Nutritional epidemiology sheds light on the effects of alfalfa on dairy cow production and reproduction

Session 49: Nutrition in health and welfare of ruminants

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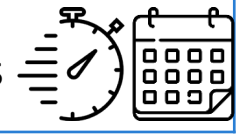
Why nutritional epidemiology?

	Animal experimental studies	Nutritional epidemiology for animals
Sample size	Small 	Large 
Representativeness	Low 	High 
Measurement exposure	Precise 	Relatively precise 
Time frame of outcomes	Short-term 	Short & long terms 

Serhal *et al.*, 2023
Dohoo, 2003

Ariza *et al.*, 2019
Meignan *et al.*, 2019

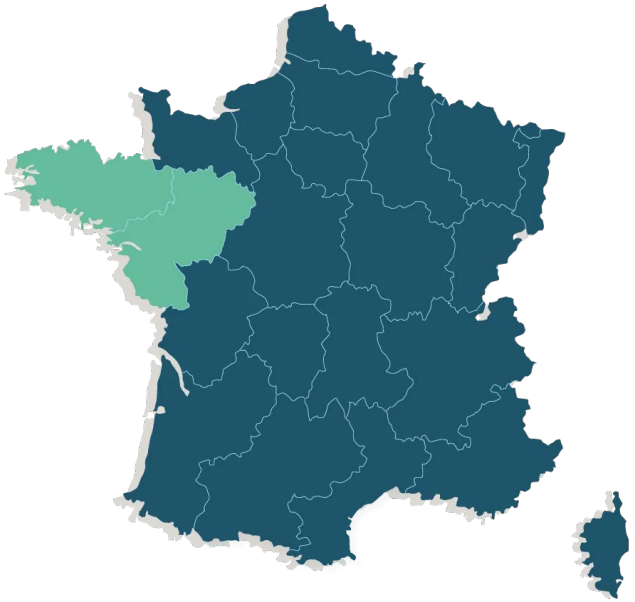
Objective

Nutritional epidemiology

Production and milk composition

Reproduction

Cohort



+848,000 milk test days

+124,000 artificial inseminations (AI)

