Evaluating environmental sustainability of Dutch dairy farms towards 2030

Preliminary results of a modeling study

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Introduction

- Dairy production systems cause pressure on various sustainability aspects (e.g. global warming, eutrophication, acidification)
- Various policy measures are implemented for Dutch dairy farms, e.g. losing manure derogation, buffer strips and limitations to total nitrogen application
- At the same time: ongoing trends in farm size and productivity, climate change

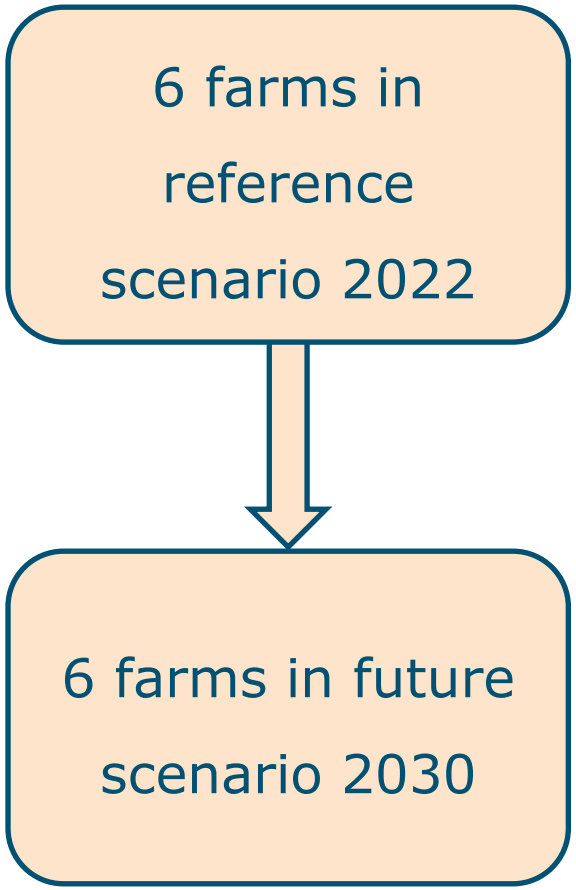
➢ **Model effects of policy measures and trends on technical and environmental performances of Dutch dairy farms towards 2030**

Materials and methods (i)

- Define 6 farm types, representative of variation in Dutch dairy sector (region, herd size, intensity, grazing, organic/conventional)
- Farm structure and performance based on Dutch Agricultural Census in 2022
- Binary choices (e.g. soil type, grazing, organic)

Farm	Soil type	Herd size (cows)	Intensity (kg milk/ha)	Grazing (y/n)	Organic/ conventional
1. Organic	Clay	90	8200	Y	Org
2. Peat	Peat	70	12500	Y	Conv
3. Clay-large	Clay	170	16700	Y	Conv
4. Sand-small	Sand	70	15400	Y	Conv
5. Sand-large-extensive	Sand	140	16100	Y	Conv
6. Sand-large-intensive	Sand	175	28000	N	Conv

Materials and methods (ii)



- Simulation of dairy farms using 'DairyWise'
  - Empirical farm-scale model
- Quantification of environmental impacts in Annual Nutrient Cycling Tool (ANCA)
  - Ammonia emission
  - Soil nitrogen surplus
  - Greenhouse gas emissions (LCA)

Assumed changes towards 2030 – policy measures

- No derogation (max. 170 kg N/ha)
- Limitation to total nitrogen use in Nutrient Polluted areas (20% reduction; 100% of area on sand, 50% on other soils)
- Mandatory buffer strips (2/3/4% of area for peat/clay/sand)
- Mandatory crop rotation on sandy soils (3 y grass/3 y maize)
- Higher groundwater table in peat areas (20 cm increase)
- Crude protein (CP) level of feed ration 160 g/kg DM
- Mandatory low-emission barn (Province Noord-Brabant)

Assumed changes towards 2030 - trends

- Increase in herd size (13-17% increase in number of milking cows*)
- Increase in farm area (based on same intensity (kg milk/ha) as reference scenario)
- Increase in milk yield per cow (+70 kg/cow/y, +35 on peat)
- Trends in forage yields (genetic component)
  - Grass: +44 kg DM ha^{-1} $year^{-1}$
  - Maize: +173 kg DM ha^{-1} $year^{-1}$, +1.7 feed unit milk (VEM) kg DM^{-1} $year^{-1}$
- Increase in drought (reference scenario: typical weather year (2015), scenario 2030: warmer winter, precipitation deficit in spring, heat wave in summer (2022)

