Greenhouse gas emissions during ensiling and feed-out phase of corn silages

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Dutch Public-Private-Research programme

- Dutch government provides research funding to consortia with knowledge institutes and private partners
- 50% governmental subsidy, 50% contributions from private industry




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Introduction

Worldwide: need to reduce GHG emissions in animal production.

Focus has been on enteric methane emissions. However, during the production of silages, several processes occur during which O_2 is consumed and CO_2 is produced.

- **Aim of our project:** improve on-farm feed management, reduce nutrient losses and support circular dairy farming
- **Aim of today**: (reduction of) emissions of greenhouse gases during ensiling, storage and feed-out process.

Total grass- and maize silage in the Netherlands

9-13%

dry matter losses

~900-1,300 million kg dry matter *losses* per year

Dry matter losses during ensiling

Goal: reduce dry matter losses by 12-15%

This would save *yearly* **150 million kg dry matter silage**

Reducing the need to buy **165 million kg concentrate**

Saving additional feed costs of **46 million euro**

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Research questions

- What amount of (greenhouse) gases is released during the anaerobic and aerobic phase of ensiling?

- Can inoculants reduce the losses?

Climate respiration chamber facility

- Total gas measurement of animals, eggs in a closed environment

- System adjusted for measurement of silages in mini silos

Flow and gas detection

Gas detection every 5 min: CO_2, O_2, CH_4, NH_3

Spot sampled: N_2O

Air flow

Trial design

- Gas emissions (n = 6 boxes)

<u>Three treatments (n=2 per treatment):</u>

1 untreated (**control**)

2 treated, combination product **E**[a]

3 treated, combination product **P**[a]

[a] both inoculants were blends of homofermentative and heterofermentative strains (*L.buchneri* / *L.plantarum*)

- 6 mini silos per box
- 2 boxes per treatment

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Harvest

- Maize silage: early variety LG31.218
- Harvested 25 September 2023
- Conventional harvest with maize chopper
    - Cut at conventional chop length (9 mm)
    - Weighed and mixed in mixer wagon
    - Output: three weighed separate portions
    - Inoculants sprayed on maize on plastic sheet

Lab silos

- All mini silos filled within 3-4 hours

Treat-ment	Inoculant	DM (g/kg FM)	Filling weight (kg FM/ 20L)	Density (kg DM /m3)	# mini-silos
1	water	348	16.0	278	12
2	Ecocool MTD1 PJB1	352	16.0	282	12
3	Pioneer 11C33	350	16.0	280	12

- With help of customized lab silo press →

Trial design

After ensiling on 25 September 2023:

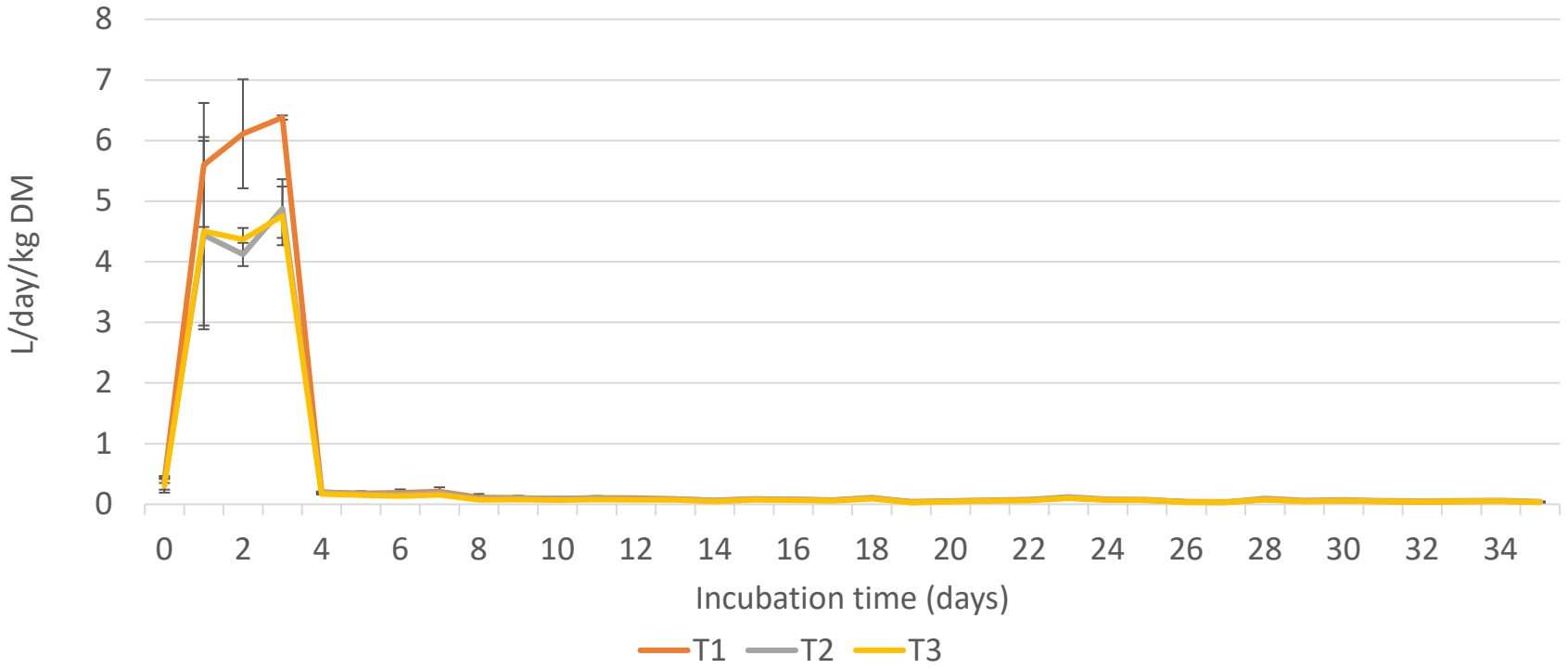
Anaerobic phase

- 5 weeks in closed system (2 boxes per treatment)

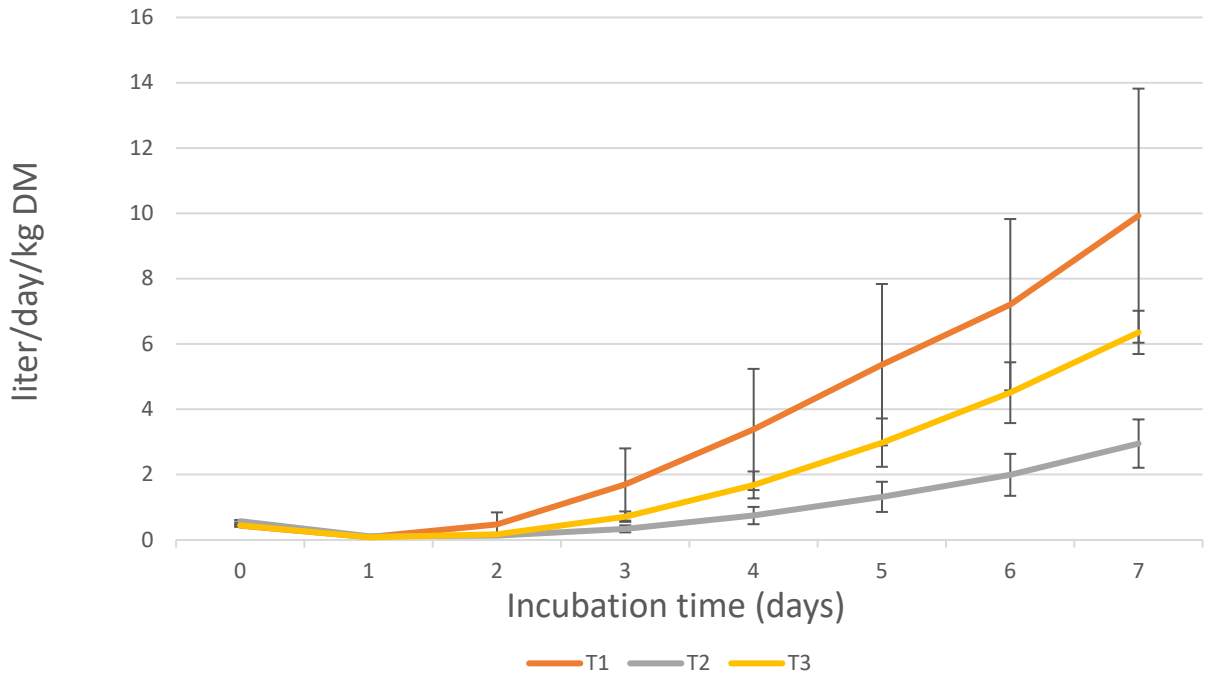
Feed-out phase

- Open boxes, open minisilos, mix contents, return into box
- Controlled humidity (50%) and temperature (25°C)
- 14 days monitoring in closed system