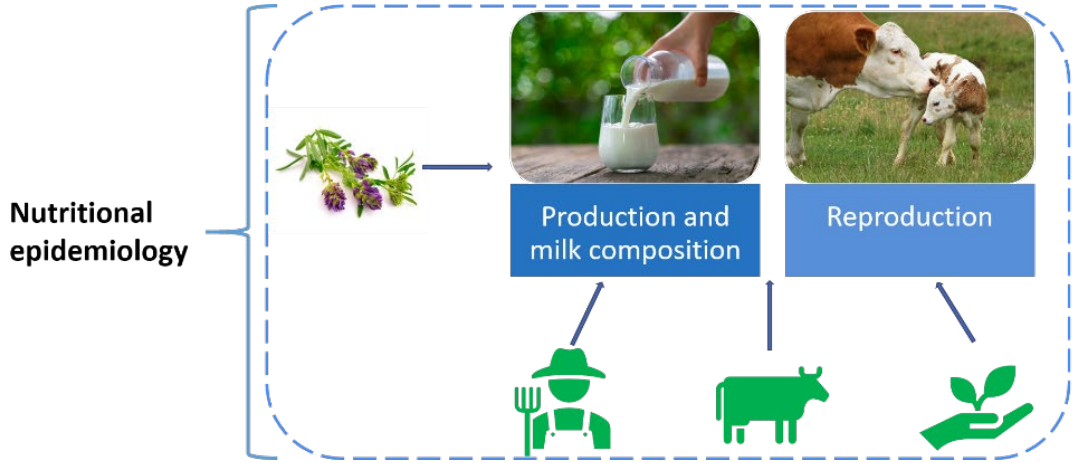
5 years: 2019 – 2023

4 French departments

+574 herds using alfalfa

+45,000 Prim'Holstein cows

Challenges



Multiple risk factors & interactions

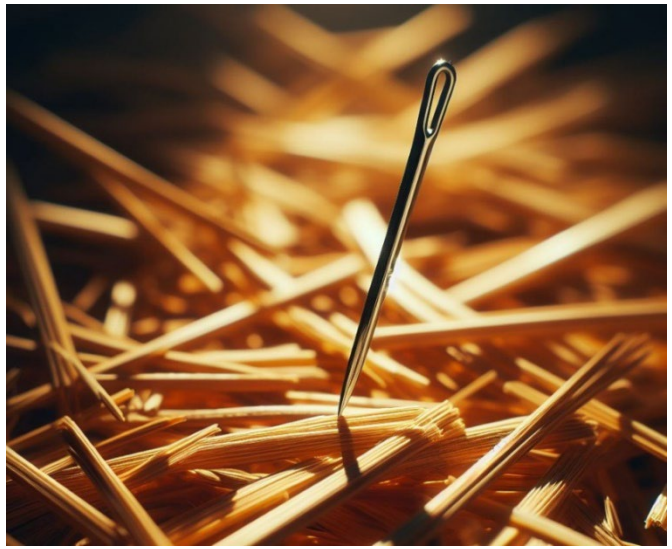
→ Literature + science-based modeling

Unmeasured factors & clustered data

→ Random effect

Selection bias

→ Data cleaning independent of outcome



Characterizing nutritional exposure

+25,000 monthly feed reports

Corn silage

Other silage

Grass

Alfalfa
Meslin
Other

Dry fodder

Wrapped grass

Hay
Dehydrated fodder
Straw
Root and tuber

Green fodder

Pasture

Other
Alfalfa

Concentrate

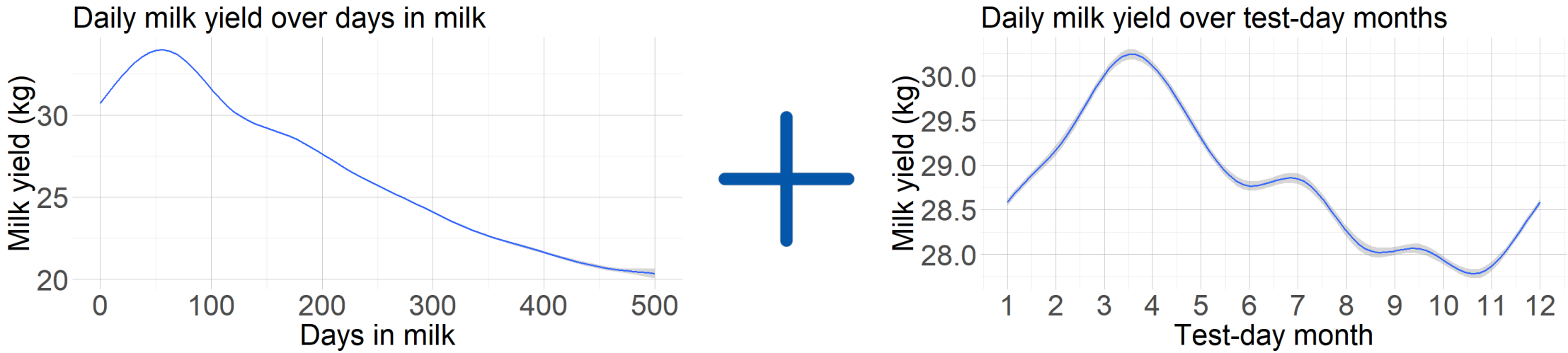
Nitrogen corr.

Energy corrector
Production conc.

