ASSESSMENT OF CATTLE MANURE ACIDIFICATION EFFECTS ON AMMONIA AND GHG EMISSIONS AND CROP YIELD

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INTRODUCTION

- ✓ Farm livestock manure is an important source of NH_3 and other greenhouse gases.
- ✓ Reducing emissions from manure is important for the protection of the environment and also for preservation of the nutrients in manure and making it more absorbable to plants.
- ✓ It is known that nitrogen in manure is converted to either NH_4 under acidic or neutral pH conditions, or ammonia (NH_3) at higher pH levels.
- ✓ Manure acidification is recognized as one of best treatments available to reduce ammonia emission from manure. Acidification can minimize ammonia losses from livestock manure and improve availability and the suitability of manure as a replacement for mineral fertilizer.
- ✓ However, the potential to reduce the emissions of polluting gases, as well as the effects on crop yield have been poorly studied.

The AIM of our study was to evaluate the effect of acid treatment on NH_3 and other GHG emissions from manure and assess the effects on plant nutrient utilization

The study was conducted as part of project **„Climate Care Cattle Farming“** tasks contributing to „Study and monitor manure storages and innovative handling techniques“

MATHERIALS AND METHODS

EXPERIMENTAL DESIGN

The study was conducted on laboratory and field scale.

Laboratory scale trial: fresh liquid manure from dairy cattle was immediately delivered to the laboratory, homogenized and placed into 20 manure tanks with a capacity of 32 liters. Gas emissions measured using passive chamber method.

Field scale trial: slurry acidification tehniques *in-field* (SATs) was used to determine the influence of manure acidification on crop yield during application to the soil

FIELD TRIAL

(BARLEY)

Treatment field	Fertilization (description)
No 1	Without fertilization
No 2	Mineral fertilizers (NPK 20-10-10)
No 3	Untreated cattle slurry
No 4	Acidified cattle slurry

(SPRING WHEAT)

Treatment field	Fertilization (description)
No 1	Without fertilization
No 2	Mineral fertilizers (NPK 20-10-10)
No 3	Untreated cattle slurry
No 4	Acidified cattle slurry

Gas Concentration Analyses

NH_3 CH_4 and CO_2 concentration were measured daily during first 3 days and then every 2 days for 3 weeks in hermetically closed chambers with installed gas analyzer Dräger Pac III M40 (Keison Products, England), Almemo 2890-9 (Ahlborn Mess- und Regelungstechnik GmbH, Germany) and handheld remote laser methane detector (LMD) for CH_4 analyses.

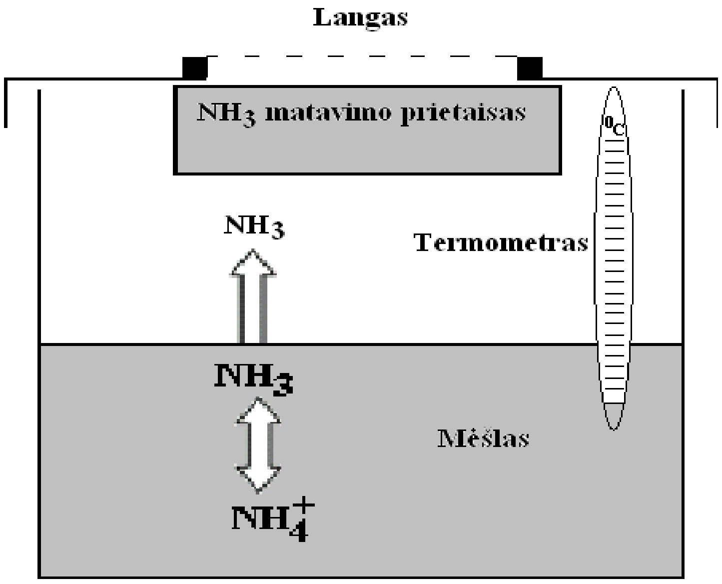
Manure Composition Analyses

Total nitrogen content (TN) was analyzed by the Kjeldahl method (Peters (ed.) et al., 2003);

Ammonium nitrogen (NH^{+4}-N) – by distillation and a device FOSS Tecator™ (Denmark) apparatus.

