insulation of the walls, floors and/or ceilings of animal houses |
| | Use of energy-efficient lighting |
| | Apply natural ventilation |
| Techniques for reducing odour emissions | Ensure adequate distances between the plant/farm and the sensitive receptors |
| | Cover slurry or solid manure during storage |
| | Minimise stirring of slurry |
| | Compost solid manure |
| | Band spreader, shallow injector or deep injector for land spreading of slurry |
| | Incorporate manure as soon as possible |
| Techniques for reducing emissions from the storage of solid manure | Store dried solid manure in a barn |
| | Store solid manure on solid impermeable floor equipped with a drainage system and a collection tank for the run-off |
| | Select a storage facility with a sufficient capacity to hold the manure during periods in which the application to land is not possible |
| | Store solid manure in field heaps placed away from surface and/or underground watercourses which liquid run-off might enter |
| | Reduce the ratio between the emitting surface area and volume of the manure heap |
| | Cover solid manure heaps |

| | |
|---|---|
| Techniques for reducing $NH_3$ emissions from slurry store | Reduce the ratio between the emitting surface area and the volume of the slurry tank |
| | Reduce wind velocity and air exchange on the slurry surface by operating at a lower level of fill |
| | Minimise stirring of slurry |
| | Natural crust |
| | Use stores that are able to withstand mechanical, chemical and thermal influences |
| Techniques to prevent emissions to soil and water from slurry collection, piping and from a tank and/or an earth-banked storage (lagoon) | Select a storage facility with a sufficient capacity to hold the manure during periods in which the application to land is not possible |
| | Construct leak-proof facilities and equipment for collection and transfer of slurry (e.g. pits, channels, drains, pump stations) |
| | Store slurry in earth-banked stores (lagoons) with an impermeable base and walls e.g. with clay or plastic lining (or double-lined) |
| | Install a leakage detection system, e.g. consisting of a geomembrane, a drainage layer and a drainage pipe system |
| | Check structural integrity of stores at least once a year |
| Techniques for on farm manure processing | Mechanical separation of slurry |
| | Aerobic digestion (aeration) of slurry |
| | Composting of solid manure |
| Manure land spreading | Assess the manure receiving land to identify risks of run-off |
| | Keep sufficient distances between manure spreading fields (leaving an untreated strip of land) and areas where there is a risk of run-off to water and neighbouring properties (including hedges) |
| | Avoid manure spreading when the risk of run-off can be significant. |
| | Adapt the manure application rate taking into account the nitrogen and phosphorus content of the manure and taking into account the characteristics of the soil (e.g. nutrient content), the seasonal crop requirements and weather or field conditions that could cause run-off |
| | Synchronize the spreading of manure with the nutrient demand of crops |
| | Check the spreading fields at regular intervals to check for any sign of run-off and properly respond when necessary |
| | Ensure adequate access to the slurry/manure store and that loading of manure can be done effectively without spillage |
| | Check that machinery for the spreading of manure is in good working order and set at the proper application rate |
| Techniques for land spreading of liquid manure (slurry) | Band spreader (trailing hose) |
| | Band spreader (trailing shoe) |
| | Shallow injector (open slot) |
| | Deep injector (closed slot) |
| Techniques to reduce ammonia emissions to air from the application of manure to land | To incorporate the manure into the soil as soon as possible. |
| Techniques for reducing emissions from pig housing | Fully or partly slatted flor with a vacuum system for frequent slurry removal |
| Housing systems for laying hens, | Cage systems with manure removal by belts with at least:<br>- one removal per week with air drying; |

| | |
|---|---|
| | or- two removals per week without air drying |
| Techniques for monitoring N and P excretion | Calculation using a mass balance of nitrogen and phosphorus based on the feed intake, dietary content of crude protein, total phosphorus and animal performance |
| | Estimation using manure analysis for total nitrogen and total phosphorus contents |
| Monitoring process parameters | BAT is to monitor the following process parameters at least once a year:<br>Water consumption<br>Electric energy consumption<br>Fuel consumption<br>Number of incoming and outgoing animals, Including births and deaths when relevant<br>Feed consumption<br>Manure generation |

**Assessment methodology for the identification of BAT**

For a transparent assessment of technologies and comprehensive identification of BAT a methodology has been developed according to the domestic sectors requirements and regarding the data availability. In order to compare the technologies together the following indicators for the assessment were identified:

- Atmospheric emissions (ammonia / odour, PM (PM10), methane, nitrous oxide, dust and other (noise, $CO_2$, NOx);
- resources (energy demand, water demand);
- animal health;
- animal welfare;
- cost (capital, operating, labor, additional);
- practical experience;
- technical reliability;
- worker safety;

Since data on emissions and other environmental effects are limited, the consortium decided to recommend a qualitative assessment method in order to compare various techniques according to their effectiveness. This qualitative method was used to identify BAT, conditional BAT and emerging techniques.

To identify BAT for technological elements the BREF 2003 approach was applied. According to this approach all the technologies are considered on an individual basis: they are assessed by BAT criteria and compared to a reference (traditional) technology.

The main steps in BAT identification are as follows.