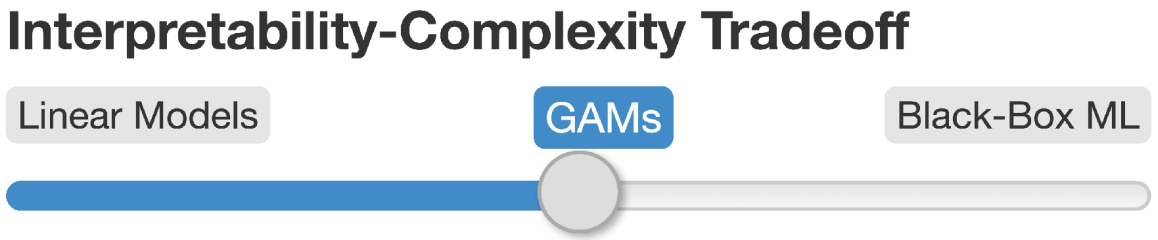
MacQueen, 1967

Diets obtained using clustering

Modeling production



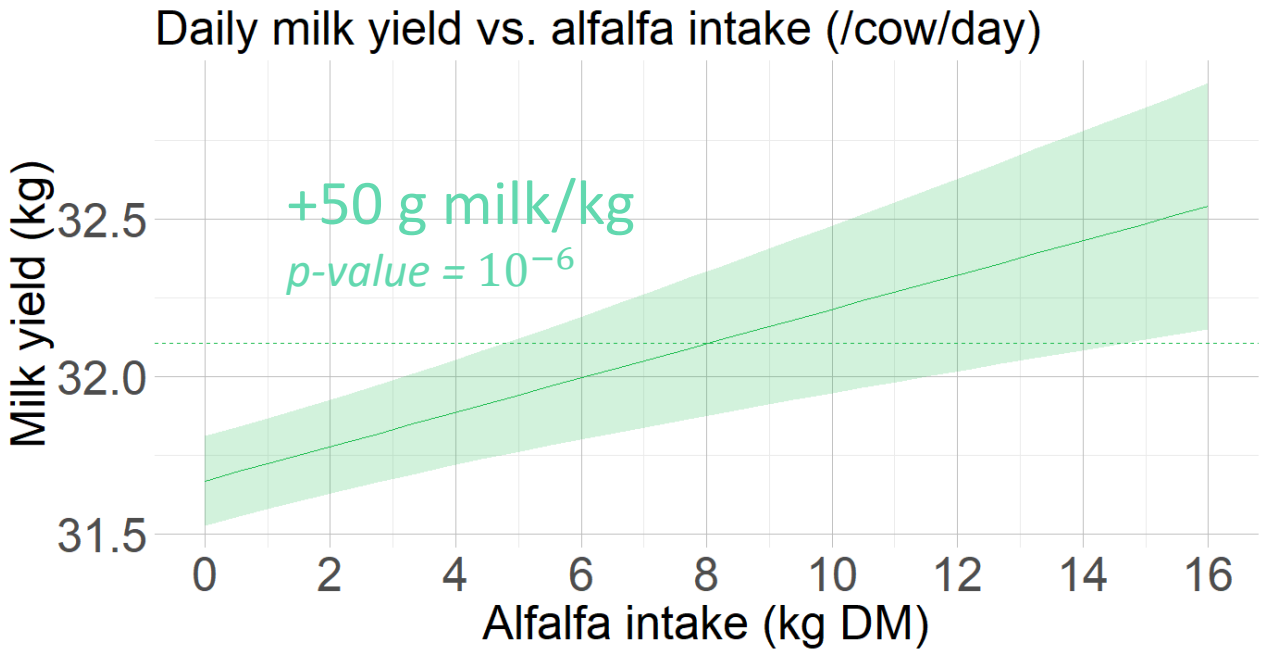
Generalized additive mixed models (GAMMs):

