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Ways to reduce anthropogenic load on environment in dairy farming

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Abstract. One of the most urgent world challenges today is to prevent environmental pollution from both animal farms and industrial enterprises in addition to lowering the overall energy inputs in various production processes. As far as dairy farming is concerned, the main ways to address these problems are as follows:

1. Improvement of available animal housing and handling technologies.

SZNIIMESH has developed technical and process solutions for a lactation department with the aim to produce solid cattle manure with its consequent composting, and to reduce substantially the amount of manure-bearing waste water from the milking parlour.

2. Development of application techniques of manure-bearing waste water from the milking parlour and ventilation emissions from the barns as recoverable resources in protected horticulture.

Investigation outcomes demonstrate that application of manure-bearing waste water, when growing leaf vegetables and flowers in greenhouses, reduces mineral fertilizer input and mitigates environment pollution with this kind of waste. The estimated power potential of waste water in this case is 90 MJ per one cow a day.

Tests show that inner barn air stimulates the growth and development of flowers. The height of plants grown in the barns exceeded the reference by 11%, the overall mass by 60%, and the number of stems by 198%.

The most effective and safe methods of ventilation emission utilization is to direct it to the root layer of the soil. Investigations on filtration efficiency of barn ventilation emissions through the soil substrate layer proved higher fertility of the latter.

Key Words: Dairy farm, manure-bearing waste water; ventilation emissions, environment pollution, greenhouse.

INTRODUCTION

Animal farms along with industrial enterprises contribute greatly to environment pollution. One of the major hazards to nature and human health is manure and manure-bearing waste water as well as ventilation emissions from animal houses and manure storing and processing facilities (Fig. 1).

In terms of pollutant content the waste water from a large livestock farm is comparable with that from a big settlement. But its cleaning procedure is much more complicated than that of household waste water since its pollution level is 300 times higher than that of municipal sewage water.

On the other hand, animal excrements are a valuable organic fertilizer. They contain all nutrients which the plants need. However, fertilizing application of manure and manure-bearing waste water has a number of restrictions in terms of rates, time, place, disinfection, and others.

Among ventilation emission gases carbon dioxide is the most hazardous one, its high atmospheric content resulting in climate change due to the greenhouse effect.

MATERIALS AND METHODS

One of the most urgent world challenges today is to prevent the pollution of environment and to lower the overall energy inputs in various production processes. In the context of dairy farms some approaches addressing these challenges are in our opinion the following:

1. Improvement of animal housing and handling practices.

In SZNIIMESH the elements of cattle housing and handling technologies were arranged into matrices of possible technology options for all dairy farm departments (Khazanov, E. E., Gordeev, V. V., Khazanov, V. E., 2009).

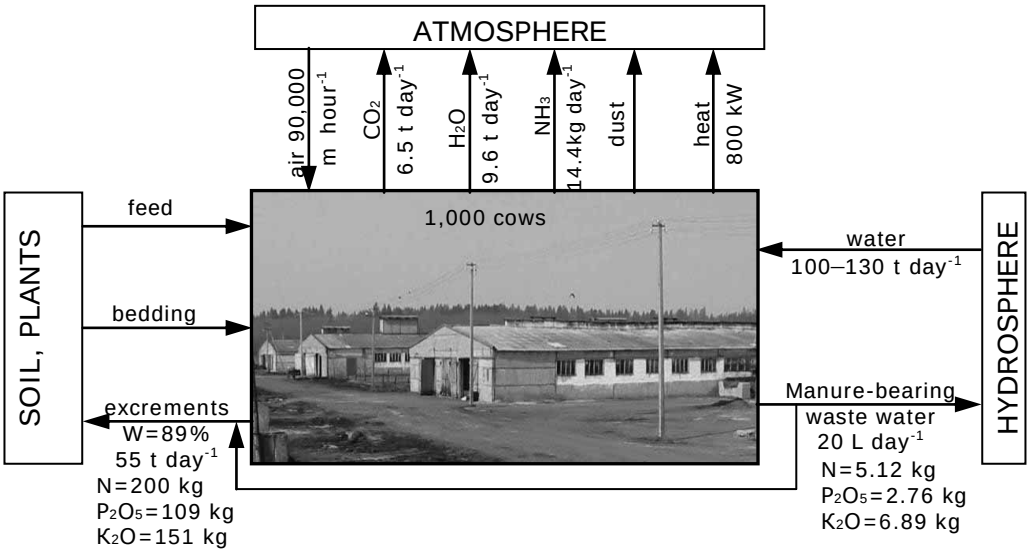

Figure 1. Information and environment model of a dairy farm.