- to create an assessment matrix of all the relevant factors for each group of techniques (machinery, technologies, processes);
- to identify the key environmental issues for each group of techniques;
- to identify the reference technique (to be compared with) for each group of techniques;

- to give a qualitative rating (-; 0; +) for each technique, where quantitative data are not available;
- to rank the techniques by their environmental performance (for example in terms of reduction of ammonia emissions);
- to assess the technical applicability, the operability and the animal welfare aspects of each technique;
- to assess the environmental cross-media effects caused by each technique;
- to estimate the costs of applying each technique in new and in retrofit situations;
- to identify BAT and to decide if it is BAT for new and/or for retrofit situations.
- Rating -; 0; + (in general "-" – negative effect, "+" positive effect)

Finally technologies are to be grouped in 3 BAT Categories: "0" – is not BAT, BAT one is BAT in general, BAT II is conditional BAT. As reference (basic) technology is to choose the most common one in the sectors practice. BAT candidates are supposed to have the smaller environmental impact than the reference technique.

# 4 Advisory assistance for the preparation of the reference documents for intensive livestock farming of pigs and poultry

By the initiative of the Agriculture Ministry of the Russian Federation on 16 August 2016, several relevant Technical Working Groups (TWG) were established within the BAT Bureau to develop the relevant Russian BAT reference books: TWG 41 Intensive rearing of pigs; TWG 42 Intensive rearing of farm poultry; TWG 43 Slaughter of animal on meat processing plants; combined slaughterhouse with refrigeration and storing of meat; animal by-products; TWG 44 Foodstuffs manufacturing; TWG 45 Manufacture of beverages, milk and dairy products.

A number of IEEP experts were appointed the full-fledged members of TWG 41 and TWG 42: Aleksandr Briukhanov, Eduard Vasilev, Natalia Kozlova, Ekaterina Shalavina, Alexey Trifanov and Igor Subbotin. The work on these reference books was organised via the web-portal of BAT Bureau.

Parallel to the Ministries initiative for drafting the reference documents in phase 2 of the project various activities were initiated in order to support the TWGs work.

In order to better assess current practices and technical standards and to derive the need for the introduction of further environmental protection techniques, study trips were conducted in the Russian Federation and Germany. A seminar on integrated approval procedures was to convey the framework conditions for the implementation of Best Available Techniques applicable in the European Union and Germany. Finally, a guideline for a manure management plan was developed.

## 4.1 Study tours

The study tour in Russia provided an insight into current and anticipated intensive livestock farming practices and the opportunity to analyse the key problems as regards the compliance with the Russian environmental legislation, to test the initial information gathering procedure for the preparation of Russian BAT reference books on intensive pig and farm poultry rearing. The study tour took place in 2016, and included the visits to three pig complexes, three poultry factories and five dairy complexes in three regions (Leningrad, Voronezh and Vladimir) and was attended by 9 Russian and 4 German experts.

**Figure 2: Lagoon for pig manure with homogenizing device in Russia**

Source: [DöhlerAgrar]

The study tour in Germany/Italy took place 2017 and was aiming at the information of the Russian project partner and other Russian experts about the experience gained in Central Europe and Germany with the implementation of environmental sound techniques related to the IRPP BAT issue. Emphasis was being laid on the demonstration of practicable and experienced techniques for livestock rearing itself, but as well as for a proper manure management. The study tour was attended by 6 Russian and 3 German experts.

**Figure 3: Project consortium in front of a sow housing system in Bavaria**

Source: [DöhlerAgrar]

An important finding of the study visits was that the production standards in Russia's intensive livestock farming are at a high level including biosecurity management. However measures to protect the environment, in particular measures to reduce emissions in the livestock buildings and measures for the environmentally sound management of animal manures have not yet been sufficiently implemented. The greatest ecological challenges currently facing intensive livestock farming in Russia are associated with the management of manures. During the study trip to Germany, examples of successful management and the mobile and stationary technologies required for this were demonstrated which also appear to be feasible for their implementation in Russia.

## 4.2 Workshop on integrated permitting

On 16 May 2017, in the framework of the 10th International Scientific and Practical Conference "Ecology and Farming Technologies: Agro-Engineering Approaches" the workshop "Integrated Environmental Permitting for farms specialising in intensive rearing of pigs and poultry" was held.

In total 15 experts were participating, including Vice-Chairman of Technical Committee 113 of Federal Agency on Technical Regulation and Metrology, Head of TWG Secretariat in BAT Bureau, TWG 41 "Intensive rearing of pigs" members; TWG 42 "Intensive rearing of poultry" members, representative of German Federal Environmental Agency (UBA) and experts from DöhlerAgrar consultancy company.

At the workshop, the head of TWG Secretariat in BAT Bureau reported on reforming of Russian environmental legislation, development of BAT reference books and transition to Integrated Environmental Permitting. Helmut Döhler spoke about the Integrated Environmental Permitting

experience in Germany. After that, the vice-chairman of Technical Committee 113 dwelt on the development of the draft Decree of the Russian Federation Government "The procedure for issuing integrated environmental permits, their re-registration, revision, amendment as well as revocation". Schedule for integrated environmental permitting implementation in all industry sectors:

- 2015-2018. The development and adoption of a relevant regulatory and legal framework, including information and technical reference books on BAT; state registration of objects with negative environmental impact. Almost all large pig and poultry enterprises are assigned to the first category (significant) and second category (moderate) of negative environmental impact.
- 2019-2022. First integrated environmental permits are to be issued for 300 pilot enterprises (enterprises of intensive livestock rearing are not included in the list of the pilot sectors); All newly built facilities have to obtain integrated environmental permits.
- 2023-2024. Issuing of integrated environmental permits and the transition of all category I enterprises to BAT-based regulation. Category II enterprises have the right to voluntarily obtain integrated environmental permits.

