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CHANGE IN CATTLE MANURE PROPERTIES AS RESULT OF NEW LIVESTOCK TECHNOLOGIES APPLICATION: CASE OF THE NORTH-WEST OF RUSSIA

Research article

Abstract

In Russia the animal housing/feeding and manure handling technologies have changed significantly over the past 20–30 years. At the same time, the reference data concerning the manure nutrient content remained unaltered, corresponding to the old technologies. Another weak point of available reference documents is that they were elaborated for the entire country and therefore may not be accurate enough, as the different regions have different climatic conditions, cattle breeds and relevant livestock farming practices. The aim of the study was to identify the currently relevant characteristics of cattle manure, corresponding to modern technologies for the North-West of Russia – the Russian part of the Baltic Sea Region. 148 manure samples were collected in 2017–2019 at 8 farms located here. The values obtained by averaging the results of laboratory analysis of manure samples were compared with the values from current reference documents. The comparison showed that the average nitrogen content in the dry matter of fresh cattle manure was 34.7% lower than that in the reference document. The average nitrogen content in the dry matter of cattle manure after its processing and storage was 59.5% lower than that in the reference document. The average phosphorus content in the dry matter of fresh cattle manure differs slightly from the value in the reference document – by 3.2%. However, the average phosphorus content in the dry matter of cattle manure after its processing and storage was significantly higher than the value in the reference document – by 106.3%.

Keywords: manure properties, nitrogen content, phosphorus content, Baltic Sea Region, manure data.

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ИЗМЕНЕНИЕ СВОЙСТВ НАВОЗА КРС КАК РЕЗУЛЬТАТ ПРИМЕНЕНИЯ НОВЫХ ТЕХНОЛОГИЙ НА ПРИМЕРЕ СЕВЕРО-ЗАПАДА РОССИИ

Научная статья

Аннотация

Технологии содержания животных, кормления и обработки навоза значительно изменились в России за последние 20–30 лет. В то же время нормативные и справочные данные о содержании питательных веществ в навозе остались прежними, соответствующими старым технологиям. Еще одним недостатком существующих нормативных и справочных документов является то, что они были разработаны для всей страны в целом и, следовательно, могут быть недостаточно точными, поскольку в разных регионах существуют разные климатические условия, породы скота и технологии кормления, содержания скота, навозоудаления. Целью исследования было выявление актуальных в настоящее время характеристик навоза крупного рогатого скота, соответствующих современным технологиям для Северо-Запада России - российской части региона Балтийского моря. В 2017–2019 годах на 8 фермах, расположенных здесь, было собрано 148 образцов навоза. Значения, полученные путем усреднения результатов лабораторного анализа образцов навоза, сравнивались со значениями из действующих нормативных и справочных документов. Сравнение показало, что среднее содержание общего азота в сухом веществе свежего навоза КРС было на 34,7% ниже, чем в действующем нормативном документе. Среднее содержание азота в сухом веществе навоза КРС после его обработки

и хранения было на 59,5% ниже, чем в нормативном документе. Среднее содержание фосфора в сухом веществе свежего навоза КРС незначительно отличается от значения в нормативном документе - на 3,2%. Однако среднее содержание фосфора в сухом веществе навоза крупного рогатого скота после его обработки и хранения было значительно выше значения в нормативном документе - на 106,3%.

Ключевые слова: свойства навоза, содержание общего азота, содержание фосфора, регион Балтийского моря, данные о навозе.

1. Introduction

Over the past 20-30 years, there have been significant changes in the technologies of animal housing/feeding, and manure handling in Russia. In 2017, the average productivity in the North-West of Russia increased to 6,600 kg of milk per head that was nearly twice as much as in 1995. The intensification of the dairy industry resulted in the change in the structure of livestock farms – the share of farms with the cow stock above 1000 head rose from 29% in 2000 to 55% in 2017. The farm size was growing with the introduction of the loose housing systems of farm animals that resulted in bigger amounts of semi-liquid manure produced. According to experts, its share will exceed 60% by 2020. Change-over to different animal housing practices and, consequently, different manure removal systems caused the obvious changes in manure properties.