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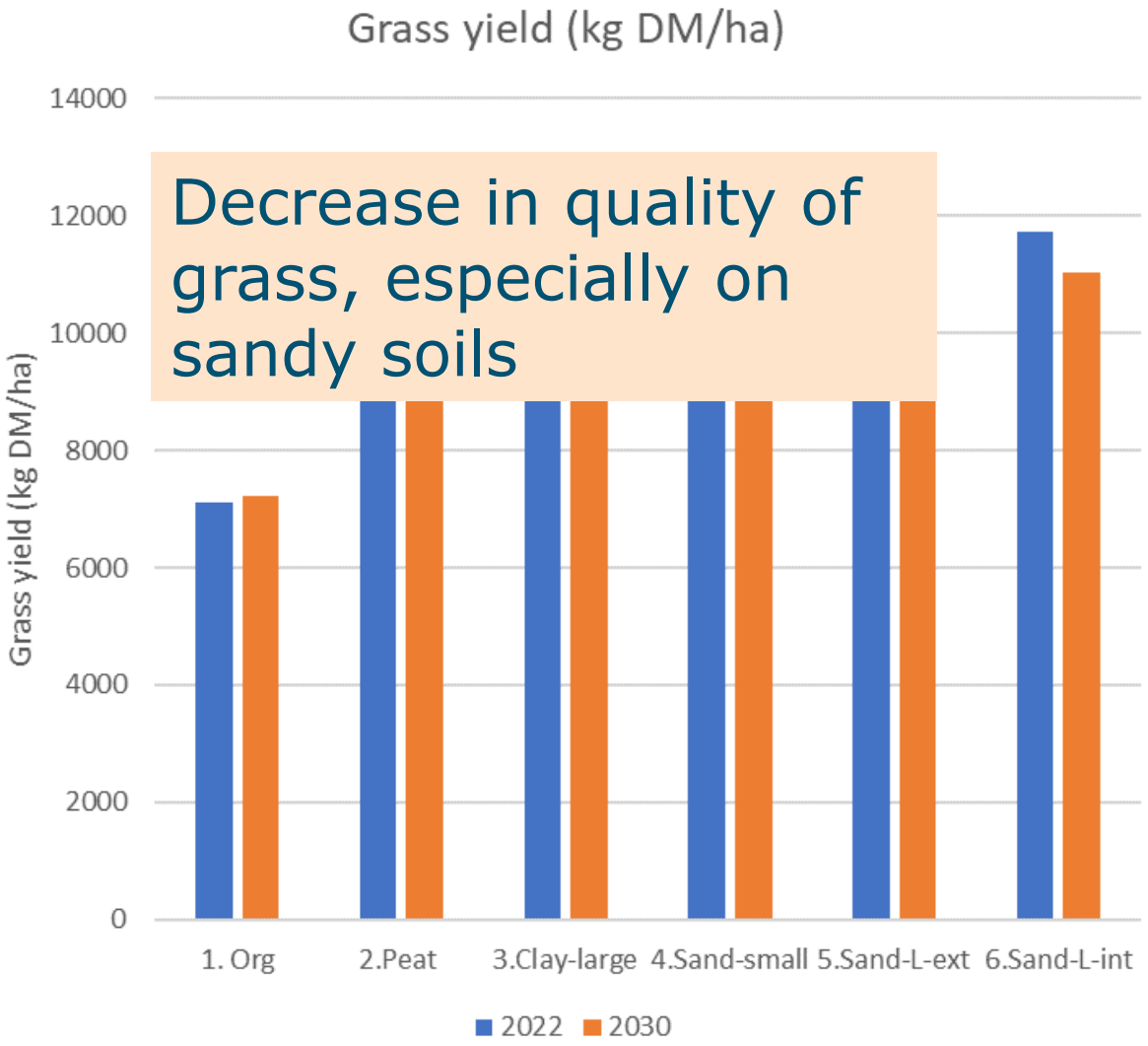
** Beldman et al. 2020. De Nederlandse melkveehouderij in 2030; Verkenning van mogelijke ontwikkelingen op basis van economische modellering. WECR rapport 2020-090.*
*** Schils et al. 2020. Disentangling genetic and non-genetic components of yield trends of Dutch forage crops in the Netherlands. Field Crops Research; vol. 249.*