Integrated environmental permits are issued on the basis of: the positive opinion of the expert commission and in case the requested conditions of the integrated environmental permit comply with BAT criteria and requirements specified by the environmental legislation; the approval of the environmental efficiency improvement programme (if necessary); the approval of the programme of the on-farm environmental monitoring and control; the obtained approvals (absence of any objections) of authorized federal executive bodies; recommendations of the coordination meeting (if such a meeting is held).

DöhlerAgrar highlighted the idea and the practical implementation of integrated permitting in Europe and in Germany in particular:

The EU Directive 2010/75/EU on industrial emissions forms the basis for the integrated approval of intensive livestock farming systems in Germany. It regulates the application of best available techniques and the authorisation of environmentally relevant industrial installations in particular on the basis of a cross-media approach which, among other goals, aims to prevent the pollution from simply being transferred to other environmental media. To ensure a high level of environmental protection, the IE Directive aims to cover all emissions from an installation to air, water and soil, including waste management, resource and energy efficiency and accident prevention.

Basically, the integrated concept of the IE Directive has two main objectives: In the first place, it describes the required complete coordination of the authorities involved in the approval procedure and, in the second place, it provides production-integrated environmental protection as a guideline for the approval of industrial plants. The Industrial Emissions Directive is thus based on the principle of sustainable production.

An essential requirement of the IE Directive is to link the authorisation of industrial installations listed in Annex I of the IE Directive to the application of best available techniques. For operators and permitting authorities, this means that at the latest four years after publication of the BAT conclusions, livestock installations must apply best available techniques or environmentally equivalent techniques. In particular, permitting authorities must ensure compliance with the new European emission levels set out in the BAT conclusions.

In Germany, integrated permit approval procedures are conducted within the framework of the Federal Immission Control Law, which represents the implementation of the EU Directive 2010/75/EU on industrial emissions. The German Federal Immission Control Law (Bundes-Immissionsschutzgesetz), in its long term form: law for the protection against harmful environmental impacts caused by air pollution, noise, vibrations and similar processes, regulates an important sub-area of environmental law, the immission control law, and is the determining practice-relevant body of rules in this field of law. It regulates the protection of humans, animals, plants, soils, water, atmosphere and cultural assets against immissions and emissions. With the help of the Federal Immission Control Act as a right of licensing for industrial and commercial facilities, harmful environmental impacts caused by emissions to air, water and soil are to be avoided and reduced, including waste management. The aim is to achieve a high level of protection for the environment as a whole.

The principle and consequences for plant operators were demonstrated by means of a concrete approval procedure for a pig farming facility in Germany.

During the workshop discussion, the participants emphasized, integrated environmental permitting topic to be a pressing issue for Russia, the main steps (stages) in the integrate permitting procedure in Europe/Germany to be much similar as specified in the above mentioned draft for the Russian Government Decree, nevertheless additional normative legal acts to be needed for the integrate permitting procedure under the specific conditions of agricultural production, environmental performance indicators from the farms are difficult to obtain. It is expedient to further continue sharing the BAT-related experience in EU.

**Figure 4: Workshop on integrated permitting**

Representatives from IEEP, the BAT Bureau and DöhlerAgrar during the workshop.
Source: [IEEP]

## 4.3 Exemplary development of a manure management plan

During the project phases 1 and 2 it was noted, that livestock operations are running their systems with highly advanced technical equipment on a high performance level and with a strict hygiene management. Nevertheless the weak point on many facilities is a poor manure management, in particular often due to a lack of land, poor technologies for transport and application, but also due to a lack of contracting partners willing to uptake the organic fertilizers.

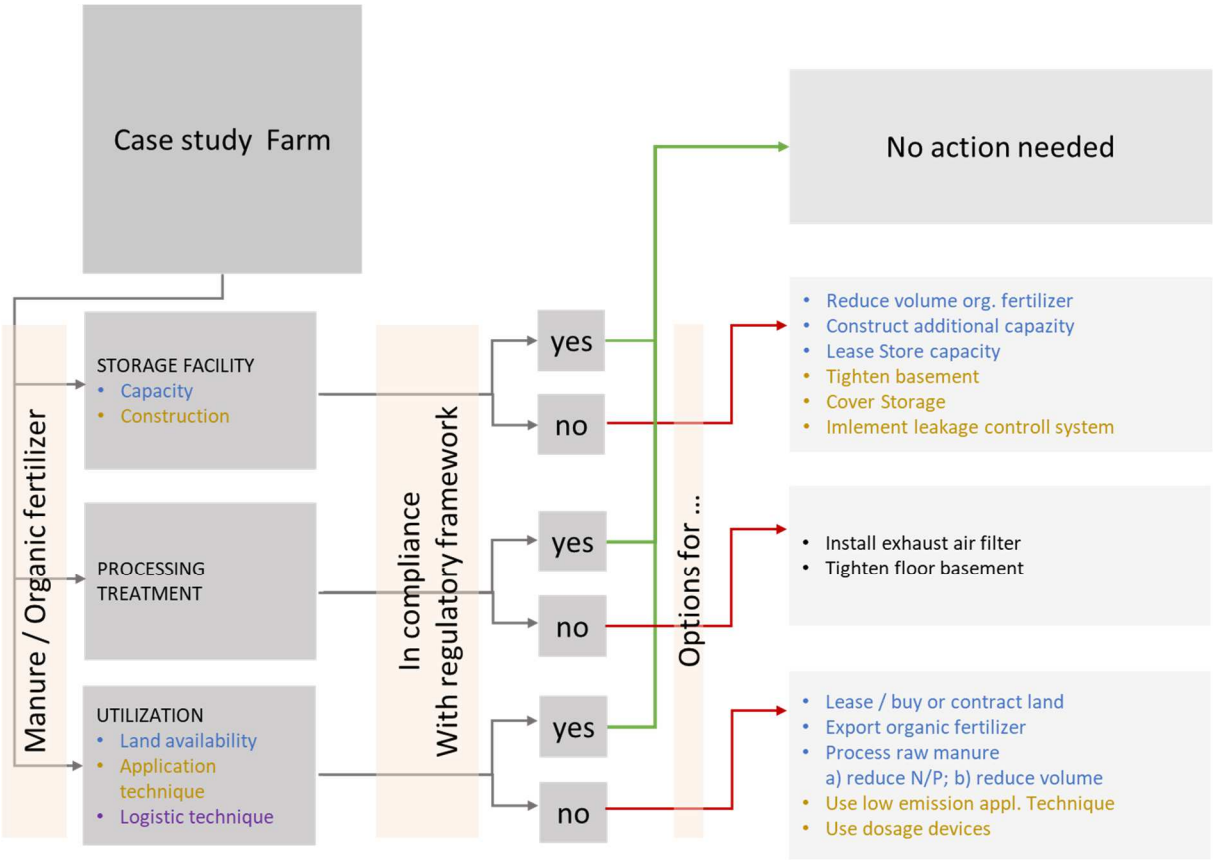
Therefore a Manure Management Plan has been developed within the projects frame, which was intended to serve as the guidance for the development of plans for environmentally sound manure use on agricultural enterprises for intensive pig and farm poultry rearing in Russian Federation.

