INSTYTUT ZOOTECHNIKI
PAŃSTWOWY INSTYTUT BADAWCZY
NATIONAL RESEARCH INSTITUTE OF ANIMAL PRODUCTION

Development of standards for protecting the climate from the adverse effects of animal farming

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Plan of the presentation

- General Information
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- Technologies to reduce the emission
- Proposed categories of actions to reduce GHG emissions and Carbon Food Print from animal production
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General information

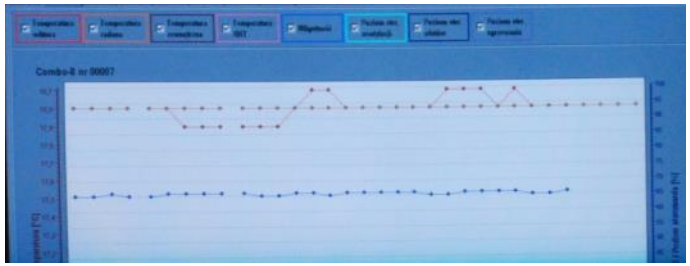
The National Research Institute of Animal Production in Kraków-Balice, founded in 1950, is the largest institute in the agricultural sector serving the whole country. The Institute is engaged in research and development work, which comprises the breeding of all species of farm animals and the entirety of animal production issues.

Livestock breeding, like all forms of agriculture, is directly related to the natural environment. The intensification production methods has led to progress but it can also cause contamination and degradation as well as climate change.

Research facilities of the Institute

Microclimatic chambers

- The studies on animals were performed in six microclimatic chambers with full computerised environment control system.



Unique equipment of the chambers

- The microclimatic chambers were located in a single building equipped with heating and cooling systems. Every chamber was supplied from a separate ventilation duct whose inlet was located outside the building, beyond the discharge zone of worn-out air. The temperature in the building and chambers was maintained within the thermal neutrality range depending on the technological group examined. During individual repetitions gas concentrations were measured continuously using electrochemical and infrared probesand a gas chromatograph.

Field research – aerodynamic tunnels

Studies on fertilisers were done with the use of aerodynamic tunnels with a constant flow of air mass.

Our research results

Emissions from basic animal housing systems

The studies were performed on various technological groups of cattle, pigs, poultry, and fur bearing animals.

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

Gaseous compounds	Housing system					
						Slated stall
Milk Cows						
	Deep staw bedding		Deep sawdust bedding			
methane	123,53		126,32			
nitrogen oxides	0,062		0,073			
- carbon dio						X
- methane	108.4abcd	112.91aeig	123.53beni	126.32cini	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

Level of gas emissions from basic housing systems of various technological pig groups (kg/year/head)

Group/ Gases	Housing system					SEM
	Weaners					
			Deep litter		Slope floor	
	methane (kg/y/head)		1,53		0,42	
- H_2O_2	nitrogen oxides (kg/y/head)		0,038		0,020	39,19
- CO_2						50,63
- NH_3						0,50
- H_2S						0,03
- CH_4						0,19
- NO_x	**Fattening pigs**					0,01
			Deep litter		Slope floor	
- H_2O_2						7,02
- CO_2						5,57
- NH_3	methane (kg/y/head)		2,5		1,64	0,11
- H_2S						0,007
- CH_4						0,08
- NO_x	nitrogen oxides (kg/y/head)		0,071		0,043	0,002
- H_2O_2						20,01
- CO_2	773,89a	728,91b	818,34c	797,89ac	748,60ab	7,47
- NH_3	2,93a	2,31b	3,67c	5,24d	2,89a	0,29
- H_2S	0,091A	0,084A	0,108B	0,322D	0,129AB	0,02
- CH_4	1,91a	1,64a	2,5b	2,25b	1,83a	0,07
- NO_x	0,054a	0,043a	0,071b	0,048a	0,039a	0,003

Level of gas emissions from pigs waste managing places (kg/t).