Results: CO_2 production, anaerobic phase



Results: CO2 production, aerobic phase



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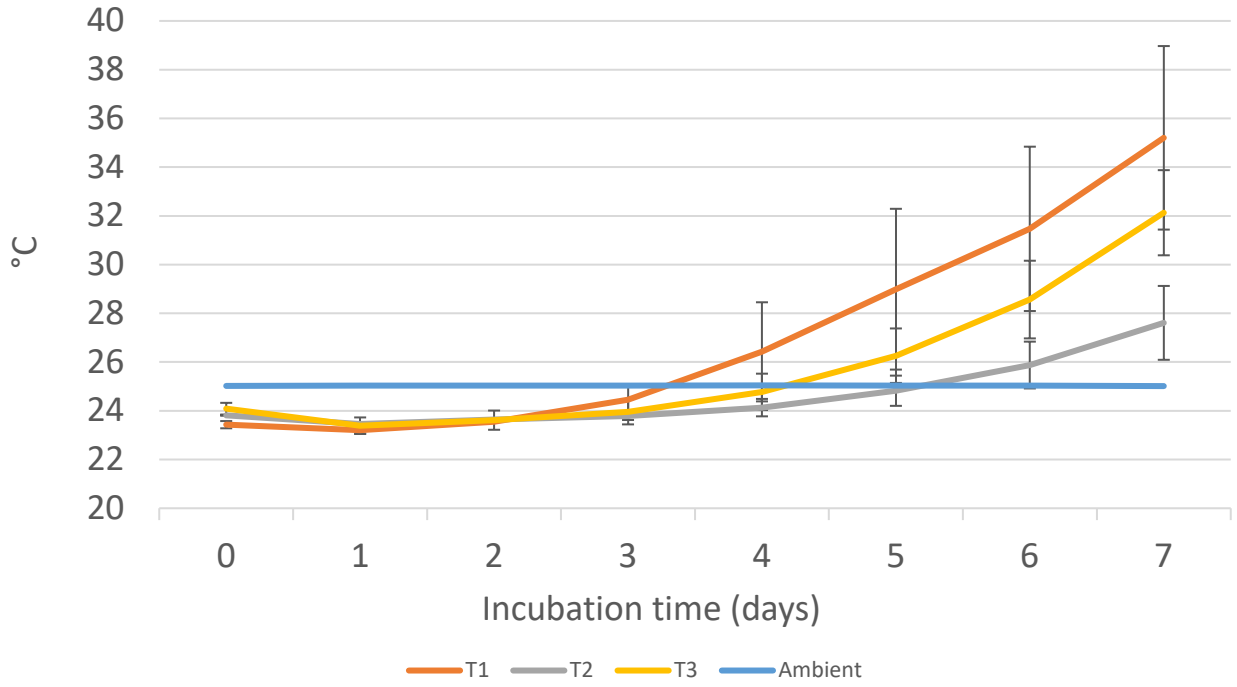
Results: Temperature aerobic phase



°F = (°C x 1,8) + 32:
25 °C = 77 °F;
30 °C = 86 °F;
35 °C = 95 °F

Total gas production

Total greenhouse gas emission in L per kg DM during ensiling (5 weeks) and feed out (**7** days) for the three treatments.

		CO_2	O_2	CH_4	N_2O	NH_3
T1	Anaerobic	21.2	2.6	0.017	0.036	0.00
T2	Anaerobic	16.6	2.1	0.013	0.045	0.00
T3	Anaerobic	16.2	2.1	0.015	0.046	0.00
T1	Feed out	29	28	0.003	0.0014	0.00
T2	Feed out	8	4	0.015	0.0000	0.00
T3	Feed out	17	16	0.018	0.0000	0.00

Total gas production

Gas production with anaerobic and **3d** aerobic phase in silage clamp (200,000kg)

Parameter	Unit	T1	T2	T3
CO2 production, anaerobic phase	Kg	8340	6520	6380
CO2 production, aerobic phase, 3 days	Kg	1063	458	555
Total CO2 production	Kg	9403	6978	6935
Total CH4 production	Kg	2.8	3.3	3.7

Conclusions

Limitations of trial design (low power)

Still, quite interesting results:

- No NH_3, and very low CH_4 and N_2O production from maize silage
- Inoculants reduced
    - Microbial counts and spoilage (not shown)
    - Feed losses and feed quality losses (not shown)
    - Total CO_2 production (until -30%)

Van Wikselaar, P., Bruinenberg, M. and Goselink, R.M.A., 2025. *Greenhouse gases produced by maize silages treated with different inoculants; Harvesting season 2023*. Wageningen Livestock Research, Public Report 1552.

What else?

- Another experiment with maize silage
    - 3 treatments
    - 3 replicates (better statistics!)
- Experiments with grass silage

Thank you!

Questions?

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