The Manure Management Plan includes the list of organisational and technical measures, which ensure the safe removal of manure from the animal houses, environmentally safe storage, safe and cost-effective use of manure in the agricultural enterprise, and, depending on the location of the enterprise, the legal and environmentally sound transfer of manure from the territory of the enterprise.

In conclusion, the Manure Management Plan shall serve entrepreneurs and authorities as a guidance

- to identify and avoid the excess application of nutrients, in particular nitrogen and phosphorous with the organic fertilisers on agricultural land;
- to monitor the nutrient (total N and P) flow on the operating livestock rearing facility – from manure generation to organic fertiliser application;
- to reduce ammonia emissions from manure spreading devices and storages
- to plan the nutrient application in the field according to the individual crop need and to eventually “export” surplus manure nutrients to neighbouring enterprises
- to eventually reorganise manure management strategy towards manure processing systems
- to optimise the machinery, tractor and trailer fleet for manure/organic fertiliser handling
- to ensure the long-term sustainable operation of o the livestock-rearing complex.

**Figure 5: Scheme of a decision tree for manure management**




Decision tree for farms with intensive pig and poultry rearing on how to manage the manure
Source: [DöhlerAgrar]

## 4.4 Elaboration and issue of Russian federations BAT Reference documents for intensive rearing of pigs and poultry

The Ministry of Agriculture of the Russian Federation responsible for Russian BAT reference books on intensive rearing of pigs and intensive rearing of poultry appointed responsibility for the elaboration of the BREFs the Donskoy State Agrarian University and Moscow Timiryazev Agricultural Academy, under the supervision of the BAT bureau, located in Moscow.

Activities to prepare the reference documents for intensive livestock farming in the Russian Federation started in August 2016. Initially, technical working groups were established - separately for the pig and poultry sectors (TWG 41 and 42). IEEP experts were actively involved in the activity of TWG´s. They introduced to the TWGs members for their consideration the "Recommendations and requirements how to identify BATs for intensive livestock farming in the Russian Federation, which had been developed during Phase 1 of the project and which included the structure of the contents of Russian BREFs and a list of technologies and methods recommended to be included in those books.

In March 2016, all farms falling under scope of the Russian legislative act on BAT introduction (around 600 pig and poultry farms) were informed by the BAT Bureau and the information required for BREF preparation was obtained through questionnaires filled in by enterprises. The Technical Working Groups, when preparing the questionnaire, closely followed the characteristics defined by the project consortium in its project Phase 1. Nearly one third of the farms delivered the detailed information to the BAT Bureau. The filled-in questionnaires were the main source of information during the process of BREF elaboration.

The following structure of the contents was the approved for the Russian BAT reference documents and drafted until May 2017:

- Introduction
- Foreword
- Scope
- Chapter 1. General information on the agriculture sector
- Chapter 2. Description of technological processes currently in use in the agriculture sector under consideration
- Chapter 3. Current levels of emission into the environment
- Chapter 4. Identification of Best Available Techniques
- Chapter 5. Best Available Techniques
- Chapter 6. Economic aspects of introduction of Best Available Techniques
- Chapter 7. Emerging technologies
- Annex A (obligatory) Main and additional activities with due account for the spheres of BAT application and the valid in the Russian Federation codes from the Russian Classification of Economic Activities and types of activities specified in the Russian Classification of Products by Economic Activities.

- Annex B (obligatory) The list of marker compounds and technological indicators
- Annex C (obligatory). The list of BAT, which allow to abate emissions into the environment, to cut down the inputs of raw materials, water and energy and to reduce the waste generation.
- Annex D (obligatory) Energy efficiency
- References

From May to August 2017, the drafts of the reference books were discussed on the web-site of BAT Bureau; the amendments were introduced following the comments; and the TWG members voted. IEEP, supported by the German project partner closely cooperated with BAT Bureau, Donskoy State Agrarian University and Moscow Timiryazev Agricultural Academy. IEEP submitted various texts to be included in the relevant reference books. Some of the materials were uploaded directly on the portal of BAT Bureau in the section of TWG 41 and TWG 42.