Quantitative pH analysis – by pH meter HI 98128, HANNA instruments, USA).

SCHEME OF PASSIVE CHAMBER METHOD



Calculation of Gas Emission Rate

$$F = V\ M\ p\ (C_1 - C_0)/R\ (T+273)\ A\ l\ h$$

where, F (mg/(m^2 l h)) – gas emission rate; V (m^3) – headspase capacity in the chamber; M (g/mol) – gas molar mass; p (kPa) – gas pressure; C_1 (ppm) – gas concentration in the chamber at the fifth minute of measurement; C_0 (ppm) – gas concentration in the chamber at the beginning of measurement; R (8.314 J/K · mol) – gas constanta; T (^{o}C) – gas temperature; A (m^2) – the surface area of manure; l (l) – the amount of manure; h (0,08 h) – the extension of gas measuring period.

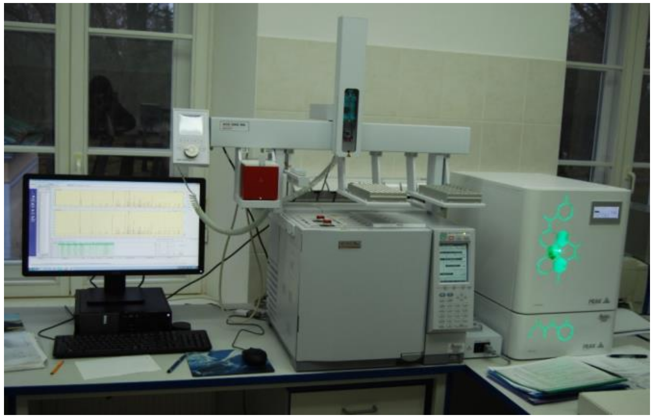
ENVIRONMENTAL CONDITIONS:

- Temperature – 18.6 C°,
- Relative humidity – 68

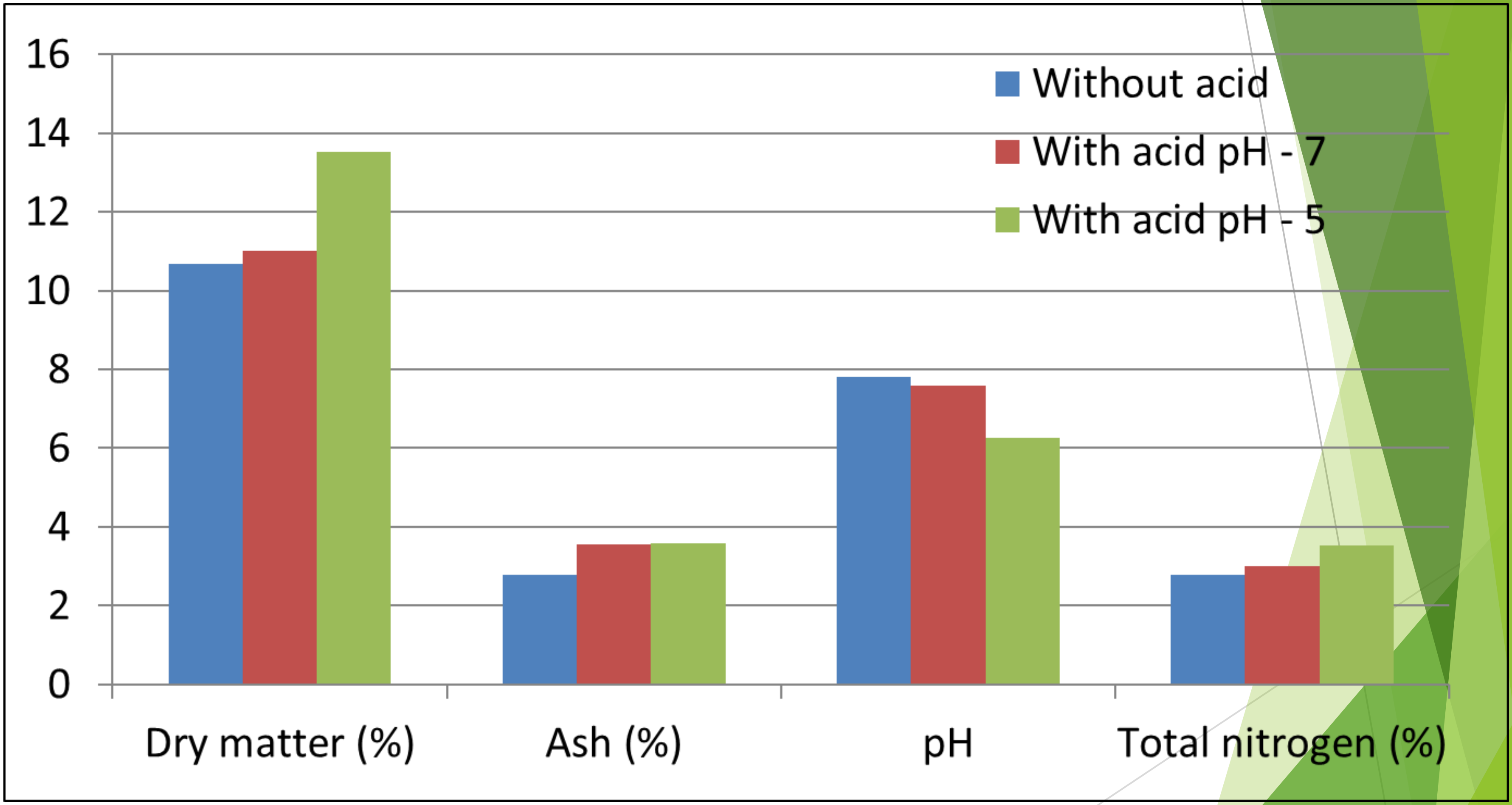
CHARACTERISTICS OF MANURE AT THE BEGINNING OF THE EXPERIMENT, % :