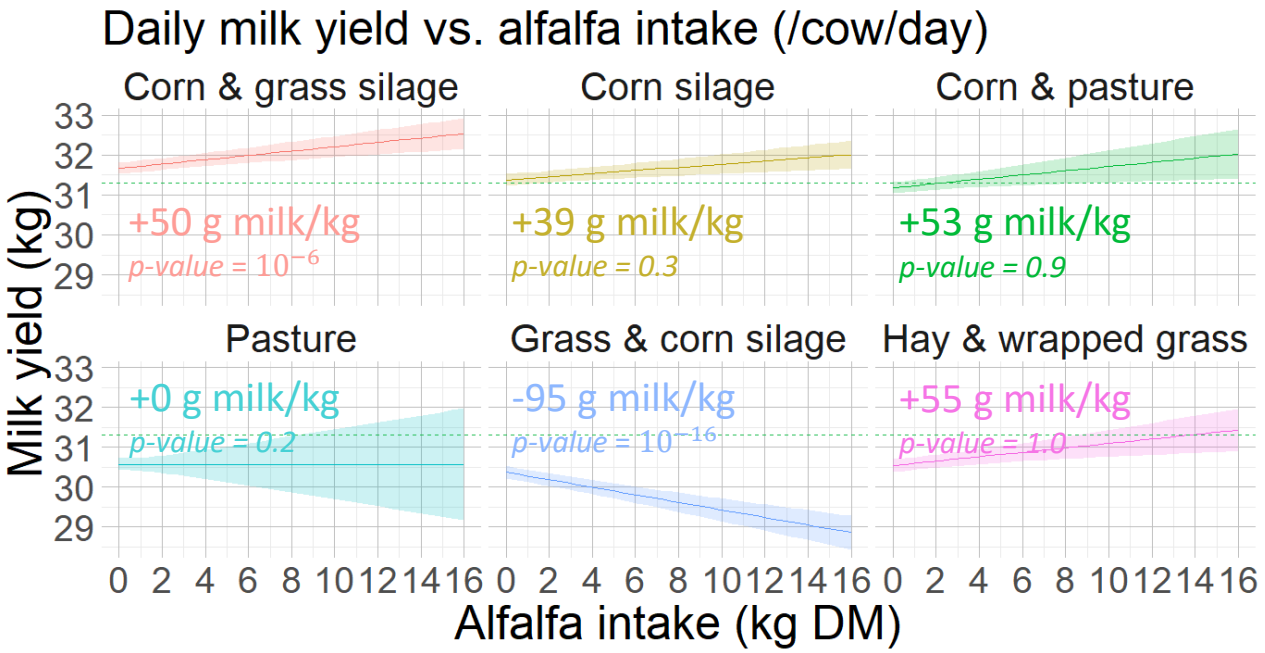


Wahba, 1990
Hastie and Tibshirani, 1999
Ross, 2017
Wood, 2020

Daily milk yield results

Mean alfalfa intake: 2.10 kg DM/cow/d



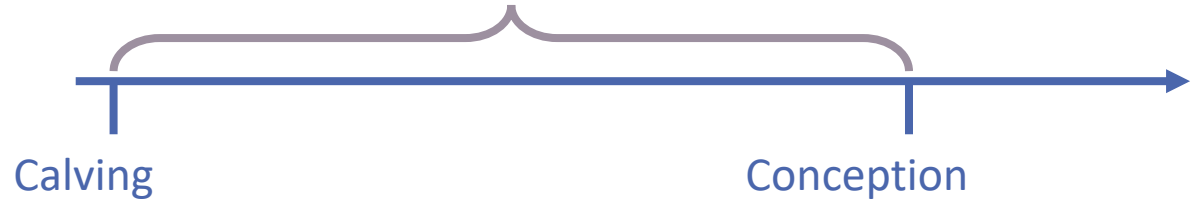


Reference:

- Gestation stage: NA
- Ration R1
- June 2020
- Parity 2
- Days in milk: 161
- Herd 35******

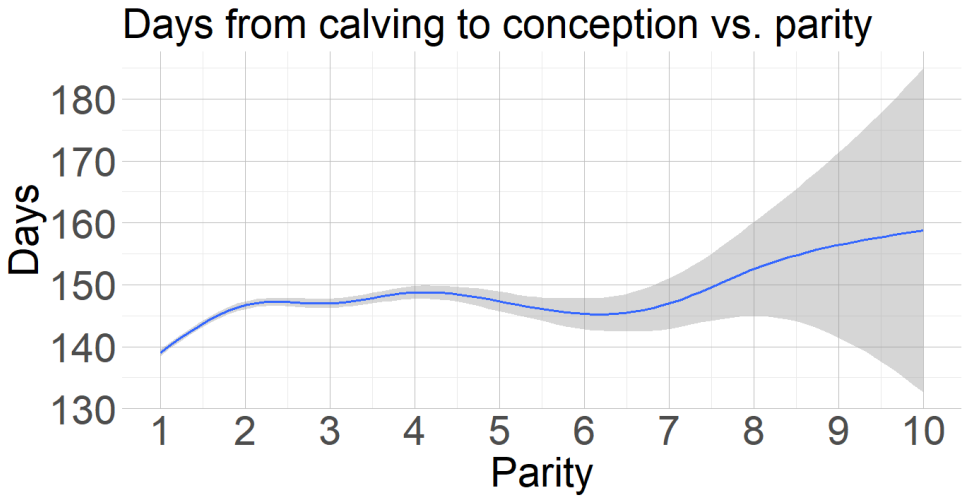
Modeling reproduction

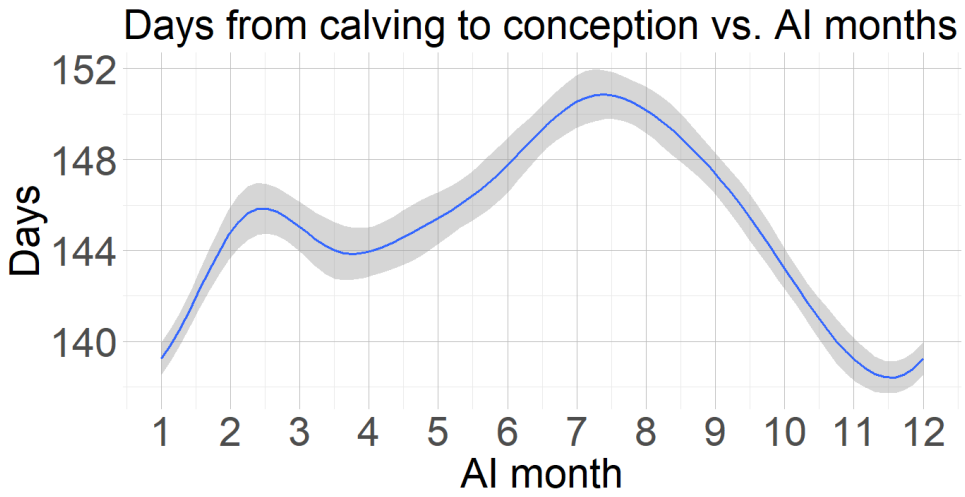
Time from calving to conception = fecundity



