RESEARCH IN FARM ANIMAL BREEDING TECHNOLOGICAL PARAMETERS

Armins Laurs[1], Juris Priekulis[1], Zigurds Markovics[2], Aivars Aboltins[1]
[1]Latvia University of Agriculture; [2]Riga Technical University, Latvia
armins.laurs@promedia.lv, juris.priekulis@llu.lv, zigurds.markovics@rtu.lv, aivars.aboltins@llu.lv

Abstact. The task of the research was to state the peculiarities of the farm animal breeding technologies that are most widespread in Latvia with the purpose to use the research results for calculation of greenhouse gas emissions (GHG). With a view to this, it was necessary to state the length of the farm animal pasturing (grazing) period as well as the sizes of the herds at which the transition from production of solid litter manure to liquid manure or manure without solid litter (for laying hens) takes place. The expert method was used in the research. The research results show that the longest pasture (grazing) period is for cattle (they spend in pastures 85 % of the total number of hours per year), but the shortest – for goats and milk cows (they spend in pastures 14.6 and 18.8 % of the total number of hours per year). It is to a great extent related to the necessity to milk these animals. In turn, transition from production of solid litter manure to liquid manure for cows takes place, if the size of the herd reaches 85 cows, for pigs – if this number reaches 500 pigs, but for laying hens the transition from production of litter manure to manure without litter, i.e. to keeping the poultry in cage batteries – if this number reaches 1000 laying hens.

Keywords: farm management technologies, size of the herd, expert method.

Introduction

Implementing the project "Development of a Methodology for Calculating GHG Emissions in the Agricultural Sector and Modelling Tool for Data Analyses, Integrating Climate Change" of the European economic zone program "National Climate Politics" the task was set: to state what kinds of farm manure are obtained from the most widespread in Latvia groups and species of farm animals and poultry, as well as to determine the proportion of distribution of these kinds of farm manure. It was necessary for usage of the research results in calculations of greenhouse gas emissions caused by management of farm manure.

In order to calculate the proportion of farm manure obtained from the corresponding farm animals a new methodology was developed [1] based on the statistical data and on usage of the zootechnical and technological parameters of the farm animals. Some of the zootechnical and technological parameters necessary for the calculations are given in scientific literature and in the normative documents issued by the government [2; 3]. Still, it is in addition necessary to state the marginal sizes of the herds of every animal group, at which the transition from production of manure of one kind to another kind takes place, as well as the length of the animal pasturing (grazing) period. It was not possible to trace all farms (population) engaged in animal and poultry breeding in Latvia with this purpose, as it required very large working force and financial resources. The same, it was not possible to form representative and from the point of view of the size big enough sample farms, as the farms engaged in animal and poultry farming are unevenly distributed along the whole territory of Latvia. But it was possible to solve this problem orienting on the researches in farm animal and poultry farming technologies depending on the size of their herds applying the expert evaluation method.

Materials and methods

Tracing the barns of different farm animals it is possible to make a conclusion that for every group of animals different farming solutions are used depending not only upon the animal species, but also on their age, physiological condition, local conditions and other factors. If the animals are pastured, manure is not collected, but if the animals are kept in barns, manure is regularly transported to the storage. Therefore, the amount of manure obtained in farm animal barns is related to the used technological solution.

There are differences also in the kinds of the produced farm manure. If, for instance, milk cows are kept in the barn and their herd is comparatively small, the animals are kept tied in stalls, but for bedding litter is used. Therefore, in this case solid litter manure is obtained. If, in turn, the size of the herd exceeds more than several hundreds of cows, loose handling of animals in boxes is used. In this case the need for litter essentially decreases and half-liquid manure is obtained. Still, considering that

in the system of farm manure collection manure is mixed with water from washing the waiting yard and the milking parlour, as the final result liquid manure is obtained.

A similar situation can be observed also in pigsties. If the number of animals is small, the pigs are kept on straw litter producing solid litter manure. But if there are several thousands of pigs, grated floors are introduced in such pigsties and liquid manure is obtained.

Solid litter manure is obtained also on farms, where there is a small number of laying hens, most often 10 to 20 hens. If, in turn, there is a larger number of laying hens, they are kept in cage batteries and poultry manure without litter is obtained.

In order to specify these issues relating them with the technologies of farm animal breeding, the expert method was chosen [4-8]. The advantage of the method is that in this case it is not necessary to perform enquiries in many farms that is a very time consuming task and requires investments of financial resources. For the research a separate group of experts was chosen for every species of farm animals and poultry, organizing in total nine groups of experts. Within the groups of experts the Latvian Agricultural Advisory and Training Centre (LLKC) advisers, the leading specialists of farm animal and poultry breeding associations as well as competent farm managers were included. According to the recommendations [4], every group of experts was organized with 10 to 20 people in a group. For the research special enquiry forms were developed, and the task of the experts was to show the interval of the values, in which, according to their opinion, the actual value of the object falls or to choose one definite answer.