Gases	Solid waste						Liquid waste							
	Manure - fattening pigs	Deep litter - fattening pigs	Manure - weaners	Manure – pregnant sows	Deep litter – pregnant sows	Manure – sows with piglets	Sllury – fattening pigs	Liquid manure - fattening pigs	Sllury - weaners	Liquid manure - weaners	Sllury - pregnant sows	Liquid manure - pregnant sows	Sllury - sows with piglets	Liquid manure - sows with piglets
NH_3	1,73aA	4,39bB	1,44cA	1,76aA	3,47dAB	2,76eAB	4,91fB	5,17gB	2,53eAB	2,93hAB	3,04hAB	3,30dAB	3,87iAB	3,40dAB
NO_x	0,19aA	0,49bB	0,15cA	0,19aA	0,36dC	0,30dC	0,69eD	0,82fE	0,42bB	0,53gB	0,38dC	0,62eD	0,59gB	0,40bB
CH_4	6,93aA	10,92bB	9,59cB	8,73dAB	15,64eC	9,35cB	18,18fD	25,06gE	32,03hF	39,42iG	29,97jH	37,45kGI	25,73lE	35,38mI
H_2S	0,89aA	2,11bB	0,97cA	0.82aA	2,21bB	1,25dA	7,25eC	6,97eC	6,43fC	5,95gC	4,83hC	4,31iCD	5,43jC	5,04kC
NMVOC	44,10aA	67,79bB	61,10cB	68,87bB	75,63dB	57,80eA	10,00fC	13,82gC	16,28hCD	24,80iD	14,73jC	19,71kCD	13,63gC	17,08lCD

ab – statistically significant differences (P≤0,05); AB – statistically highly significant differences (P≤0,01)

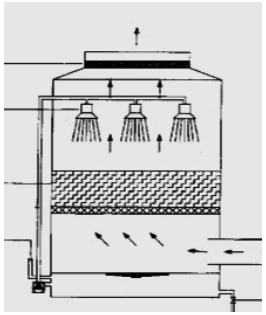
Technologies to reduce enteric methane emissions

- Technologies to Reduce Enteric Methane Emissions
  - Animal Manipulation
    - Animal Breeding
      - Residual Feed Intake
      - Efficiency
    - Management Systems
      - Alternative Livestock Systems
      - Unproductive Animals
  - Diet Manipulation
    - Forage Quality
    - Plant Breeding
    - Dietary Supplements
      - Dietary Oils
      - Probiotics
      - Enzymes
      - Dicarboxylic Acids
    - Plant Secondary Compounds
      - Tannin & Saponin
  - Rumen Manipulation
    - Biological Control
      - Bacteriophages Bacteriocins
      - Reductive Acetogenesis
    - Vaccination
    - Chemical Defaunation

Research conducted by the Institute- possibility of reduction

Level of gas emissions from hens housing with different types of biofilters (kg/year/head).

Gaseous compounds	Group			
	Without filtration	Filtration typ 1	Filtration typ 2	Filtration typ 3
VOC	0,024	0,022	0,030	0,028
NH_3	0,33A	0B	0B	0B
NO_x	0,109A	0,111A	0,105A	0,042B
CH_4	0,51	0,49	0,48	0,50



NOx emissions from animal housing systems (kg/head/24h) with supplementation of different reduction methods

Group/Supplement	Typ of animal production		
	Cows	**Fattening pigs**	**Broilers**
Control	0,0014539Aa	0,000368Aa	0,0000527Aa
Ionization	0,0013422 Aa	0,000297 ABab	0,0000375 ABCbc
$CaCO_3$	0,0013751 Aa	0,000319 ABab	0,0000436 ABab
Microphlora	0,0014966Aa	0,0001117Cc	0,0000542Aa
Zeolit	0,0012716Aa	0,0003907Aa	0,0000276BCcd
Feeding enzym	-	0,000217A	0,0000189B
SEM	0,0001	0,00002	0,000003

Our proposals for effective actions to reduce emissions and carbon footprint from animal production in Poland

Perspective till 2050

Based on the results of research and technical feasibility of the farms, taking into account the increase in production costs and prices of materials, it was verified the following solutions

Proposed categories of actions to reduce ghg emissions In polish livestock breeding till 2050

Livestock - Antimethanogen vaccine

Vaccinating ruminants against methanogenic microflora of the rumen, like other activities aimed at de-faunisation or transformation of this ecosystem have been continued as a research topic since the 1960s.

