Preventing the climate change effect in livestock production.

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Contemporary livestock production, based on intensive methods of feeding and housing, could be a source of various adverse effects on the natural environment. These are both of local and global scope. The latter, broader importance is associated with the emissions of greenhouse gases (GHG). The issues pertaining to their emissions cover three areas: mitigation, sequestration, and adaptation. Of Poland's total GHG emissions agriculture accounts for 8.5% (34787.73 Gg eq. CO_2).

Within the animal production sector, the reduction of GHG emissions may be obtained by methods associated with feeding, breeding, and technological measures. The feeding methods that have great potential for reducing emissions are principally not ready yet, and they are among more expensive methods, bearing a major risk of increased costs of production. The breeding methods happen to be the cheapest because they are implemented by continuous progress in breeding aimed at increased effectiveness of production. However, the potential of these methods is relatively limited. The technological solutions are principally concerned with the collection and storing of animal faeces.

Methane production accompanies, to various extent, the anaerobic metabolism of organic matter in the digestive tract of any animal. In the case of ruminants, however, the methanogenesis is of particular importance and dimension since it is an integral part of the physiological cycle of feeding with all the anatomical consequences of the development of the fore-stomach, and particularly, of the rumen. Some 2-12% of the gross energy provided to ruminants as fodder is lost as methane after the fermentation process.

Technological group of ruminants	Mean body mass (kg)	Mean daily food requirement MJ ME	Mean daily loss in CH_4 emissions MJ ME (MJ/head/day)
Fat stock	500	83	11.0
Milk cows	450	203	18.0
Breeding ewes	45	13	1.2

Nitrogen oxides are produced primarily in the nitrification process and – to a lesser extent – in the denitrification of organic compounds present in animal faeces. In the case of monogatric animals from 70% to 91% of nitrogen taken with fodder is released back to the environment with dung and urine. In cattle it is from 75% to 95% of nitrogen.

Livestock Feeding and Feed Supplements

This category covers a very wide spectrum of activities. It includes permitted feed supplements: probiotics, enzymes, tannins, and oils but also supplements which naturally increase the digestibility of feed. The dry mass content is also considered. Applying papilionaceous plants in feeding (composition of feed ration), improvements in digestibility, or feeding young grass or ground grains of oil plants results in a similar effect in reducing methane. Generally, feeding methods include:

- Increasing the concentration of feed ration – up to 50% reduction in beef cattle, up to 9.5% in milk cattle.
- Replacing cereal silage (maize) by grass silages – increased proportion of propionic fermentation – 10% reduction.
- Using natural feed supplements – saponins, tannins, rhubarb and garlic extracts reduce the methane emissions by up to 20%.
- Changing the pattern of feeding, improvement of pasture quality – introducing fresh grasses with papilionaceous plants, reduced emissions by 10% via the presence of active chemical compound (tannins).
- Lengthening the pasturing period – reduction by 12%
- Fat or oil additives (linseed oil, sunflower oil and others) – have a toxic effect on methane-producing microorganisms, protozoans, and they block the decomposition of fibre, but they have an adverse effect on livestock animals themselves – reduction by up to 50 %.
- Ionophores – compounds like monensin, having an antibacterial effect, increase digestibility by 6% and therefore reduce the intake of dry mass, shift the balance in the rumen towards volatile fatty acids. Emission reduction by up to 5%. Banned by the EU.
- Defaunisation of the rumen – eliminating protozoans reduces methane emissions by over 50%.

Breeding methods
The range of activities including the genetic improvement of animals (better utilisation of feed, improving breeds with lower methane emissions) as well as lengthening their use (longevity) together with the reduction of stock and decrease in remounting herds. Routinely performed selection for productivity and utilisation of feed improves somewhat the gross use of energy and reduces GHG emissions. An annual reduction by 3% can be obtained by these measures. Although the purposeful selection of animals for lower methane emissions is feasible it is also very expensive. Research demonstrates the differences in methane emissions between specific genotypes of milk cattle amounting to 10-20%. Improved condition, health state, and the welfare of animals also reduces the mitigation by up to 3%. The effectiveness of breeding methods reduce culling, therefore lengthening the longevity of animals. The number of animals may thus be reduced, and unproductive periods reduced which are included in the unit cost of production in terms of emission. By this method, the reduction of GHG emission by 10-15% is achievable. Therefore, it is suggested that the lactation period be established at such length as to obtain one calf per 18 months instead of one per year.

Technological methods
The longer period of time slurry is stored in anaerobic conditions at a higher temperature, the higher methane emissions. The production of nitrogen oxide requires aerobic conditions, thus in the case of solid dung or manure its emission is higher than in natural liquid fertilisers, although it can also be considerable particularly when they are applied on soil.
The technological solutions used to reduce GHG emissions involve the following:
Shallow bedding system in cattle rearing – up to 15% reduction, provided that the bedding is removed frequently.
Slated stall system in pig rearing – up to 25% reduction.
Bedding additives changing pH – up to 10% reduction.
Microbiological bedding additives – up to 20% reduction.
Covering slurry tanks – up to 40% reduction.
Afterburning methane from slurry tanks – up to 70% reduction.

Incinerating of dung – up to 80% reduction
Filtration of air from livestock buildings results in 25-30% reduction depending on the method used, i.e. ozonation or ionization. Biofiltration using the types of filters developed to date does not affect the potential of this method.
Biogas production – 100% reduction with respect to storing dung.
Applying RES (Renewable Energy Sources) in animal production – does not directly affect the reduction of GHG emissions from farms but may indirectly affect some 35% of equivalent reduction of GHG-related cost of energy management. It pertains both to heating or ventilation of buildings but also to the reduced consumption of fodders.

Nitrification is an aerobic process, therefore a number of solutions are proposed for livestock buildings aimed at reducing the contact surface between faeces and air via reducing the defecation zones. In the beddingless systems it is essential to move faeces as fast as possible to tanks, sealing them airtight, cooling the slurry, or chemically processing it in agricultural biogas stations. Such solutions may well reduce the emission by even as much as 30%.

Level of GHG emissions from basic housing systems of various technological cattle groups (kg/year/head).

Gaseous compounds	**Housing system**					
	Straw bedding	**Saw dust bedding**	**Deep straw bedding**	**Deep sawdust bedding**	**Beddingless**	**Slated stall**
Milk cows						
- carbon dioxide	2664.8 aBCD	2545.3aEFg	2989.4 BEhi	2844.1 CFhij	2764.8 DGij	X
- methane	108.4abcd	112.91aefg	123.53behi	126.32cfhi	119.2dgij	X
- nitrogen oxides	0.032aBCD	0.045aeFG	0.062BehI	0.073CFhJ	0.416DGIJ	X
Heifers						
- carbon dioxide	1944.6abd	1823.8aefgH	2078.3beijk	1924.5fil	1998.2gj	2129.7dHkl
- methane	56.3BCde	57.4FGhi	79.32BFjkl	84.27CGjMN	66.73dhkMo	67.58eilNo
- nitrogen oxides	0.015a	0.016fghi	0.019bfjkl	0.021cgjm	0.022dhkn	0.024eilmn
Calves						
- carbon dioxide	X	X	1108.23ab	1046.3ac	X	987.8bc
- methane	X	X	21.21ab	24.47ac	X	19.68bc
- nitrogen oxides	X	X	0.006aB	0.004aC	X	0.003BC

aa – statistically significant differences; AA, BB –highly significant statistical differences