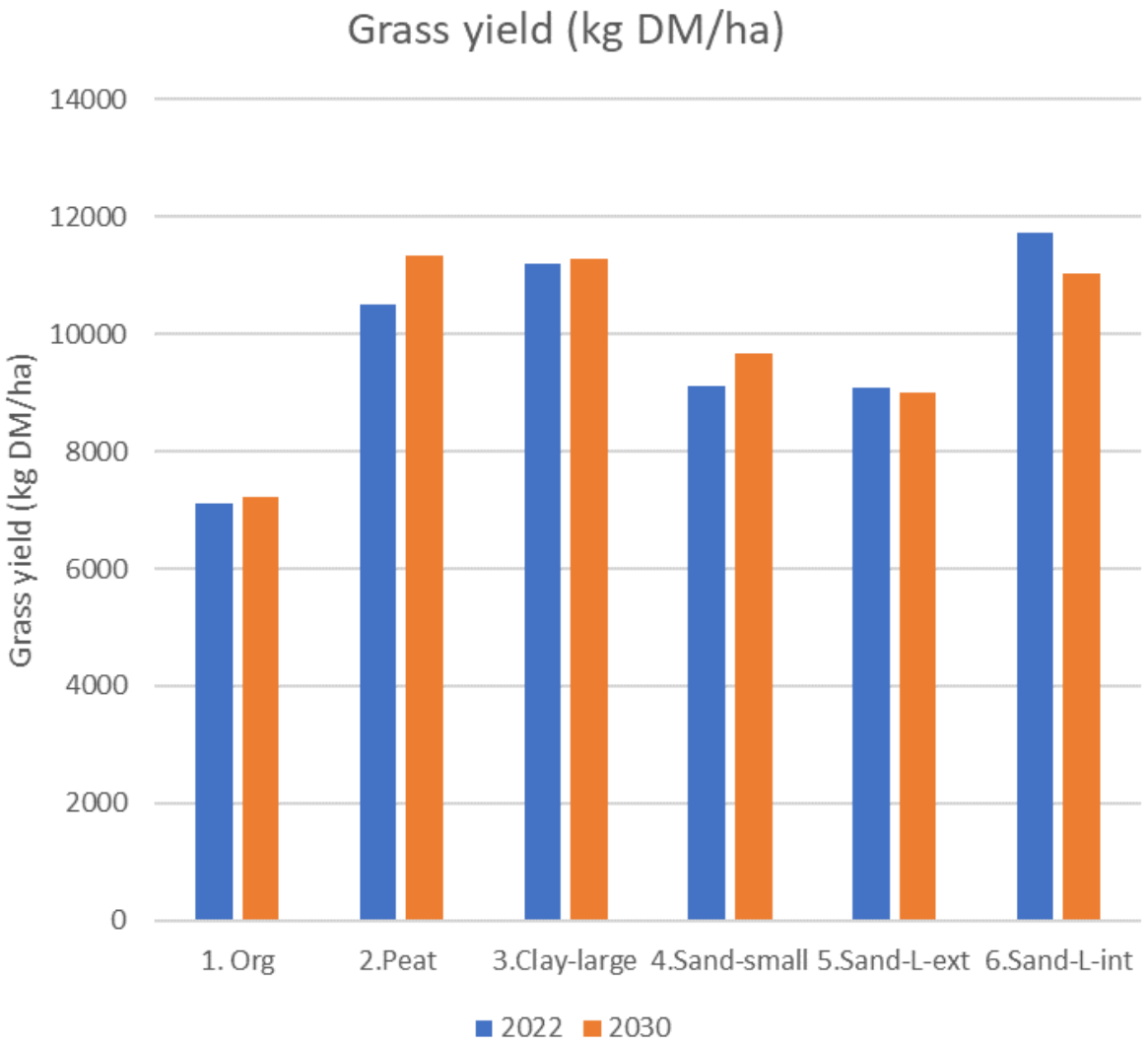
Results - grass yield

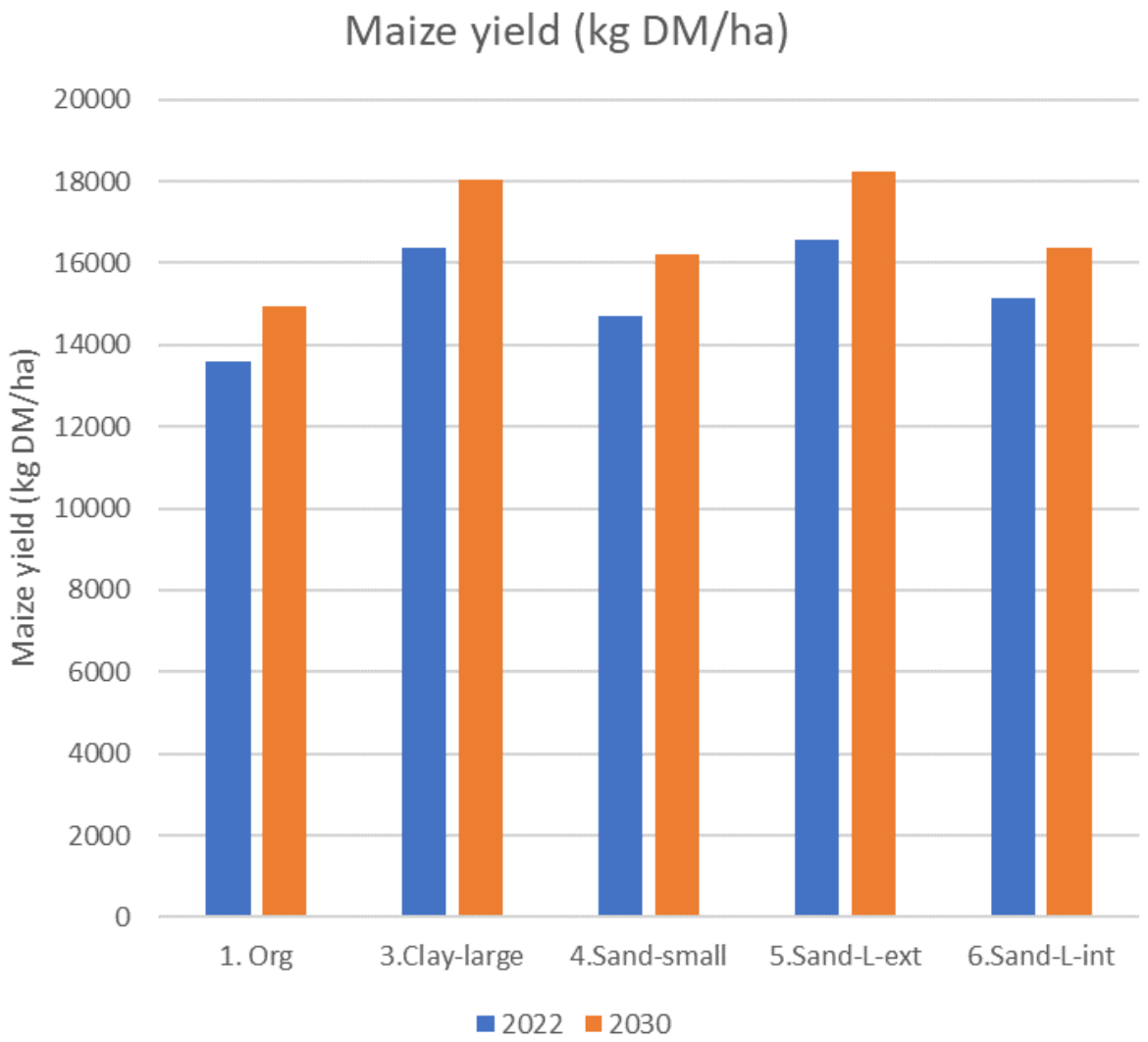


Decrease in quality of grass, especially on sandy soils

- − Less N fertilization (loss of derogation, total N restrictions)
- − Precipitation deficit in spring
- \+ Earlier growth, grazing and mowing (dry, warm spring)