Cox, 1972
Klein and Moeschberger, 2003
Wood *et al.*, 2016

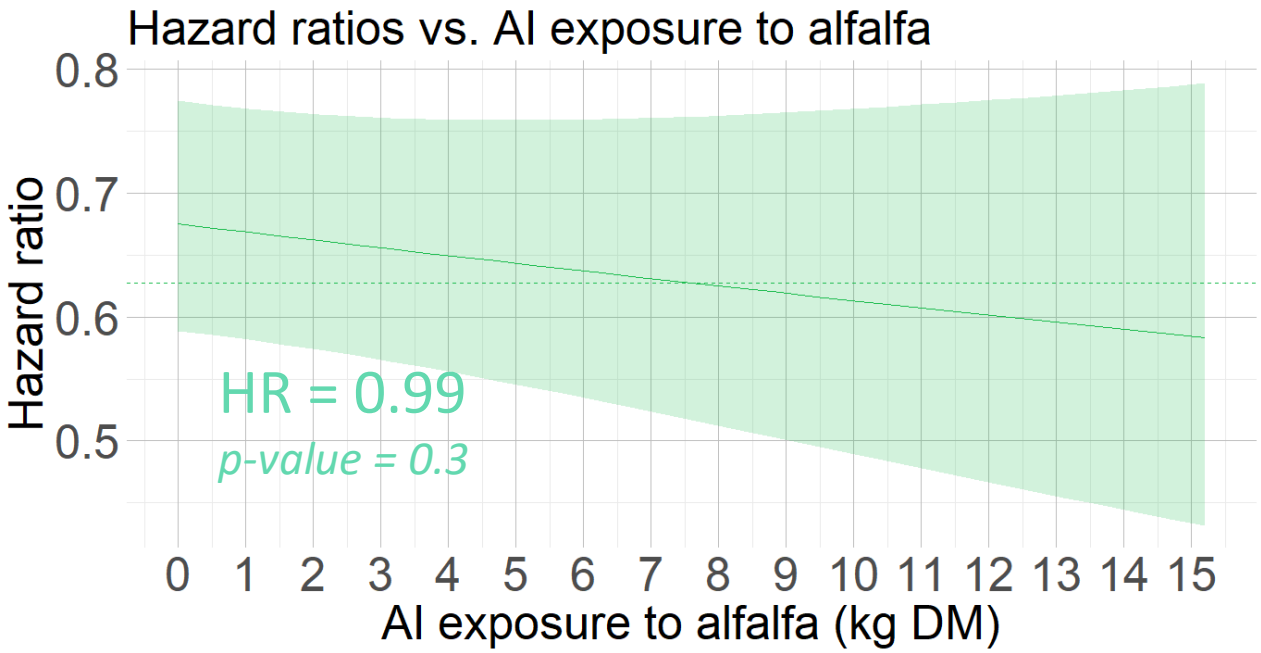
Fit a Cox proportional hazards model to survival data using GAMMs:

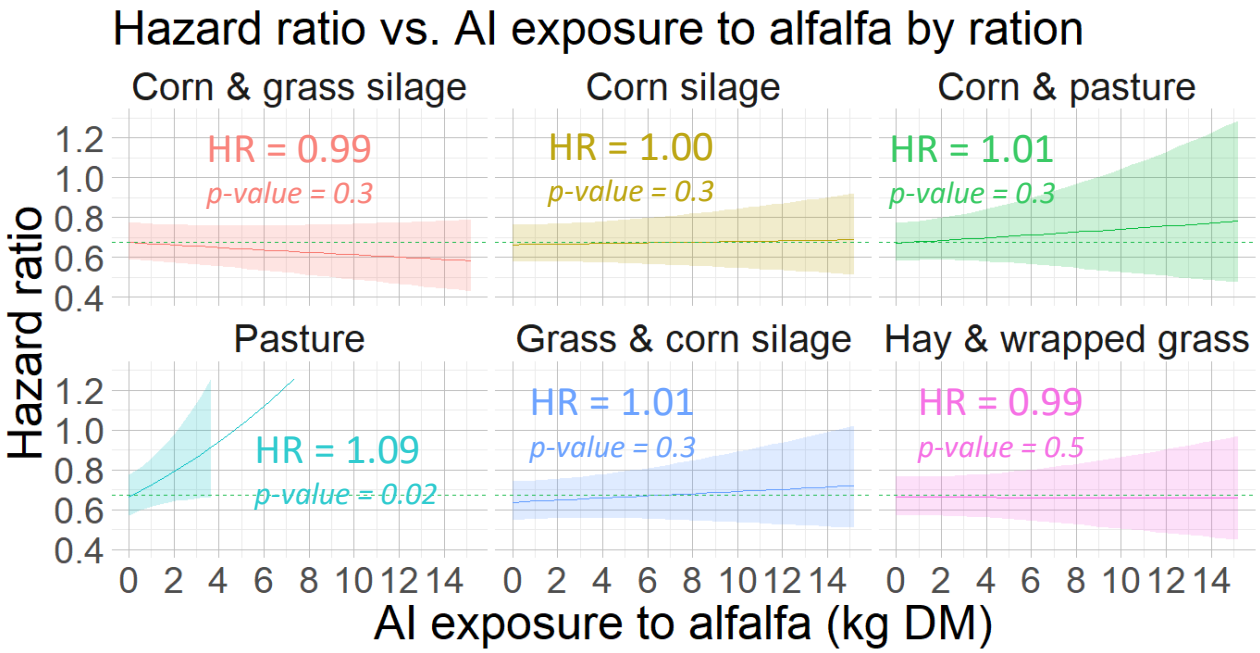




HR = 1 → no effect
HR > 1 → better fecundity
HR < 1 → worst fecundity

Fecundity results





Reference:
- Ration R1
- June 2022
- Parity 1

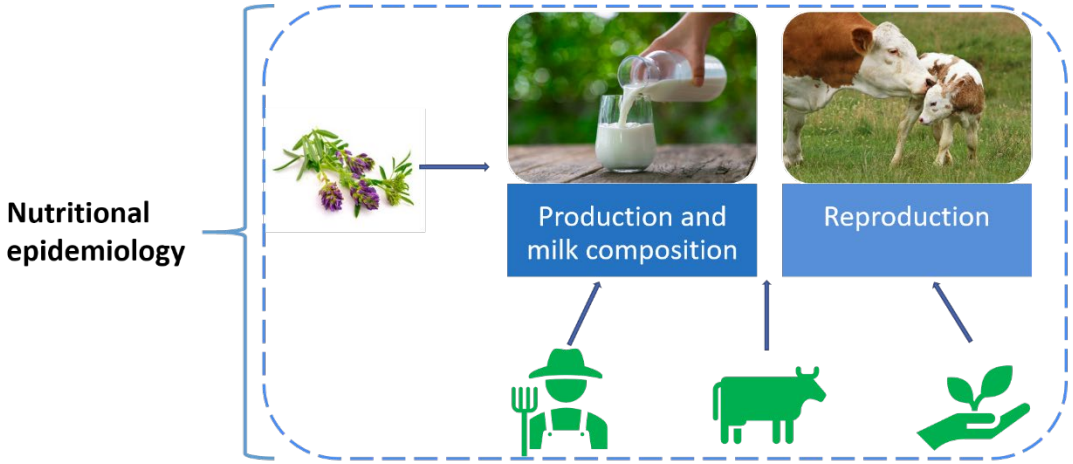
- Max peak milk yield: 34.6 g/kg milk
- Min peak protein: 29.2 g/kg milk
- Herd 35******
- Easy calving