At the same time, the current reference documents specifying the manure nutrient content remained the unaltered, corresponding to old technologies. One more their weak point is that they were elaborated for the entire territory of Russia and therefore may not be accurate enough, as different regions of the country have different climatic conditions, farm animal breeds and relevant farming technologies.

The aim of the study was to identify the currently relevant characteristics of cattle manure, corresponding to modern technologies for the North-West of Russia – the Russian part of the Baltic Sea Region.

Manure total nitrogen and total phosphorous content were of particular interest from both environmental and economic points of view. Manure is a significant source of pollution in agriculture, so it is the subject of many studies [1], [2], [3], [4], [5]. Therefore, the clarification of relevant characteristics of cattle manure is a current issue. The previous comparison of manure samples in 2015-2017 revealed significant deviations of actual and reference values [6]. To have more objective evidence, more systematic and repeated in different seasons sampling was performed on several selected farms with a bigger number of samples.

2. Materials and methods

New manure data was obtained by sampling, laboratory analysis and mathematical processing of the results. 148 samples of cattle manure were collected at 8 farms in the Russian part of the Baltic Sea Region (Leningrad Region and Pskov Region) in 2017–2019.

The samples were collected on all the farms in different seasons of the year. Part of this activity was performed in the framework of the project “Advanced manure standards for sustainable nutrient management and reduced emissions - Manure Standards” of EU Interreg Baltic Sea Region 2014-2020 Programme. The samples were taken in three places – fresh manure inside the livestock house (ex-animal), manure removed from the livestock house (ex-housing) and manure removed from the storage before application (ex-storage).

The samples were collected following the Russian standard GOST R 54519-2011 “Organic fertilizers. Methods of sampling”. In the case of liquid and semi-liquid manure at least eight point samples were taken from different depths, with each being at least 1 liter. Point samples were put in one vessel and mixed, and a laboratory sample was taken, packed and sent to the laboratory for analysis. In the case of solid manure fifteen point samples were taken from the three layers at different depths, five samples per layer. Each point sample was at least 100 grams. All point samples were put in one vessel and mixed. A laboratory sample was taken with the weight of at least 1 kg.

The manure samples were analysed following the applicable Russian standards:

1. State Standard GOST 26713-85: Organic fertilizers. Method for determination of moisture and dry residue (GOST 26713-85, 1985) [7].
2. State Standard GOST 26714-85: Organic fertilizers. Method for determination of ash content (GOST 26714-85, 1985) [8].
3. State Standard GOST 26715-85: Organic fertilizers. Methods for determination of total nitrogen (GOST 26715-85, 1985) [9]. The Kjeldahl method was used to determine the total nitrogen.
4. State Standard GOST 26717-85: Organic fertilizers. Method for determination of total phosphorus (GOST 26717-85, 1985) [10].

Currently, three reference documents associated with manure are valid in Russia:

1. Management Directive for Agro-Industrial Complex RD-APK 3.10.15.01-17. “Recommended practice for designing of systems for animal and poultry manure removal, treatment, disinfection, storage and utilization”.
2. Management Directive for Agro-Industrial Complex RD-APK 1.10.15.02-17. “Recommended practice for engineering designing of systems for animal and poultry manure removal and pre-application treatment”.
3. “Guidelines for determining the nutrient balance of nitrogen, phosphorus, potassium, humus, and calcium” [11].

The first two reference documents specify the data on fresh manure properties and the approximate values of nutrient loss. The third reference document specifies the data on the manure properties after its processing and/or storage.

In the study the reference data from RD-APK 3.10.15.01-17 were used as existing data for ex animal manure; the reference data from "Guidelines for determining the nutrient balance" were used as the existing data for ex storage manure.

For adequate comparison and processing of the results, regardless of manure water content, the total nitrogen content in dry matter (%) and the total phosphorus content in dry matter (%) were used. Laboratory analysis data for all samples were processed by calculating the average (median) values.

3. Results and discussions

The comparison of existing reference data and data obtained from the results of cattle manure sampling is given in tables 1, 2 and figures 1, 2.