- \+ Higher groundwater table on peatland
- \+ Increase in irrigation
- \+ Replacement of animal manure with fertilizer with higher nitrogen utilization
- \+ Genetic advancement

Results – maize yield





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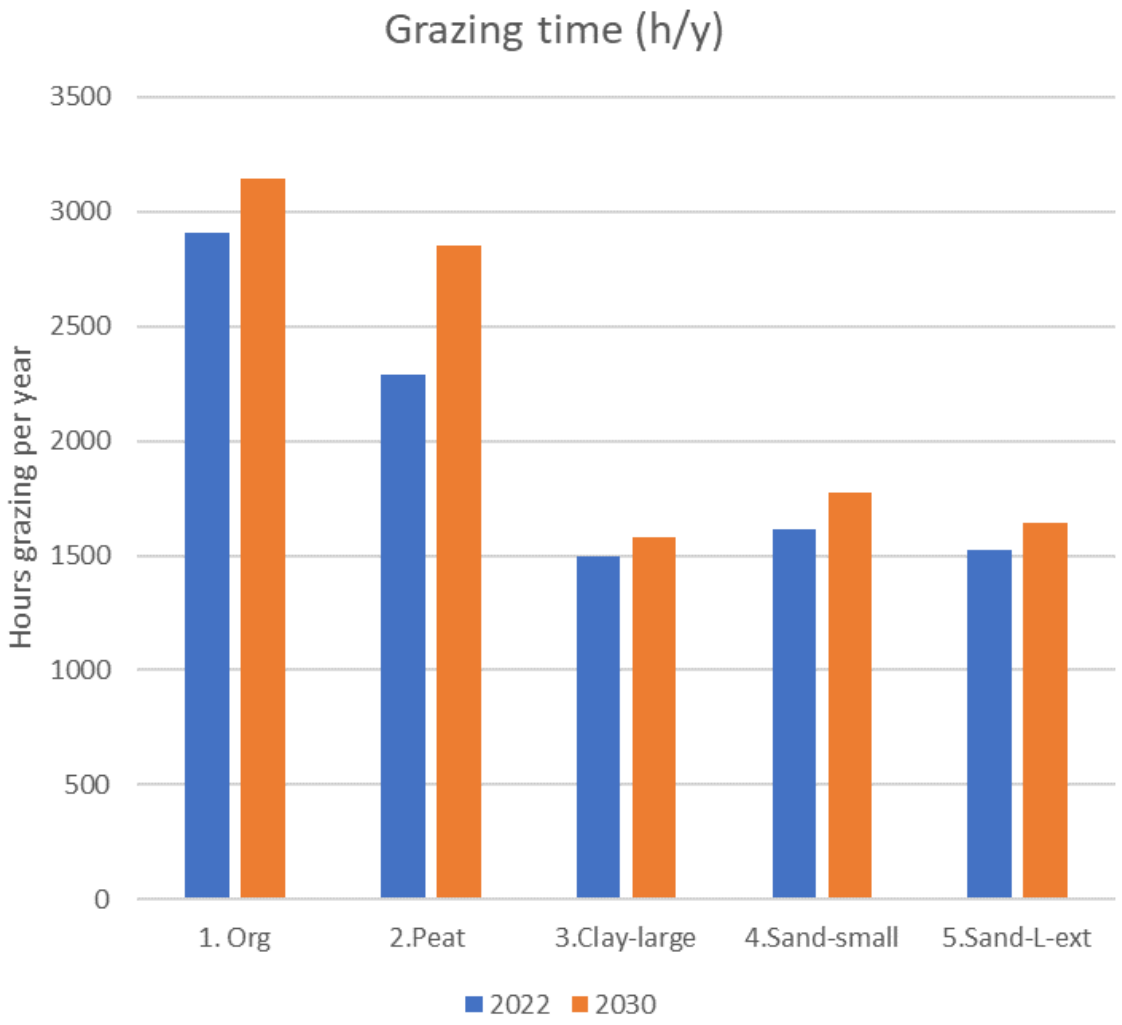
Results - grazing time & manure export