Negative opinion - can not be applied in practice!

Livestock Feed Supplements

This category includes a very broad spectrum of activities pertaining chiefly to feeding dairy cattle. It results from very low levels of sheep stock, which has been covered by the activities aimed at protecting genetic resources (PROW), and low profitability of breeding beef cattle by extensive methods (grazing on pastures). The activity includes applying both permitted feed supplements in the forms of probiotics, enzymes, acidifiers, tannins, oils, and also such additives which increase the digestibility of fodder.

Positive opinion - low cost, high potential practical implementation.

Name Technology of activity	Years								Type of installations /units
	2011/15	2016/20	2021/25	2026/30	2031/35	2036/40	2041/45	2046/50	
Livestock Feed Supplements									
Maximum number of installations	90,0	150,0	220,0	270,0	300,0	340,0	400,0	470,0	Thousands
Initial capital expenditure	670	630,0	600,0	570,0	540,0	500,0	470,0	440,0	euros
Sectors providing goods and services	70% agriculture, 30% other services								
Gross operational expenditure	1650	1670,0	1680,0	1690,0	1700,0	1720,0	1740,0	1750,0	euros
Savings	0	0	0	0	0	0	0	0	euros
Net capital expenditure	1650	1670,0	1680,0	1690,0	1700,0	1720,0	1740,0	1750,0	euros
Sectors providings goods and operational services	100% agriculture								
El. energy savings	0	0	0	0	0	0	0	0	euros
Fuel savings	0	0	0	0	0	0	0	0	t
Emission reduction	0,32	0,32	0,36	0,36	0,39	0,39	0,41	0,41	t of CO_{2e}

This category includes not only feed supplements but also quality of fodder and its compositions. It pertains to dry mass content and supplements: oils, probiotics, enzymes, and tannins. Applying papilionaceous plants in feeding, improvements in digestibility, or feeding young grass or ground grains of oil plants results in a similar effect in reducing methane. Using antibiotics, de-faunisation, or analog compounds is ruled out.

Breeding, productivity effectiveness and animals longevity

The scope of activities including genetic improvement of livestock i.e. breeding progress will be of principal importance for Polish agriculture for a minimum of 30 or more years. The data provided by Eurostat show the great discrepancy between the productivity of Polish breeds of ruminants compared with the state in EU-15 countries. The progress is forced by macroeconomic factors and is of intrinsic nature.