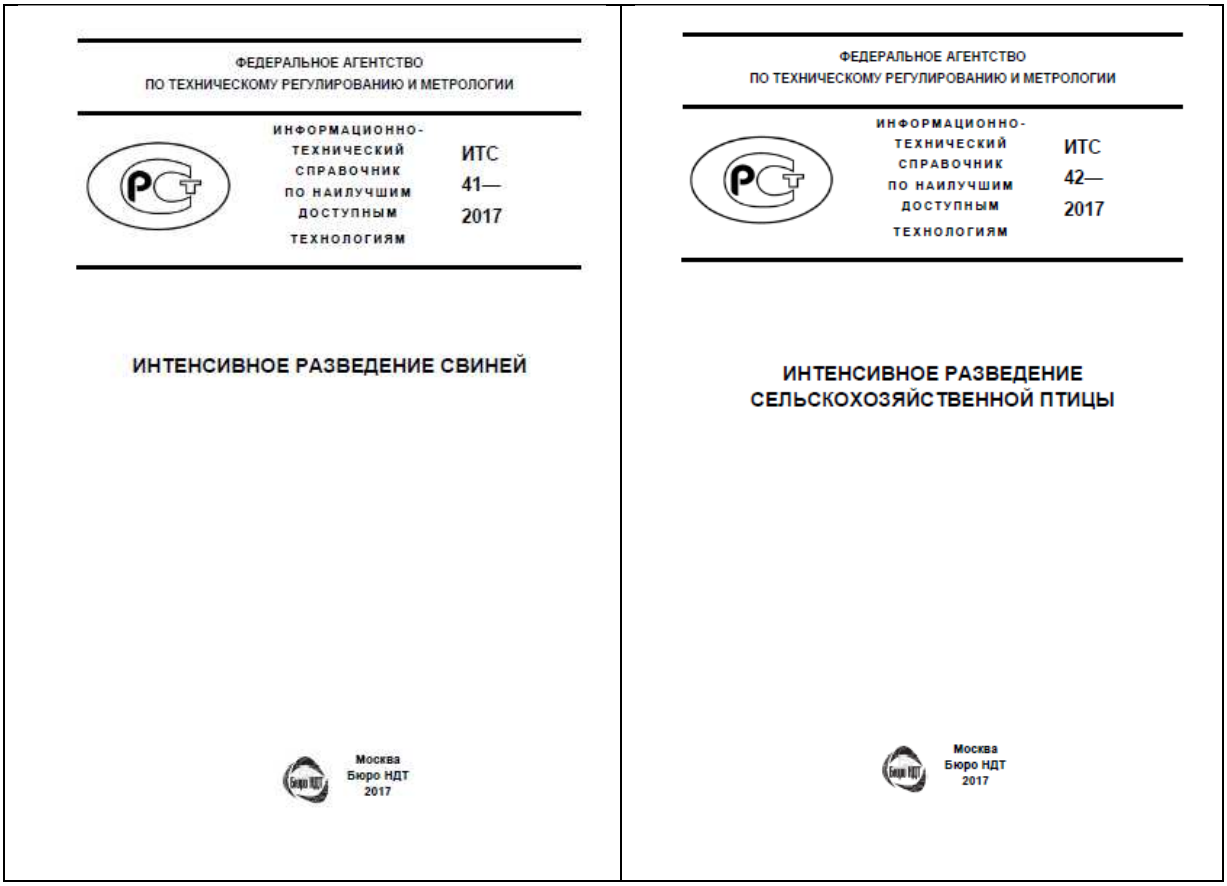
Draft reference books approved by the TWG members were posted for public comment and reviewing in August 2017. From September to November 2017 the reference books were revised and corrections were introduced. At this stage, IEEP suggested various adjustments.

Finally, by the end 2017 two information and technical reference books were completed: “Intensive rearing of pigs” (No. 41) was approved by the Order of Federal Agency on Technical Regulating and Metrology (Rosstandart) of 13 December 2017, No. 2819; “Intensive rearing of farm poultry” (No. 42) was approved by the Order of Rosstandart of 29 November 2017, No. 2667 (Fig. xx). Both reference books came into effect on 01 June 2018. They are found on the website of BAT Bureau.

http://www.burondt.ru/NDT/NDTDocsFileDownload.php?UrlId=1408 and

http://www.burondt.ru/NDT/NDTDocsFileDownload.php?UrlId=1410

**Figure 6: Front page of the Reference Books for Intensive rearing of pigs (No. 41) and Intensive rearing of farm poultry (No. 42)**



ФЕДЕРАЛЬНОЕ АГЕНТСТВО
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ИТС 41— 2017

ИНТЕНСИВНОЕ РАЗВЕДЕНИЕ СВИНЕЙ

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ИНТЕНСИВНОЕ РАЗВЕДЕНИЕ СЕЛЬСКОХОЗЯЙСТВЕННОЙ ПТИЦЫ

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# 5 Conclusion and recommendations for future activities in the Russian Federation towards advanced environmental sound livestock farming

The conclusions drawn from the project activities were summarized by the project partners to be discussed with livestock farming experts involved in the BAT reference document elaboration. On 15 May 2018 in IEEP facilities there was held the final workshop on the project, participating researchers and specialists and the Russian and the German project partners. The workshop was targeting at an exchange of experience with the elaboration of BREFs for livestock production, a strength-weakness-analysis of the process in the Russian federation and at identifying the need for action for achieving improvements for succeeding BREFs and for a harmonization of administrative framework conditions.