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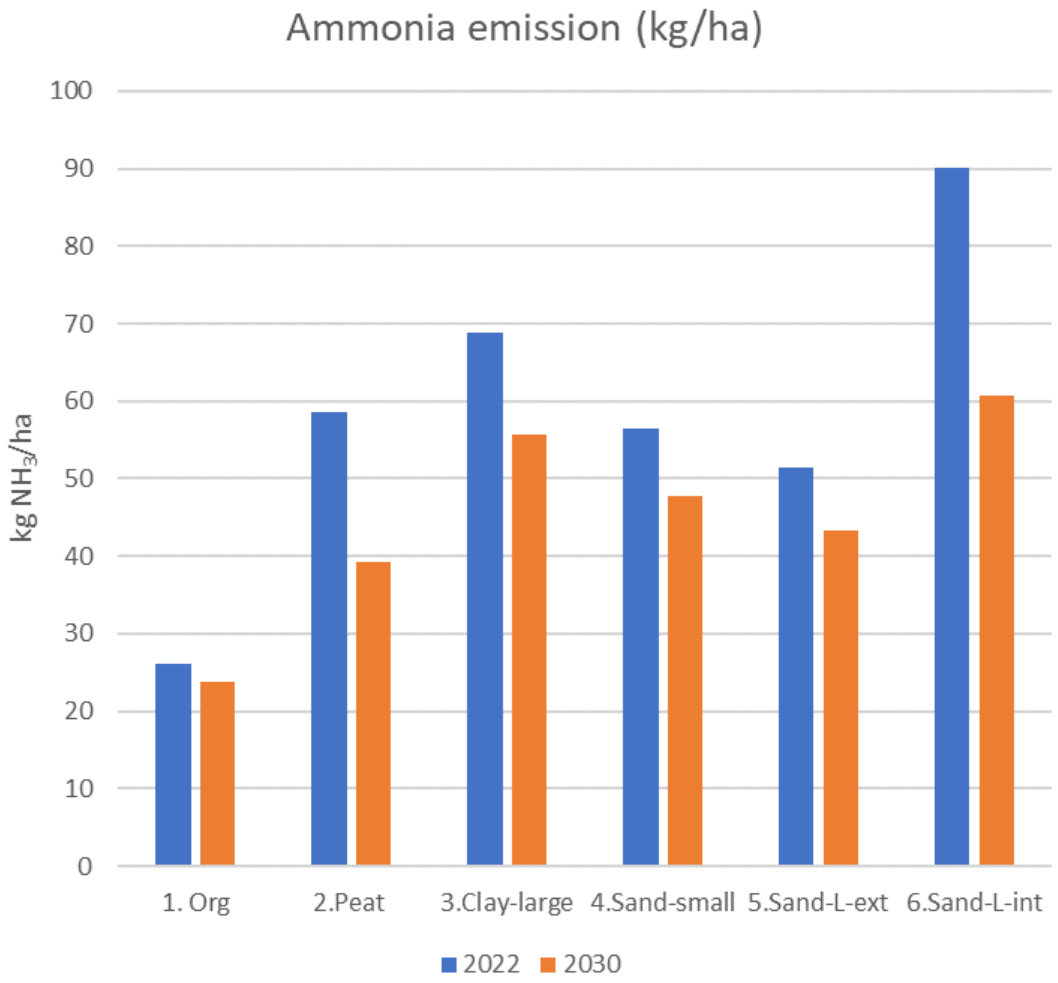
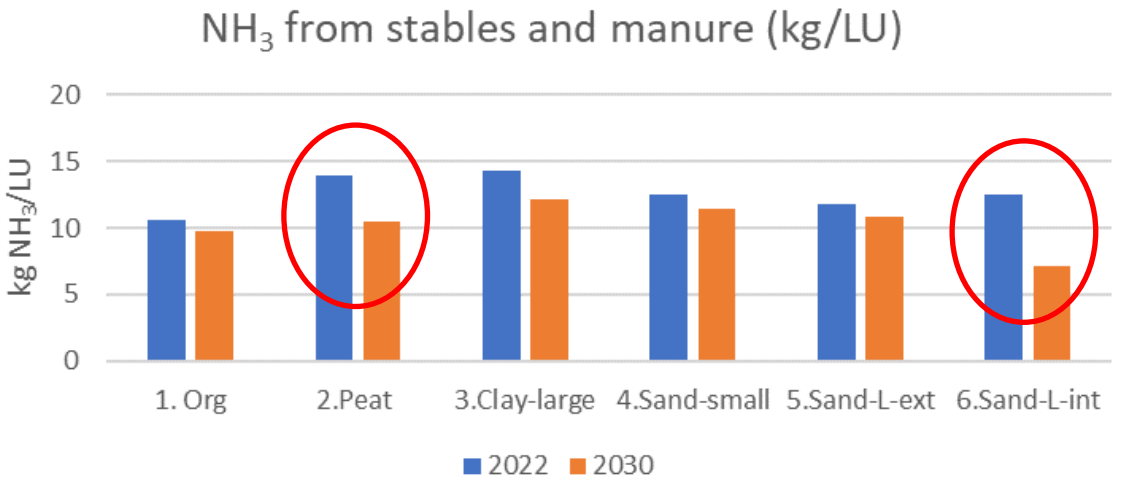
Results - ammonia emission