At the beginning of the research a pilot enquiry was performed with the purpose to specify the enquiry questions. After that, the basic enquiry was performed. The main questions asked in the basic enquiry were as follows.

- What is the average length of the pasturising or grazing period of the corresponding farm animals, h·year^{-1}?
- What is the average size of the herd at which the transition from production of one kind of farm manure to another takes place; for milk cows and pigs – from solid litter manure to liquid manure, for laying hens – from production of litter manure to manure without litter?

Processing of the data obtained during the experiment was performed in accordance with the methods recommended in literature [4-8], including:

- summarising of ranging of the results obtained in the enquiry;
- selection of the data;
- determination of conformity of the expert opinions.

This parameter is determined using the concordance correlation coefficient [4], the diapason of which can be from 0 to 1. If $W = 0$, there is no conformity with the ranging, if $W = 1$, there is complete conformity. In practice, it is considered that the concordance correlation coefficient is large enough if $W > 0.5$ [4].

Obtaining of quantitative values from the ranged rows

Based on the results of the expert enquiry the pasture usage coefficient k_{gan} could be calculated and the part of the animals (coefficient χ) could be determined from which solid litter manure is obtained.

The pasture usage coefficient is calculated according to formula

$$k_{gan} = \frac{t_{gan}}{24 \cdot 365}, \quad (1)$$

where t_{gan} – average length of the cow pasturing period, h·year^{-1};
24 – number of hours;
365 – number of days in one year.

According to the methods developed by us of calculation of farm manure proportion, the part of farm animals, from which solid litter manure is obtained, should be determined for milk cows, pigs

and laying hens. For every corresponding species of farm animals this coefficient is calculated separately using formulas (2), (3) and (4).

$$\chi_{pak} = \chi_{pak.1} + \chi_{pak.2} + ... + \chi_{pak.n-1} + \chi_{pak.n} \cdot \lambda_{z.o}\,, \quad (2)$$

where χ_{pak} – percentual amount of the corresponding species of the farm animals from which solid litter manure is obtained, %;

$\chi_{g.pak1}$; $\chi_{g.pak2}$; $\chi_{g.pak.n}$ – percentual amount of the farm animals in the first group, second group and nth group according to the proportion of the farm animals in accordance to the size of the herd, given in the statistics [3], %;

$\chi_{g.pak.n}$ – percentual amount of the farm animals in the marginal group of the herd, in which the transition from obtaining solid litter manure to production of other kinds of manure takes place, according to the proportion of the farm animals in accordance to the size of the herd, given in the statistics [3], %;

$\lambda_{z.o}$ – part of the farm animals in the marginal group of the herd, also from which solid litter manure is obtained.

$$\lambda_{z.o} = \frac{z_O - z_{1.gr} - z_{2.gr} - z_{n-1gr}}{z_n}, \quad (3)$$

where z_O – number of the farm animals in the herd, at which the transition from obtaining solid litter manure to production of other kinds of farm manure takes place (determined in the result of the expert enquiry);

$z_{1.gr}$, $z_{2.gr}$; $z_{n\text{-}1gr}$ – number of the farm animals in the first group, second group, last but one group (n-1 group) and the last group (n group or the marginal group), from which solid litter manure is obtained.

In turn, the number of animals in every group is calculated subtracting the minimal number from the maximal number of the animals in the group and adding one animal. For instance, in the first group

$$z_{1.gr} = z_{1.gr.\max} - z_{1.gr.\min} + 1, \quad (4)$$

where $z_{1.gr.\max}$, $z_{1.gr.\min}$ – maximal and minimal number of the farm animals in the first group.

Results and discussion

The information obtained in the research on the length of farm animal pasturing or grazing is summarised in Table 1.

Table 1

Length of farm animal pasturing or grazing

No.	Group of farm animals	Concordance correlation coefficient,W	Length of farm animal pasturing or grazing, h/year	Coefficient of pasture usage, k_{gan}.
1	Milk cows, their calves and young stock	0.58	1650	0.188
2	Beef cattle, their calves and young stock	0.34	7543	0.861
3	Horses	0.50	4560	0.521
4	Goats	0.50	1280	0.146
5	Sheep	0.50	4368	0.499
6	Laying hens	0.53	2880	0.329
7	Turkeys	0.53	2880	0.329
8	Ducks, geese	0.77	3120	0.356

As it is seen in Table 1, the concordance correlation coefficient W almost in all cases is larger than 0.5. The exception is only beef cattle, their calves and young stock, the concordance correlation

coefficient of which in the research of their pasture period was 0.34. It is because for this group of animals the length of the pasture period is essentially dependent on the climatic conditions. But in the eastern part of Latvia the weather conditions are considerably different from those in the western part. Still, generally it can be stated that in this research the degree of the expert opinion conformity is sufficient enough.