- Dry matter – 10, 3
- Ash – 2,34
- Total nitrogen – 2,31 (218 mg %)
- pH – 7,8

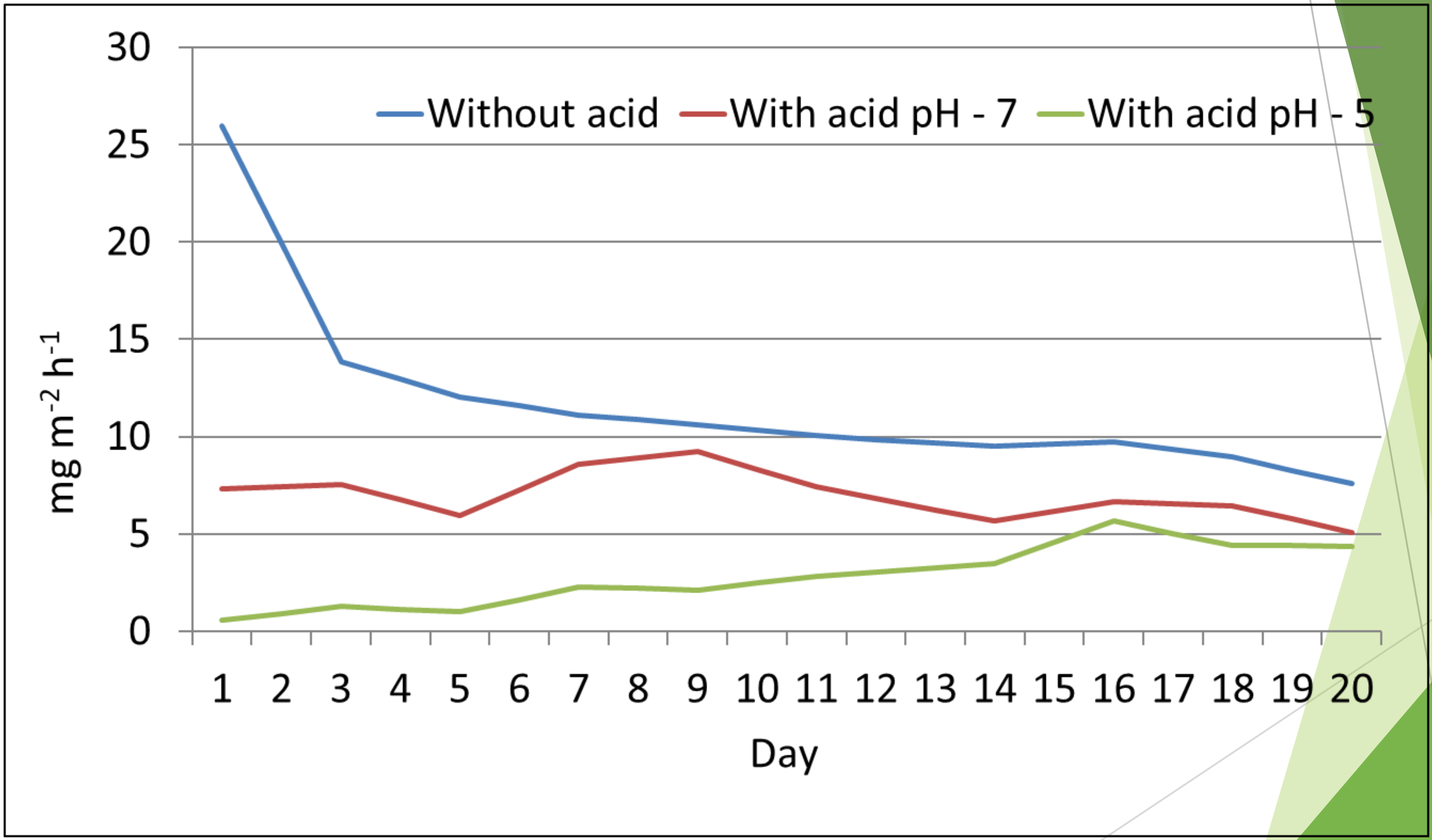
RESULTS



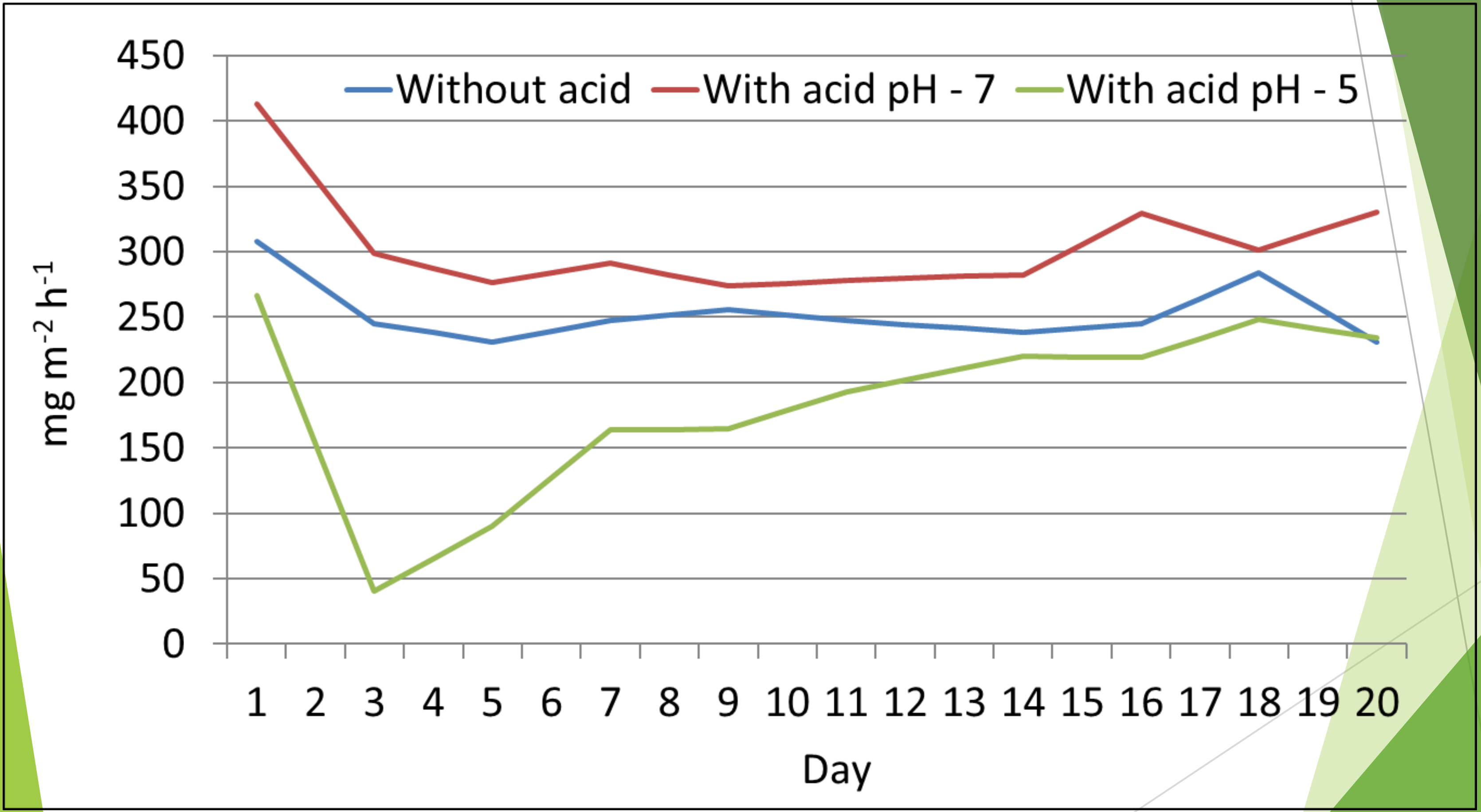
CHARACTERISTICS OF MANURE AT THE END OF THE EXPERIMENT



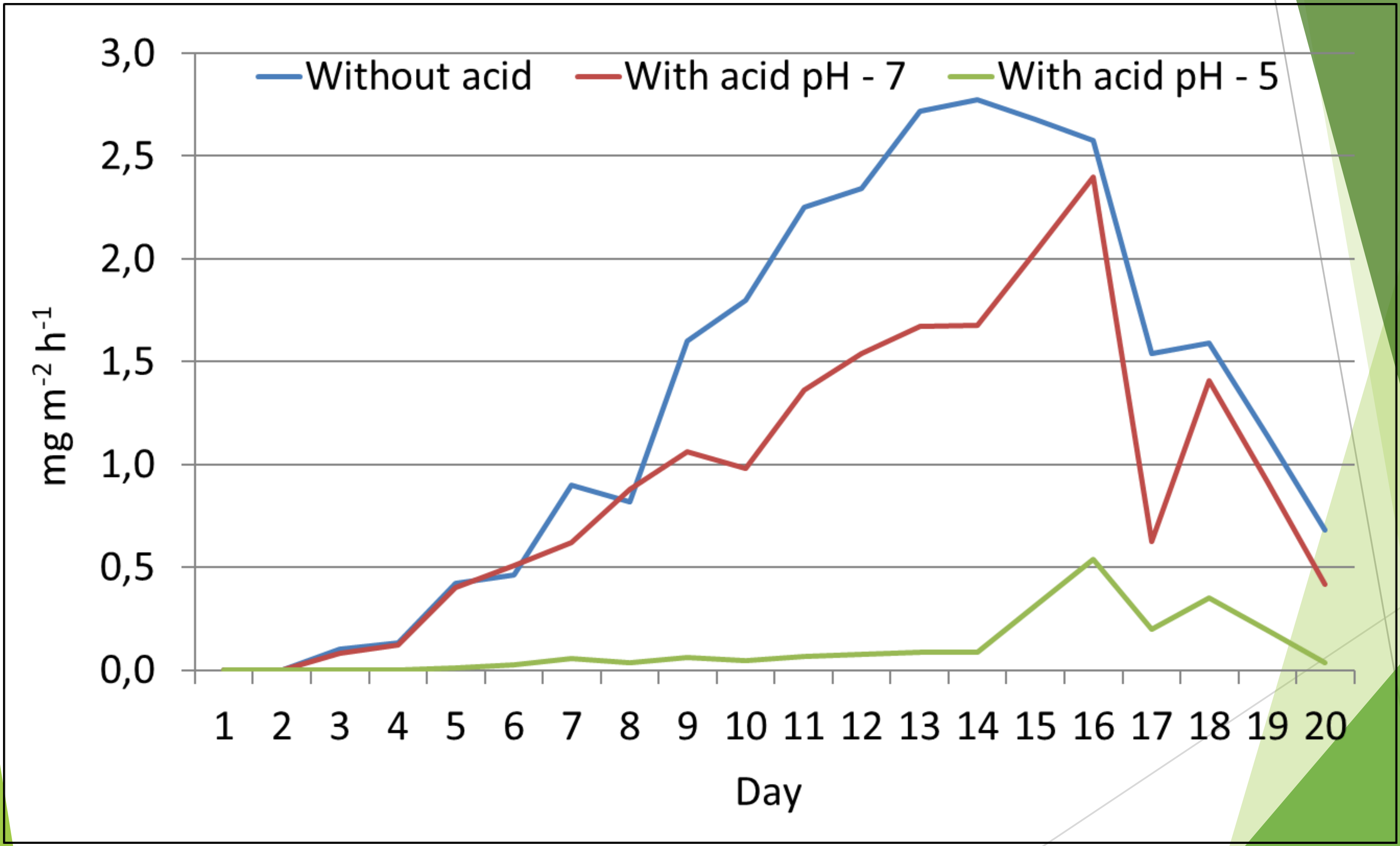
EFFECT OF ACIDIFICATION ON NH_3 EMISSION RATES FROM MANURE



EFFECT OF ACIDIFICATION ON CO_2 EMISSION RATES FROM MANURE



EFFECT OF ACIDIFICATION ON CH_4 EMISSION RATES FROM MANURE



FIELD TRIALS
Slurry acidification *In-field*

- Barley
- Spring wheat

FIELD TRIAL (BARLEY)

Harvest information

Treatment	Yield, t/ha	Moisture content, %	Protein, % in DM