- Lower crude protein of the feed ration (agreement)
- More grazing (dry, warm spring)
- Low-emission barn (farm 6)

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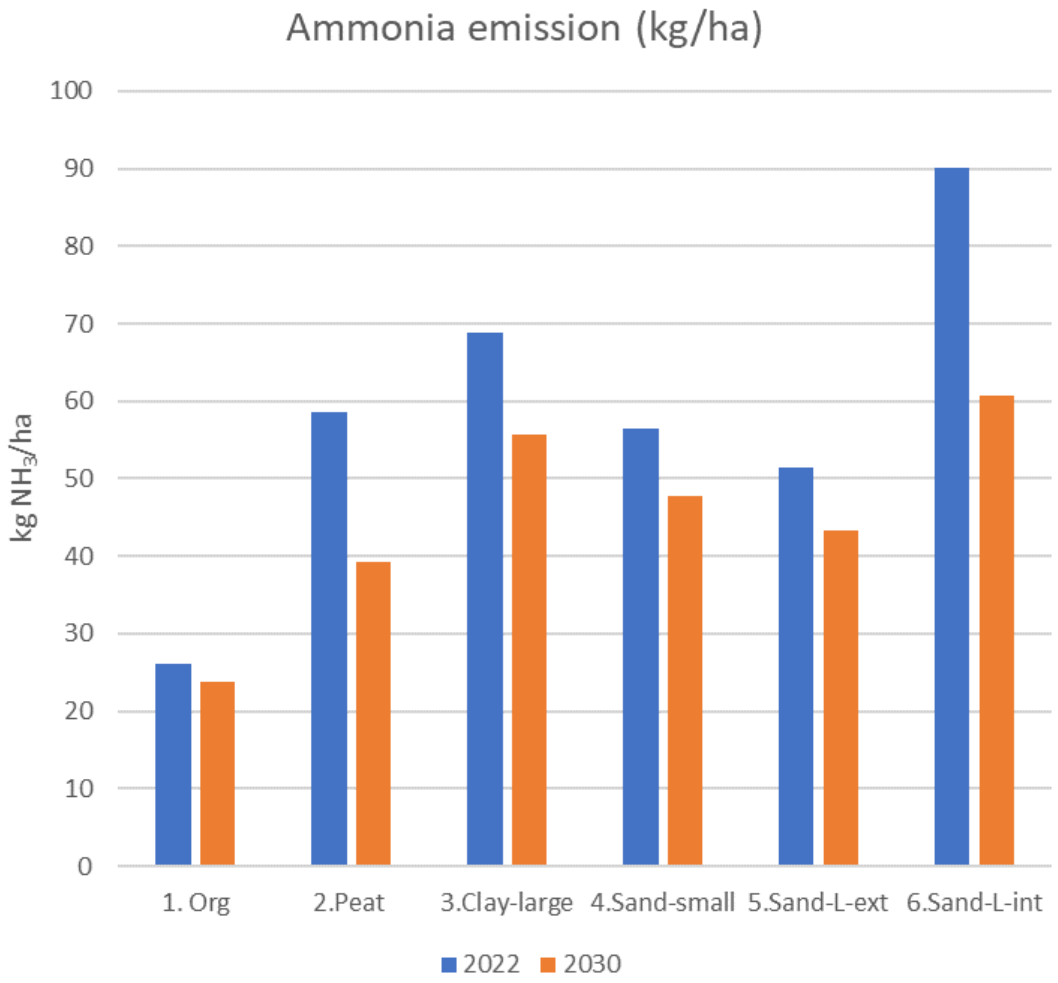
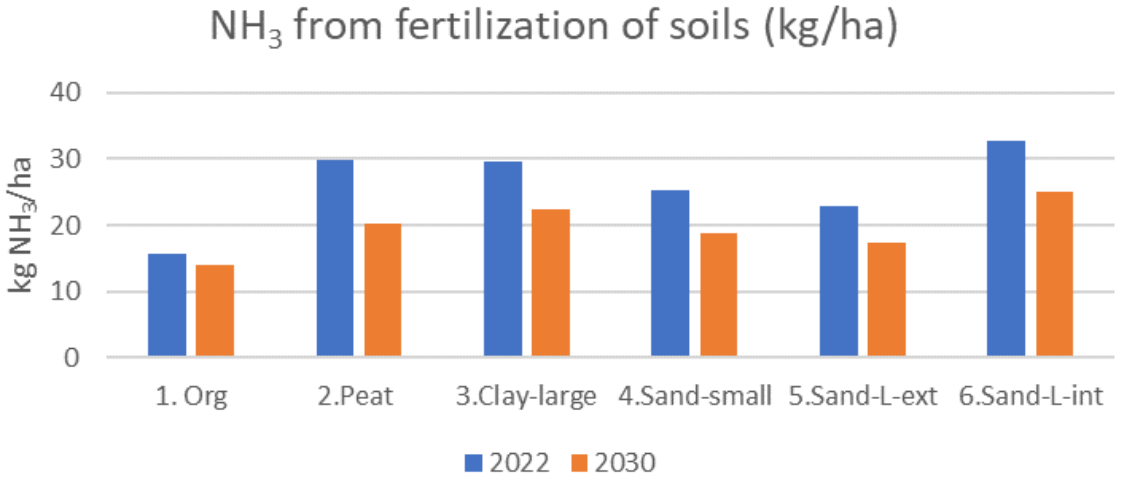
Results - ammonia emission