**Figure 7: Participants of the Final Workshop**

Source: [IEEP]

Following the presentations by the Russian and German speakers, the workshop participants noted that within the framework of the reform of Russian environmental legislation a number of complex tasks of different levels need to be addressed in order to introduce intensive livestock BAT as a tool for technical and technological modernisation of agricultural and livestock production and reduction of the level of environmental impact. These tasks identified during the workshop and those identified by the project partners are outlined hereafter.

1. Updating of information and the reference documents.
   Due to the limited time allocated for BAT reference books development and the lack of Russian data on the environmental impact assessment of individual elements and technologies of intensive livestock and poultry rearing in general, the reference books

require improvement in terms of data quality, environmental assessment and technological standards. Today, they may be regarded as a solid basis for further work. Therefore, the weak points identified in the Russian BAT reference books (i.p. a complete and sound methodology of BAT identification has not been used), require improvement in the succeeding BAT reference books in terms of a transparent environmental assessment for identifying environmental sound technological standards.

2. Scientific substantiation of the environmental safety related system in intensive livestock rearing in the context of BAT introduction. To identify BAT in the process of BAT reference books updating it appears necessary:

- to create a database on the technologies used in intensive livestock and poultry rearing in the Russian Federation;
- to conduct the theoretical and experimental studies of modern livestock production technologies in order to justify technological norms and standards for BAT introduction;
- to obtain independent, reliable data on the technologies used on “pilot farms” of intensive livestock and poultry rearing

3. Initiating of an applied research programme in order to

- assess the impact of livestock complexes on the environment and consecutively develop measures for impact reductions
- assess the impact on humans (odour, bioaerosols etc.)
- to record ammonia and other emissions the atmosphere for identifying the best techniques under domestic conditions and for establishing associated emission levels (BAT AEL)
- to record consumption levels (energy, water, etc.)
- to develop and/or test low emission techniques
- to develop low energy consuming techniques
- to record and model nitrogen and phosphorus flows at different stages of livestock production with the aim to substantiate the methods for optimizing nutrients use efficiency, for reducing the negative environmental impact and for creating closed cycle agro-ecosystems.

4. Improvement of the regulatory and legal framework for BAT system introduction in intensive livestock rearing and the procedure of integrated environmental permitting. The existing standards need to be revised and updated in terms of their links with relevant BAT reference books (No. 41 and 42).

5. Providing financial support to industry and agricultural producers with the aim to accelerate environmental sound investments for an efficient introduction of animal/poultry manure utilization systems, as well as the use of manure-based organic fertilisers. Regulatory and

legal acts need to be adopted, which would stimulate application of different types of organic and organo-mineral fertilisers.

6. Raising the awareness of agricultural producers and the public about BAT system. There still is a problem of ambiguous understanding of BAT idea, principles and methods by the specialists at all levels. An expert community needs to be organised based on BAT Bureau and branch unions for dissemination of information on BAT system through education and training, workshops, round tables, business games and publications in scientific and industry editions.

7. Stimulating of investments for implementing advanced BAT techniques and their effective use, as well as the use of manure-based organic fertilisers, through credits, loans etc.

8. Establishment of "pilot farms" of intensive livestock and poultry farming in order to demonstrate relevant BAT and to obtain their economic, environmental and technical and technological indicators.

9. Establishing of Integrated Permitting structures. A successful implementation of the idea of BAT requires the establishment of integrated permitting procedures enabling all protected natural and cultural resources at the site to be assessed equally. The actions identified for the transition to integrated permitting in Russia are:

- Establish administrative structures for permitting authorities
- Set-up guidelines and training for integrated environmental approval procedures
- Establish guidelines and training for inspection and monitoring

10. Enhancement of technical solutions for treatment and utilisation of animal/poultry manure in large-scale agricultural enterprises as the main source of negative environmental impact, with the priority areas being:

- creation of "closed nutrient loops" at farm level and upgrading of technologies for processing, transportation and field application of manure.
- develop regional manure management strategies and concepts
- develop regional/national markets for the manure processing fertilizers
- give priority to the utilization of livestock manures (instead of synthetic fertilisers)
- make sure manure management to be an obligatory part of an integrated permit
- integrate livestock facilities in rural planning concepts (livestock rearing should be privileged but with clear regulations

11. Transition to BAT system and establishment of state environmental and technical monitoring require the adjustment of the existing system of data acquisition and processing.

# 6 Documents prepared within the frame of the project

The following project outputs were prepared within the frame of the project:

1. Recommendations and requirements how to identify BAT in livestock farming:

   Methodological guidance on the assessment of BAT candidates and the identification of BAT

2. Russian environment law and analysis:
   National and local legislation, regulating permits for livestock facilities including environmental requirements, drawbacks, contradictions, loopholes, proposals for overcoming ambiguities.