No 1 (without fertilization)	3,26	12,8	9,86
No 2 (mineral fertilizers)	4,26	13,5	10,32
No 3 (slurry)	4,31	12,9	10,97
No 4 (acidified slurry)	4,96	13,9	11,36

FIELD TRIAL (SPRING WHEAT)

Harvest information

Treatments	Grain yield, t/ha	Moisture content, % at harvest time	Proteins, % in DM
No 1 (CONTROL)	3,56	12,5	14,02
No 2 (Mineral fertilizers)	4,87	13,7	15,89
No 3 (Untreated slurry)	4,93	12,8	15,95
No 4 (Acidified slurry)	5,12	13,2	16,02

CONCLUSIONS

- Acidification of manure to pH7 can reduce ammonia emissions by 39.6 % and methane emissions by 29.5 %. Acidification of manure to pH5 can reduce by 75.6 % for NH_3, and even by 91.8 % for CH_4. However, different results were found for CO_2 emission, which showed that the emission rate could be 22.2%. higher from manure with pH7, and 27.8 % lower form manure with pH5.
- Field trials have shown that acidification of slurry can have a positive effect on crop yield.
- It suggests that mild acidification of cattle manure and slurry can be a successful solution to help cattle farmers reduce NH_3 and CH_4 emissions and at the same time improve their fertilization value.

THANK YOU FOR YOUR ATTENTION!

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