- Less manure N due to loss of derogation
- Less synthetic fertilizer N due to total N restrictions
- More grazing

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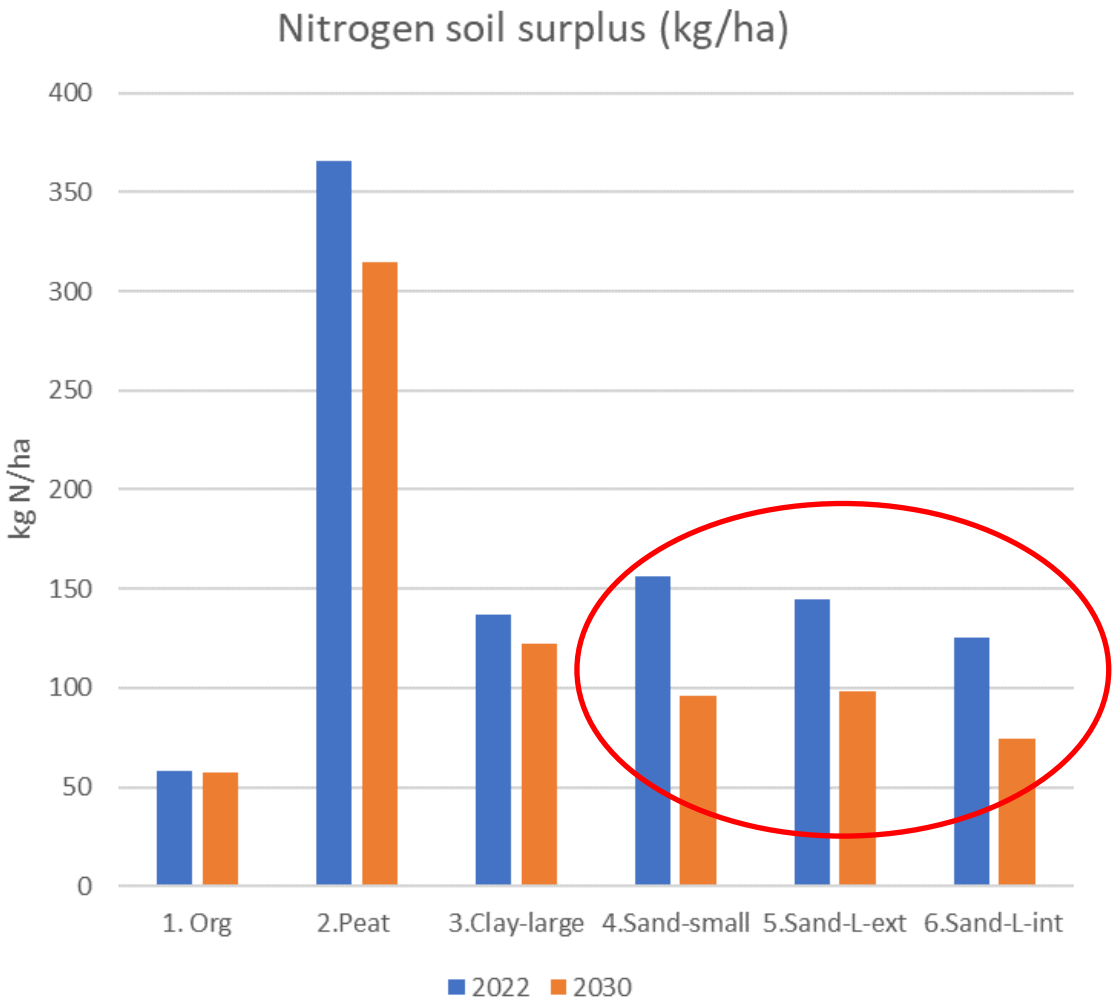
Results – nitrogen soil surplus



- Less manure N due to loss of derogation
- Less synthetic fertilizer N due to total N restrictions
- Improved nutrient use efficiency, due to shift to synthetic fertilizer and genetic improvement
- Share of maize land (increase in maize yield)