3. Study tours in Russia and in Germany:

   Program and schedule of the study tours in Russia and Germany/Italy, profiles of the visited farms/enterprises, conclusions from the study tour, photographs

4. Results of statistical analysis:

   Current state and development trends of livestock production

5. Workshop "Integrated Permits":

   Program and schedule of the workshop

6. IEEP proposals to include in the Russian BAT reference book "Intensive rearing of poultry":

   Proposals of the IEEP on technical focal points of the BREF in the TWG

7. Manure management plan (MMP):

   Principles and guidance for a management plan; exemplary case study for the preparation of a MMP on a livestock enterprise

8. Final project workshop program and resolution:

   Program and schedule of the workshop, Resolution about Russian BREF (including the essentials of discussions during the workshop)

**List of publications and presentations on the Russian-German project**

| | |
|---|---|
| 1. | **Briukhanov A.Yu., Gaas A.V.** Strategy of waste management at poultry farming enterprises based on introduction of best available techniques for manure processing. *Ecology and Industry of Russia*. 2016. Vol. 20. Issue 2. pp. 60-63 (In Russian http://elibrary.ru/item.asp?id=25520157 |
| 2. | **Briukhanov A.Yu.** Best technologies. *Agricultural News*. 2016. No.1. p.63 (In Russian) |
| 3. | **Subbotin I.A., Briukhanov A.Yu., Ranta-Korhonen T.** Choice of technologies by BAT criteria: the potential to enhance the environmental compliance of livestock farming. *Ecologically safe development of rural areas and preservation of water bodies*. Proceedings of international workshops held in the framework of the Russian-Finnish project SE717 in 2013-2015. (Ed. V.B.Minin). Saint Petersburg: Association of Assistance to Field Experiments and Rural Development. 2016. pp. 85-87. (In Russian) http://elibrary.ru/item.asp?id=25831047 |

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| 4. | **Vasilev E., Subbotin I.** Formalization of criteria for determining best available technologies: the case of Russia. *Engineering for Rural Development*. Proceedings of the 15th International Scientific Conference. Jelgava: Latvia University of Agriculture. 2016. pp. 845-850 (In English) http://elibrary.ru/item.asp?id=26092103 |
| 5. | **Kozlova N.P., Bruikhanov A.Yu., Vasilev E.V.** Best available techniques: introduction steps**.** *New Agriculture***.** 2016. No. 3. pp. 74-75. (In Russian) http://elibrary.ru/item.asp?id=26139571 |
| 6. | **Vasilev E.V., Briukhanov A.Yu., Kozlova N.P**. Effectiveness assessment of best available techniques for intensive livestock production. *Technologies, machines and equipment for mechanised crop and livestock production*. 2016. No. 88. pp. 131-142. (In Russian) http://elibrary.ru/item.asp?id=26166525 |
| 7. | **Subbotin I.A., Vasilev E.V.** Advanced method for assessment of best available techniques for intensive livestock farming. *Technologies, machines and equipment for mechanised crop and livestock production*. 2016. No. 88. pp. 142-152. (In Russian) http://elibrary.ru/item.asp?id=26166527 |
| 8. | **Bruikhanov A.Yu.** Methodology of environmentally safe functioning of livestock complexes based on the system of environmental and technological criteria. *Journal of VNIIMZh*. 2016. No. 4 (24). pp.168-175. (In Russian) http://elibrary.ru/item.asp?id=27038036 |
| 9. | **Vasilev E.V., Briukhanov A.Yu.** Method of best available techniques identification in intensive livestock farming. *Journal of VNIIMZh*. 2016. No. 4 (24). pp.125-130. (In Russian) http://elibrary.ru/item.asp?id=27038020 |
| 10. | **Briukhanov A.Yu., Subbotin I.A., Grevtsov O.V.** Substantiation of best available techniques for poultry manure processing and use. *Best Available Techniques. Application in Different Industries.* Collection of papers 6. Moscow: Pero Publ. 2017. pp.106-120 (In Russian) https://elibrary.ru/item.asp?id=29085210 |
| 11. | **Briukhanov A.Yu., Vasilev E.V., Shalavina E.V.** Methodological approach to selecting the best available techniques for intensive livestock and poultry farming*. Best Available Techniques. Application in Different Industries.* Collection of papers 6. Moscow: Pero Publ. 2017. pp.121-129 (In Russian) https://elibrary.ru/item.asp?id=29085211 |
| 12. | **Briukhanov A.Yu., Vasilev E.V., Shalavina E.V., Kozlova N.P.**. Best available techniques: introduction prospects in agricultural production of the Russian Federation. *News of the State Agricultural Academy in Velikie Luki.* 2017. No. 1. pp. 32-38. (In Russian) https://elibrary.ru/item.asp?id=29095355 |
| 13. | **Briukhanov A.Yu., Vasilev E.V., Kozlova N.P.** Nitrogen use efficiency under the introduction of BAT for intensive livestock farming. *News of the State Agricultural Academy in Velikie Luki*. 2017. No. 1. pp. 39-45. (In Russian) https://elibrary.ru/item.asp?id=29095356 |