Using this arrangement, the institute has developed technological solutions for dairy farms which are based on the most natural and comfortable housing method for cows and young animals with the output of solid manure and its further composting.

One way to decrease the amount of manure-bearing waste water on a farm is to introduce efficient engineering solutions in the lactation department, which make it possible to reduce the waiting area in the milking parlour, and, consequently, the amount of water needed for its cleansing. For example, the institute has designed so-

called modular barns (Fig. 2), and also barns with separate resting and feeding areas. Another approach is to apply automatic cattle goads which are supplied with devices for mechanical excrement removal from the waiting area floor. Some other solutions are to give the floor of the waiting area a 6° slope to facilitate manure disposal; to use high-head washing devices; to install utility meters and to introduce incentive scheme for water saving.

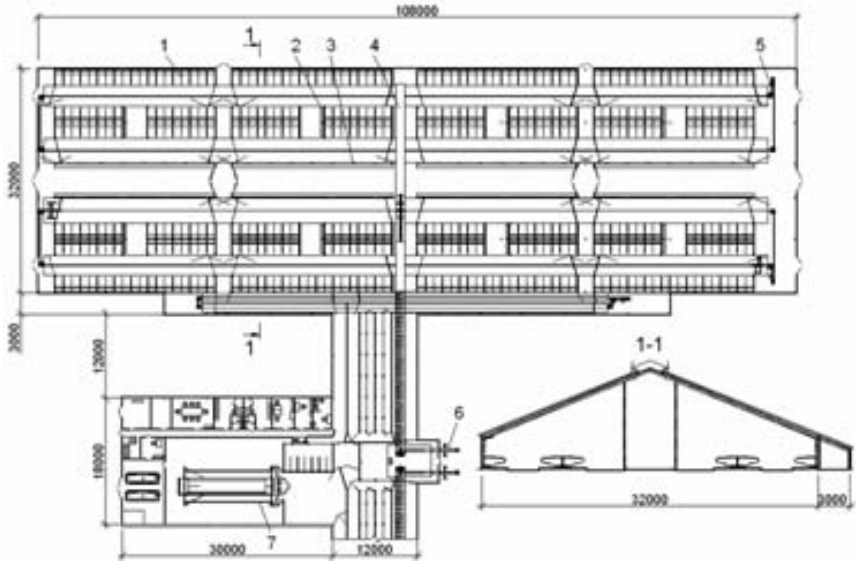

Figure 2. Modular barn for a newly built farm.

2. Development of technologies for waste utilization as a secondary resource in protected horticulture.

Both manure-bearing waste water and ventilation emissions may be considered secondary power resources with a certain energy potential, which in most cases is a waste, dissipating in environment. Measures should be taken to utilize these secondary power resources.

2.1. Manure-bearing waste water. Presently, manure-bearing waste water is either discharged into manure accumulation pits that makes manure considerably wet, lowers its nutritive value, and increases its storing, transportation, and application costs; or it is pumped from intermediate accumulation facilities and transported to the fields which worsens the environmental situation around the farm.

A solution to this problem may be a feasible combination of animal and plant production that allows the utilization of waste from these two closely related sectors in the most efficient way.

The most intensive plant production process is found in protected horticulture – in greenhouses and tropical houses. Each square meter of soil here is used most effectively practically all year round – and the latter factor is of particular importance. Such soil use requires continuous supply of water and fertilizers. A combination of both can be found in the manure-bearing waste water from the milking parlours of dairy farms.