Table 1 – Comparison of existing reference data and experimental data: nitrogen content in dry matter of manure

	Reference data, % in dry matter	New data, % in dry matter	Difference, %
Ex animal cattle manure	3.20	2.09	-34.7
Ex storage cattle manure	2.00	0.81	-59.5

Table 2 – Comparison of existing reference data and experimental data: phosphorus content in dry matter of manure

	Reference data, % in dry matter	New data, % in dry matter	Difference, %
Cattle manure, ex animal, semi-solid	0.785	0.810	+3.2
Cattle manure, ex storage, semi-solid	0.349	0.720	+106.3

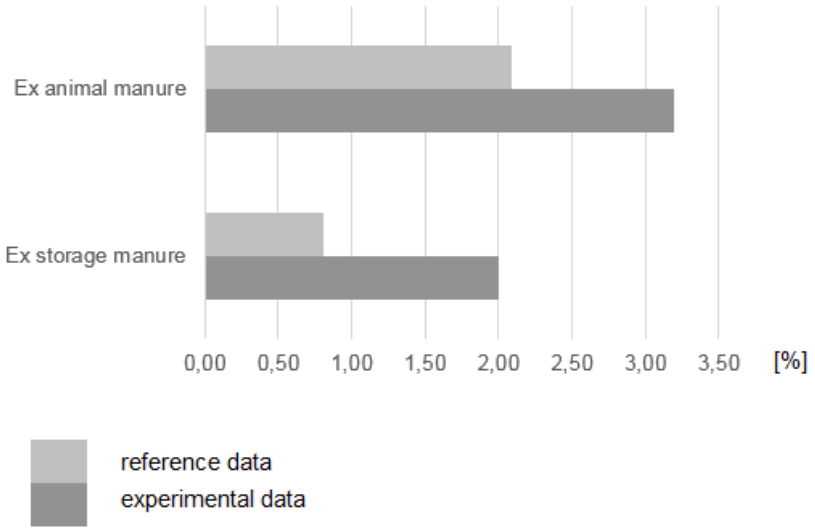

Figure 1 – Comparison of the existing reference data and the experimental data: nitrogen content in dry matter of manure

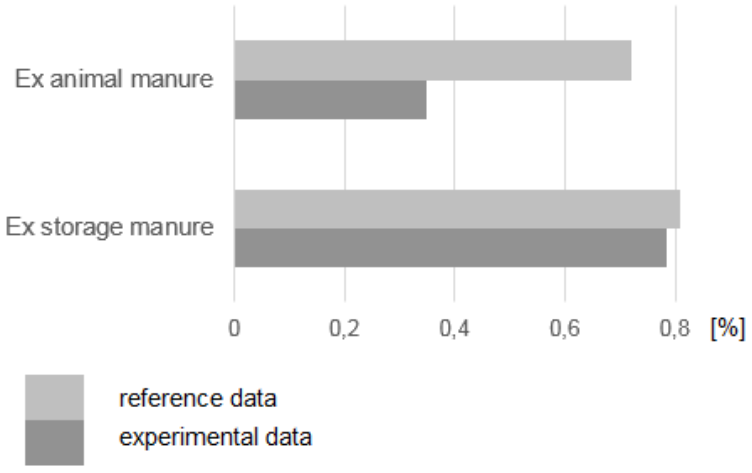

Figure 2 – Comparison of the existing reference data and the experimental data: phosphorus content in dry matter of manure

The comparison showed that the average nitrogen content in the dry matter of fresh (ex-animal) cattle manure was lower than the reference value by 34.7%. The average nitrogen content in the dry matter of ex-storage cattle manure was also lower than the reference value by 59.5%. The average phosphorus content in the dry matter of ex-animal cattle manure differed slightly from the reference value by 3.2%. The average phosphorus content in the dry matter of ex-storage cattle manure was significantly higher than the reference value by 106.3%.

4. Conclusions

The obtained manure data are more relevant for the conditions of the North-West of Russia and modern farms than the existing reference data. These data can be used for modelling the environmental risks of air emissions and water bodies pollution. In addition, these data can be used in the practical work of farmers – to calculate the maximum possible animal stock, depending on the available field area; or to calculate the required field area for available number of farm animals; or to define the organic fertiliser application rates.

In the future, it is advisable to update not only qualitative, but also quantitative data to improve the manure knowledge.

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Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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