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| 14. | **Briukhanov A., Vasilev E., Kozlova N., Lukin S.** Environmental assessment of livestock farms in the context of BAT system introduction in Russia. *Innovative solutions for sustainable management of nitrogen*. Proceedings from International Conference. Aarhus University. Denmark. 2017. p. 126 (In English) https://elibrary.ru/item.asp?id=29650380 |
| 15. | **Briukhanov A.Yu., Vasilev E.V., Shalavina E.V.** Challenges of environmental safety in livestock farming and best available methods to address them. *Regional Ecology*. 2017. No. 1 (47) pp. 37-43 (In Russian) https://elibrary.ru/item.asp?id=29392588 |
| 16. | **Vasilev E.V.** Identification of best available techniques in intensive livestock farming. *Increasing the competitiveness of Russian agricultural products in domestic and foreign markets*. Proceedings from International Agro-Industrial Congress. Saint Petersburg: Expoforum. 2017. pp. 179-180. (In Russian) https://elibrary.ru/item.asp?id=29841332 |
| 17. | **Briukhanov A.Yu., Shalavina E.V., Vasilev E.V.** Designing of the best available technologies of animal and poultry manure utilization. *Journal of VNIIMZh*. 2017. № 3 (27). pp. 124-127. (In Russian) https://elibrary.ru/item.asp?id=30268475 |
| 18. | **Subbotin I.A.** Increasing the ecological safety of manure utilization through choosing a technology by BAT criteria. *Journal of VNIIMZh*. 2017. No. 3 (27). pp. 128-130. (In Russian) https://elibrary.ru/item.asp?id=30268476 |
| 19. | **Vasilev E.V., Kozlova N.P., Subbotin I.A.** Acquisition of baseline data from agricultural enterprises to identify the best available techniques**.** *Regional Ecology.* 2017. No. 3 (49). pp. 49-53. (In Russian) https://elibrary.ru/item.asp?id=30742932 |
| 20. | **Briukhanov A.Yu., Uvarov R.A., Subbotin I.A.** The practice of best available technologies of poultry manure utilization in Leningradsky Region. *Poultry and Poultry Products*. 2018. No. 3. pp. 26-28. (In Russian) DOI: 10.30975/2073-4999-2018-20-3-26-28 https://elibrary.ru/item.asp?id=35132622 |
| 21. | **Briukhanov A., Vasilev E., Kozlova N., Shalavina E.** Background for introduction of BAT system in intensive dairy farming in Russia. *Engineering for Rural Development*. Proceedings from the 17th International Scientific Conference. Jelgava: Latvia University of Agriculture. 2018. pp. 278-284. DOI: 10.22616/ERDev2018.17.N302 (In English) |

**Participation in workshops, conferences, seminars**

| | Event | Presentation title | Participant | Date and place, organiser | Attendance |
|---|---|---|---|---|---|
| 1. | Seminar on Best Available Techniques to reduce impacts of Industrial Animal Farming (IAF) within Daugava/Western Dvina river basin | Environmental aspects and indicators of industrial livestock and poultry farming in Russia, with a focus on the Western Dvina / Daugava River basin | Briukhanov A.Yu. | 17 December 2015 Vitebsk(Republic of Belarus) Vitebsk Committee for Agricultural Production and Food | 100 |
| 2. | Seminar on Best Available Techniques to reduce impacts of Industrial Animal Farming (IAF) within Daugava/Western Dvina river basin | Recommendations on BAT selection in the North-West Russia | Vasilev E.V. | 17 December 2015 Vitebsk(Republic of Belarus) Vitebsk Committee for Agricultural Production and Food | 100 |
| 3. | Conference “Scientific support of the development of agro-industrial complex in the context of imports phase-out” | The method of identifying the best available technologies in the intensive livestock farming. | Vasilev E.V. | 28-30 January 2016 Saint Petersburg State Agrarian University | 50 |
| 4. | Joint OECD/TFRN Workshop: The nitrogen cascade and policy – towards integrated solutions | Preliminary results of the project “ Best available techniques for intensive livestock farming in Russia” within the German Advisory Assistance Program for environmental protection of the Federal Ministry for the Environment, Nature Conservation, Building an Nuclear Safety» | Natalia Kozlova, Helmut Döhler, Aleksandr Briukhanov Susanne Döhler, Eduard Vasilev and Gabriele Wechsung | 9-10 May 2016 OECD Headquarters, Paris, France | 90 |
| 5. | Workshop on Best Available Technologies and Best Practices for Environmentally Sound Agriculture | Best Available Techniques: prospects for implementation in the Russian Federation | Shalavina E.V. | 25 November 2016 Jelgava, Latvia University of Agriculture | |

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|---|---|---|---|---|---|
| 6. | Workshop on promotion of best available techniques and practices used to reduce the environmental impact of industrial livestock production | Nitrogen use efficiency under the introduction of BAT for intensive livestock farming | Kozlova N.P. | 16 December 2016 State Agricultural Academy in Velikie Luki, Russia | 70 |
| 7. | Workshop on promotion of best available techniques and practices used to reduce the environmental impact of industrial livestock production | Plans for BAT introduction in Russia | Kozlova N.P. | 16 December 2016, State Agricultural Academy in Velikie Luki, Russia | 70 |
| 8. | Workshop on promotion of best available techniques and practices used to reduce the environmental impact of industrial livestock production | Data collection in BAT format | Vasilev E.V. | 16 December 2016, State Agricultural Academy in Velikie Luki, Russia | 70 |
| 9. | International Scientific and Practical Conference of academic teaching staff “Scientific support of agriculture development and technological risks mitigation in food sector“ | Best available techniques in intensive livestock production | Vasilev E.V. | 26-28 January 2017, Saint Petersburg, Saint Petersburg State Agrarian University | 45 |
| 10. | XX International Scientific and Practical Conference “Innovative equipment and resource-saving technologies in animal husbandry” | Designing of the best available technologies of animal and poultry manure utilisation | Briukhanov A.Yu. | 19-20 April 2017, Moscow, All-Russia Research Institute for m Mechanisation of Livestock Production (VNIIMZh) | 140 |
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