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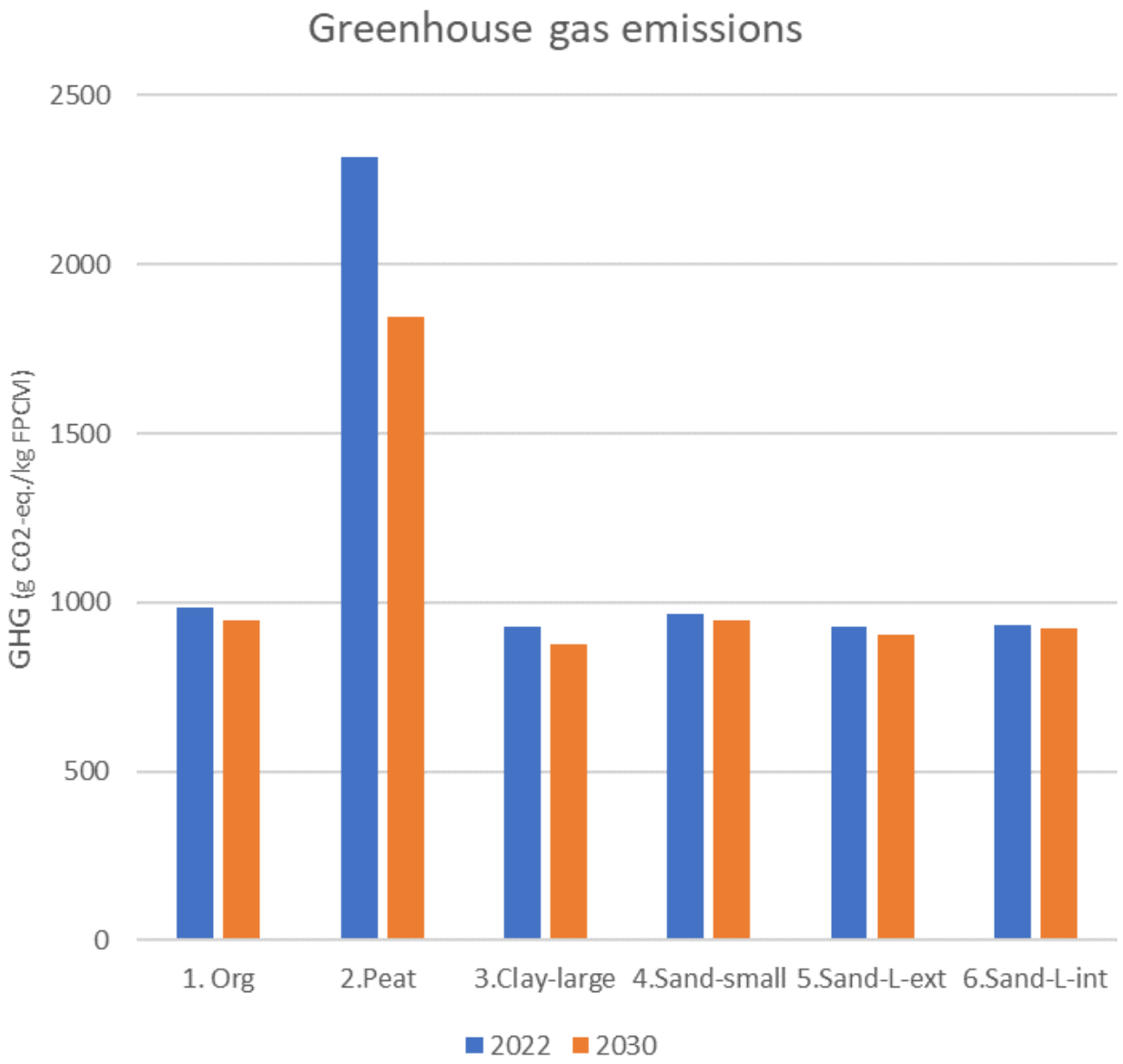
Results – greenhouse gas (GHG) emissions



- Higher groundwater table peat soil
- Various, e.g.:
  - Higher milk yield per cow
  - Less N2O from fertilization
  - Less protein in concentrates

Conclusions

- Preliminary results of effects of policy measures, productivity trends and climate change towards 2030
    - Large reduction in ammonia emission and N soil surplus
    - Small reduction in greenhouse gas emissions (except farm on peat soil)
- Uncertainty: CP goal (160 g CP), unpredictability of the weather
- Manure surpluses lead to severe economic effects (not considered)
- What is next: explore effects of alternative development pathways for the 6 dairy farms

Thank you!

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Farm characteristics (model input)

	1. Org		2.Peat		3.Clay-large		4.Sand-small		5.Sand-L-ext		6.Sand-L-int	
Scenario	*2022*	*2030*	*2022*	*2030*	*2022*	*2030*	*2022*	*2030*	*2022*	*2030*	*2022*	*2030*
Herd size (cows) ↑	90	102	70	82	170	192	70	79	140	158	175	198
Milk yield (kg/cow) ↑	6650	7210	7950	8230	8900	9460	8650	9210	9250	9810	9400	9960
Area (ha) ↑	73	87	45	52	90	105	39	46	80	94	59	69
Intensity (kg milk /ha) ↑	8200	8200	12500	12500	16800	16800	15400	15400	16100	16100	28000	28000
Concentrates (kg/cow) ↑	1600	1850	2750	2900	3150	3550	2700	3300	3000	3350	3200	3550
CP feed ration (g/kg DM) ↓	166	161	185	160	174	160	162	155	164	154	155	154