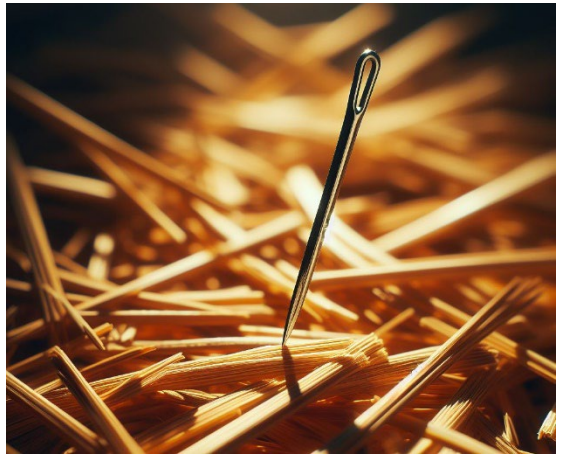
Overall results

	Production			Reproduction		
For every kg of alfalfa	**Daily milk yield** (kg/cow) Ref.: 28.66	**Fat content** (g/kg milk) Ref.: 41.52	**Protein content** (g/kg milk) Ref.: 32.86	**Fecundity** (HR) Ref.: 1.00	**Time from calving to AI1** (HR) Ref.: 1.00	**Probability of return to service** Ref.: 0.29
Alfalfa	0.05 ***	-0.08 ***	-0.03 ***	0.99	1.01	0.50
Alfalfa ↔ Corn & Grass silage	0.00	0.00	0.00	1.00	1.00	0.50
Alfalfa ↔ Corn silage	-0.02	0.00	-0.05 ***	1.01	1.00	0.51
Alfalfa ↔ Corn & Pasture	0.00	0.13 ***	-0.03 ***	1.02	1.01	0.48
Alfalfa ↔ Pasture	-0.05	-0.01	-0.10 ***	1.10 *	1.02	0.49
Alfalfa ↔ Grass & Corn silage	-0.15 ***	0.09 ***	0.00	1.02	1.00	0.51
Alfalfa ↔ Hay & Wrapped grass	0.00	0.03	0.00	1.01	1.00	0.48
	Nitrogen use efficiency?	Dilution effect?	Low energy value?			

Key message and perspective

- Thanks to nutritional epidemiology and a large amount of information gathered in the field, we've (partly) found the needle in the haystack!





- Perspective: health and the environment

Any question?

‘Nutritional epidemiology sheds light on the effects of alfalfa on dairy cow production and reproduction’

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EAAP
European Federation of Animal Science

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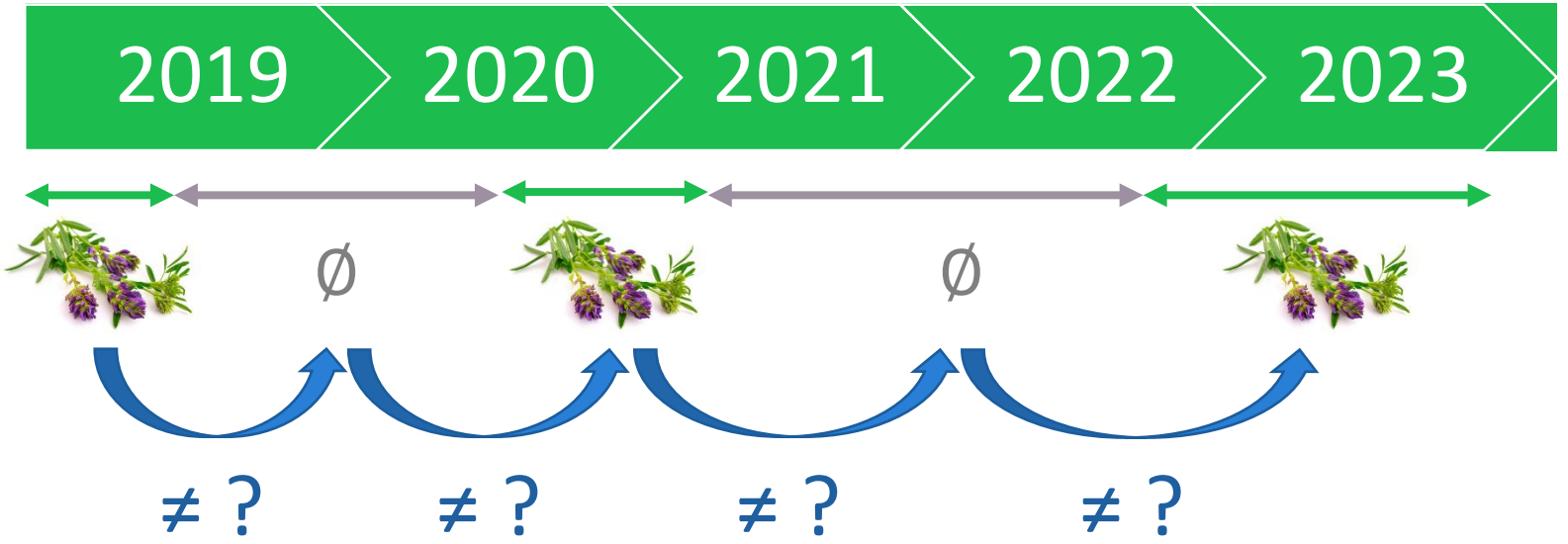
Appendices