Cattle, their calves and young stock spend the longest time in the pastures. For them the pasture usage coefficient is 0.861, and it means that these animals spend 86.1 % of the total number of hours in the year in pastures. Also for horses the pasture usage coefficient is comparatively high – 0.521, and for sheep – 0.499. In turn, small pasture usage coefficients are for goats – 0.146 and milk cows – 0.188 (if they are pastured). It is to a great extent related to the necessity to milk these animals, as during milking as well as at night they stay in barns.

It has been stated in the research that all poultry that are let out for airing stay outside the henhouse for about one third of the total number of hours in the year. Therefore, the pasture usage coefficient for laying hens and turkeys is 0.329, but for ducks and geese – 0.359.

The information stated in the research on the marginal size of the herd, at which the transition from obtaining of solid litter manure to another kind of farm manure takes place, as well as the calculated value of the coefficient χ are given in Table 2.

Table 2

Marginal sizes of the herds, at which the transition from obtaining of solid litter manure to another kind of farm manure takes place

No.	Group of farm animals	Concordance correlation coefficient,W	Marginal size of the herd	Coefficient χ
1	Milk cows	0.58	85	62
2	Pigs	0.83	500	15
3	Laying hens	0.67	1000	11

Evaluating the marginal sizes of the herds of milk cows, pigs and laying hens at which the transition from obtaining of solid litter manure to production of liquid manure or manure without litter takes place, it is possible to state that in all cases the concordance correlation coefficient was higher than 0.5. It means that in this research the degree of the expert opinion conformity has been sufficient enough.

The research shows that for milk cows the marginal size of the herd is 85 animals, but the calculated coefficient χ is 62 %. So, in the country 62 % of the cows are handled tied in the stalls and solid litter manure as well as manure left in the pastures is obtained from them, but from 38 % of the cows liquid manure is obtained. Similarly it can be concluded that solid litter manure is obtained from 15 % of pigs and 11 % of laying hens, but liquid manure is obtained from 85 % of pigs and manure without litter – from 89 % of laying hens.

Conclusions

1. It is useful to apply the expert method in the research in the technological parameters of farm animal breeding as such approach essentially decreases the time consumption necessary for the research and the investments of financial resources.
2. In Latvia, beef cattle spending 85 % of the total number of hours in the year in the pastures have the longest pasture period. In turn, the shortest pasture period is for goats and milk cows (spending in pastures 15 and 19 % of the total number of hours in the year, respectively). It is to a great extent related to the necessity to milk these animals. Also horses – 52 % and sheep – 50 % have a comparatively long pasture period. Poultry spend 33-35 % of the total number of hours in the year outside the building, if only such airing is not limited.
3. The transition from obtaining solid litter manure to liquid manure for milk cows takes place, if the size of the herd reaches 85 cows, for pigs – if this number reaches 500 pigs, but for laying hens the transition from obtaining solid litter manure to manure without litter, i.e. to keeping the poultry in cage batteries – if the number of the flock reaches 1000 laying hens.

References

1. Priekulis J., Aboltins A., Laurs A., Melece L. Research in manure management in Latvia. Proceedings of 14th International Scientific Conference "Engineering for Rural Development", May 20-22, 2015, Jelgava, Latvia, pp. 88-93.
2. IPCC 2006 Guidelines for National Greenhouse Gas Inventories. Chapter 10 "Emissions from Livestock and Manure Management". 2006.
3. Regulations of the Cabinet of Ministers No. 834. Regulations of water and soil protection from pollution with nitrate caused by agricultural activities. In force from 23.12.2014. (in Latvian).
4. Markovičs Z. Expert Evaluation Methods. Riga: RTU, 2009, 111 p. (in Latvian).
5. Dunham M.H. Data Mining: Introductory and Advanced topics. New Jersey: Pearson Education, 2003, 314 p.
6. Hand D. J., Heikki M., Smyth P. Principles of Data Mining. Cambridge: MIT Press, 2001, 425 p.
7. Tan P. N., Steinbach M. Introduction to Data Mining. Boston: Pearson Education, 2006, 769 p.
8. Voronin A. N. Method of Expert Evaluation Data Array Processing. Ergatic Management Systems. Kiev: Naukova dumka, 1974. 253 p. (in Russian).