Productivity and nitrogen flows for grass systems targeting future biorefineries: a 5-year study in Denmark

Shaohui Zhang, Poul Erik Lærke, Uffe Jørgensen, Kiril Manevski
Department of Agroecology/Centre for Circular Bioeconomy, Aarhus University, Denmark

1

Introduction and Hypothesis

- Perennial grasses have ability to grow locally across Europe, utilize external resources **efficiently** (e.g., fertilization) and **lengthily** (e.g., radiation), ultimately providing large amounts of biomass with high protein (i.e., nitrogen, N) content, compared to annual cereals (Solati et al., 2018).
- Short-term studies reveal reduced **N leaching and nitrous oxide emissions** (Manevski et al., 2018), as well as increasing soil carbon and N contents (Chen et al., 2022), whereas longer term effects are yet to be reported.
- We wanted to test the hypothesis of perennial systems and optimized rotations **leach less nitrogen** due to larger soil N sink in long term, compared to traditional systems, without significant differences in harvested biomass between the systems.

2

Exprimental Design

Field experiments started in 2012 in Denmark at Foulum on a sandy loam soil, field data was collected from 2013-2017

Cropping Systems	Composition(2013-2017)
Optimised rotations	(maze+winter rye) - (beets) - (hemp) - (triticale+clover)
Perennial grasses	M. × giganteus (medium fertilized)
	Festulolium (highly fertilized)
	Grass-legume (not fertilized)
Traditional systems	Triticale
	Maize
	Cereal rotation

3

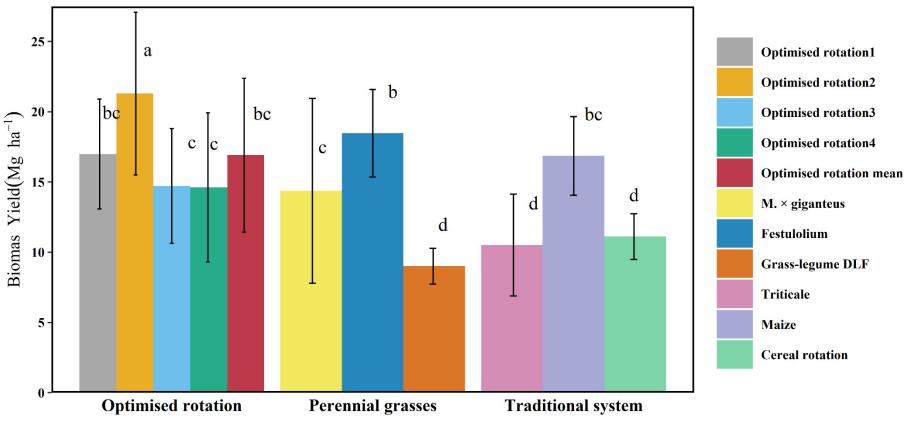
Data Analysis

$$N_{ikn} = \mu + C_i + A_k + C_i \times A_k$$

Factors	Biomass (Mg ha^{-1})	Biomass nitrogen (Kg N ha^{-1})	Nitrate leaching (Kg N ha^{-1})
Year(Y)	**	**	**
Cropping Systems(CS)	**	**	**
Y*CS	**	**	**

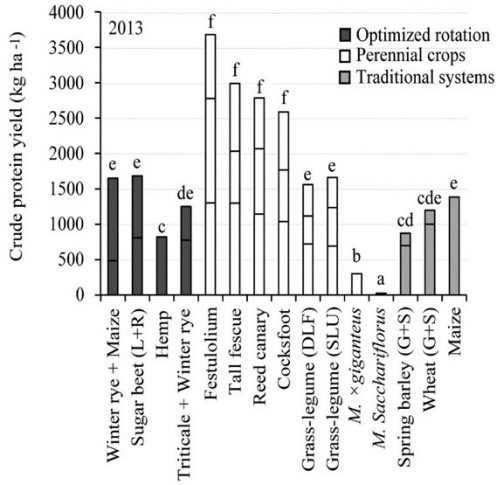
4

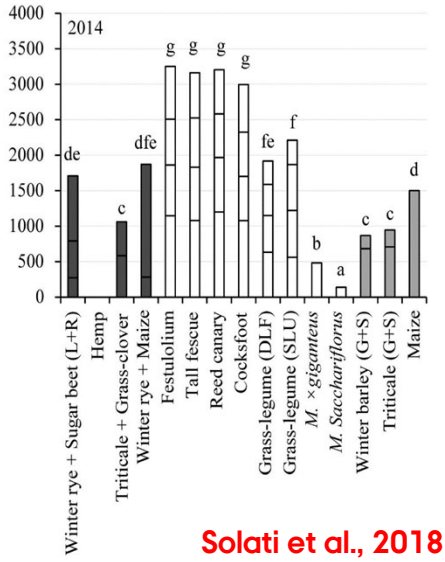
Results-Biomass yield



5

Results-Protein

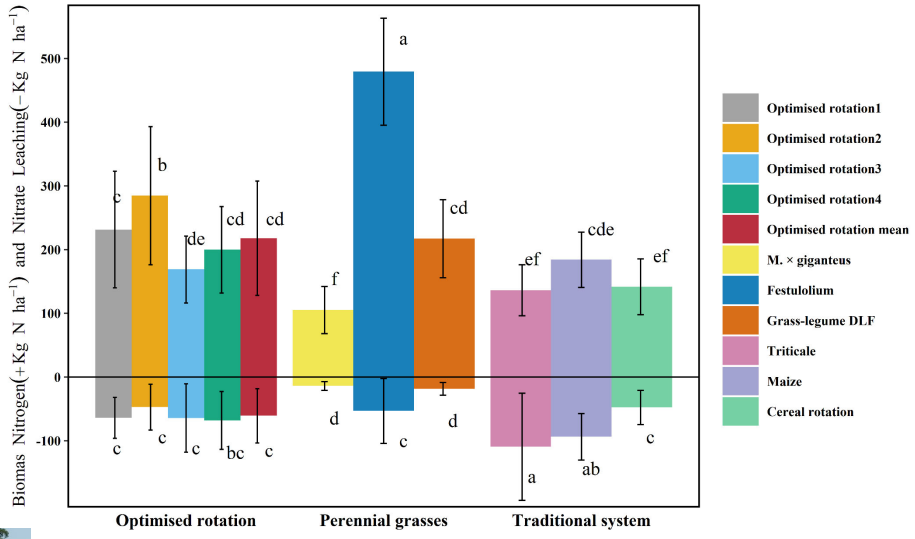




Solati et al., 2018

6

Results-Plant N and N leaching



7

Discussion and conclusion

- Prennial systems accumulated large amounts of biomass N and high protein content
- Despite year and system effects, on 5-year average the perennial systems yielded significantly lower leaching compared to all others.
- The most likely mechanism is larger soil nitrate sink for the perennials and optimized rotation, both covering the soil with canopy year round (Chen et al., 2022)

8