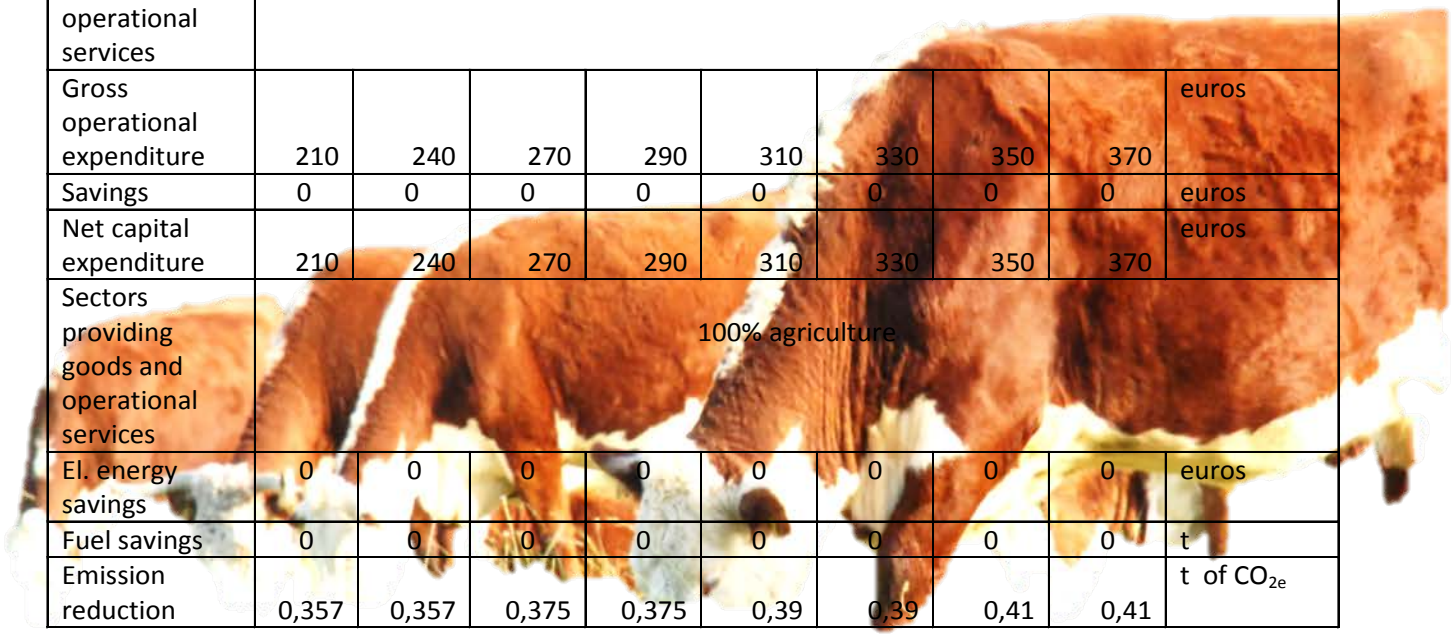
Positive opinion – possibilty of implementation but in long term.

Housing and storage, biogas production

Activities in the area of technology of rearing animals, storing faeces, and the production of agricultural biogas cover not only ruminants but also poultry and pigs. The last two species are taken into account in terms of faeces and biogas production, and these were converted per hypothetical cow (large conversion unit).

Positive opinion– the high cost of implementation, offer for large and modern farms.

Name Technology of activity	Years								Type of installations /unit
	2011/15	2016/20	2021/25	2026/30	2031/35	2036/40	2041/45	2046/50	
Breeding, productivity effectivness and animals longevity									
Maximum number of installations	200	240	290	330	380	430	490	530	Thousands
Initial capital expenditure	110	120	140	150	170	180	200	210	euros
Sectors providing goods and operational services	100% other services								
Gross operational expenditure	210	240	270	290	310	330	350	370	euros
Savings	0	0	0	0	0	0	0	0	euros
Net capital expenditure	210	240	270	290	310	330	350	370	euros
Sectors providing goods and operational services	100% agriculture								
El. energy savings	0	0	0	0	0	0	0	0	euros
Fuel savings	0	0	0	0	0	0	0	0	t
Emission reduction	0,357	0,357	0,375	0,375	0,39	0,39	0,41	0,41	t of CO_{2e}



The scope of activities includes the genetic improvement of animals (improved use of fodder, improving breeds emitting less methane) and also the longer period of use (longevity) together with reducing stock and the decrease of the remount of herds. There is a wide range of techniques.

Conclusions

The actions needed for NIRAP:

- Financial support for research on emission reduction, including the purchase of equipment,
- New legislation to implement mechanisms of reduction and to have information system of implementations,
- Financial support for implementation in farms,

Cooperation between NIRAP and international partners:

- Exchange the experiences in conducting the research,
- Exchange the information about used and planned legislations in agriculture.