2.2. Ventilation emissions. In barn ventilation emissions carbon dioxide is the most hazardous gas component, the high atmospheric concentration of which results in climate warming due to the greenhouse effect. Meanwhile, the carbon dioxide released by animals may be used for extra nutrition of plants grown in indoor structures. Calculations show that under intensive photosynthesis one square meter of a greenhouse consumes the same amount of carbon dioxide as is released by animals housed on eight square meters.

The most efficient and safe method for using ventilation emissions in indoor plant growing facilities is to direct these emissions towards the root layer.

RESULTS AND DISCUSSION

SZNIIMESH has designed and patented a technology of treatment and utilization of manure-bearing waste water from milking parlours. The trials in production conditions proved its high efficiency. Thus the trial number of calla lily (*Anglophile*) flowers was 15% higher, and the number of rose flowers was 27% higher against the reference, where flowers were grown according to the common technology with mineral fertilizers. The investigation results demonstrate that application of this kind of waste water when growing herbaceous crops and flowers in greenhouses allows to cut mineral fertilizer inputs and to avoid environmental pollution. Calculations show that power potential of waste water is around 90 MJ per one cow per day.

During the trials on a dairy farm for 1,200 cows it was established that the barn indoor climate contributed to the growth and development of flower crops. The plants grown right in the barn were 11% higher, their mass was 60% bigger, and the number of stems was nearly twice as big (198%) as in the reference group (Krasnova, 2005).

Investigations of the filtration process of barn ventilation emissions through the soil layer revealed an increase in phosphorus oxide (P_2O_5), potassium oxide (K_2O), ammonia nitrogen ($N–NH_4$), and nitrate nitrogen ($N\text{-}NO_3$) that improved the substrate fertility, reduced mineral fertilizer inputs, and mitigated nature pollution (Gordeev &Mironov, 2009).

All investigations were carried out according to the standard procedures, observing the generally accepted rules and regulations of field experiments. Agrochemical analyses were performed in a licensed laboratory in the town of Pushkin. Obtained experimental data was processed by STATGRAPHICS Plus for Windows software.

CONCLUSIONS

One of the ways to lower the anthropogenic load on environment may be to combine barns for dairy cows with greenhouses or tropical houses that would ensure the efficient use of heat, moisture, and carbon dioxide released by animals, and also manure-bearing waste water from the milking parlours. The concept of environmentally friendly dairy farms may be illustrated by the diagram shown in Fig. 3.

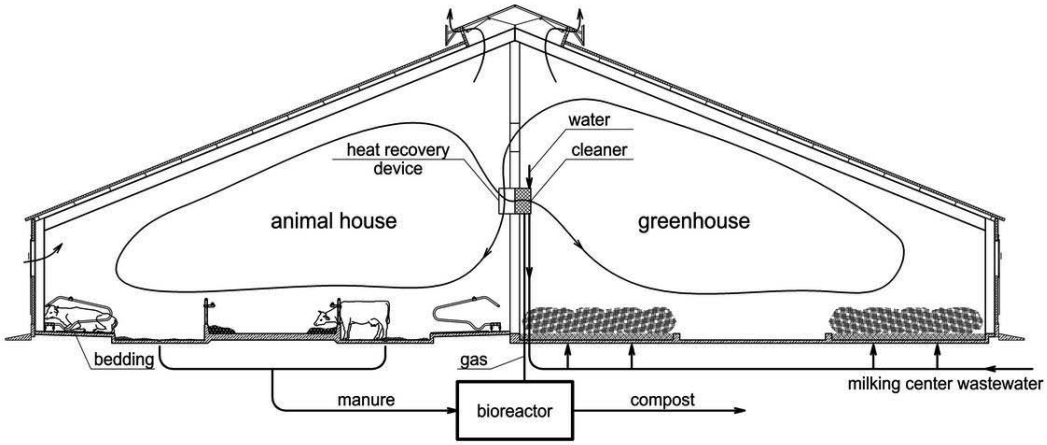

Figure 3. Pattern of manure-bearing waste water and carbon dioxide utilization in barn-greenhouse close circuit.

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