Comparing periods of exposure and non exposure for alfalfa users



Alfalfa in feed groups

Other silage

Dry fodder

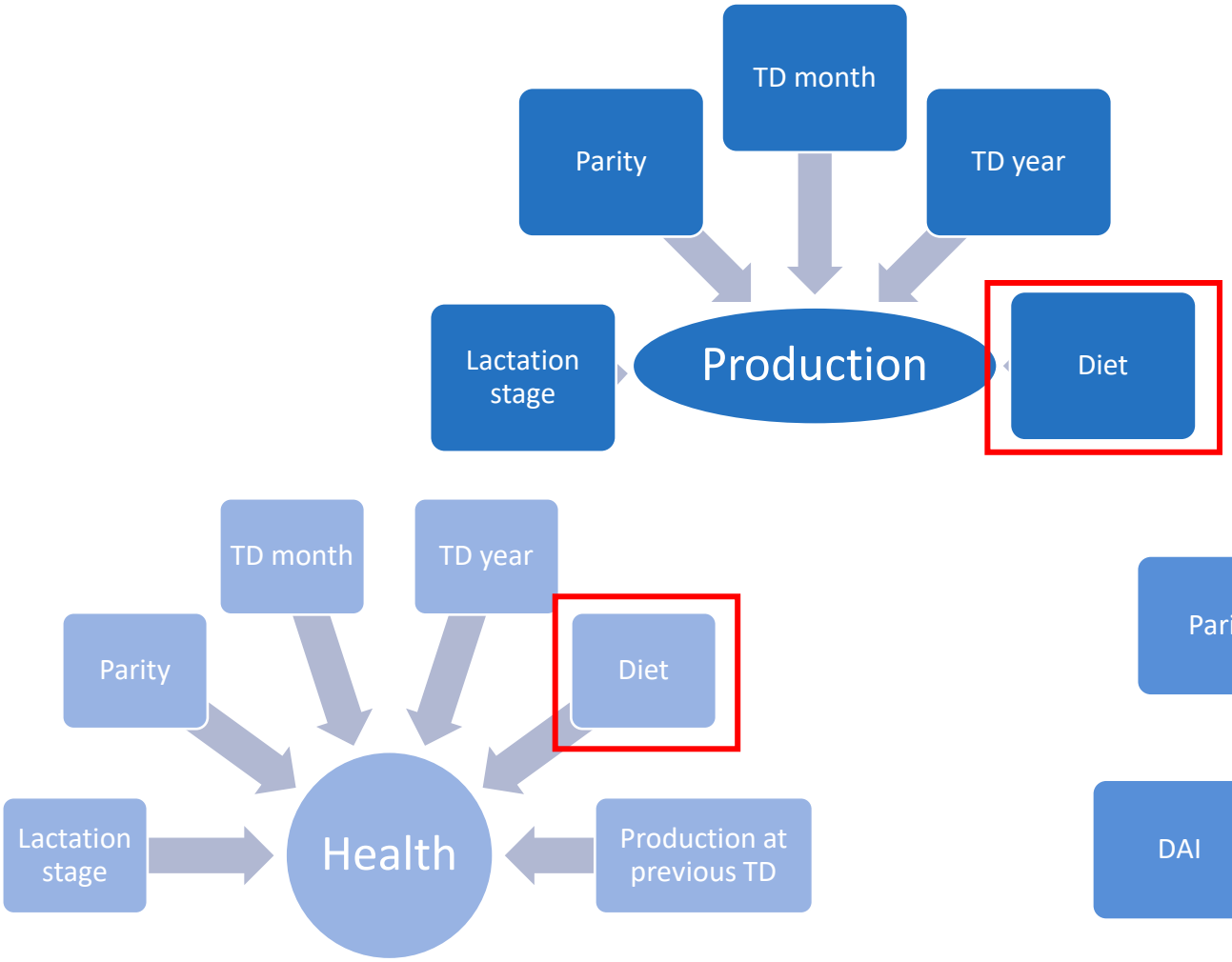
Green fodder

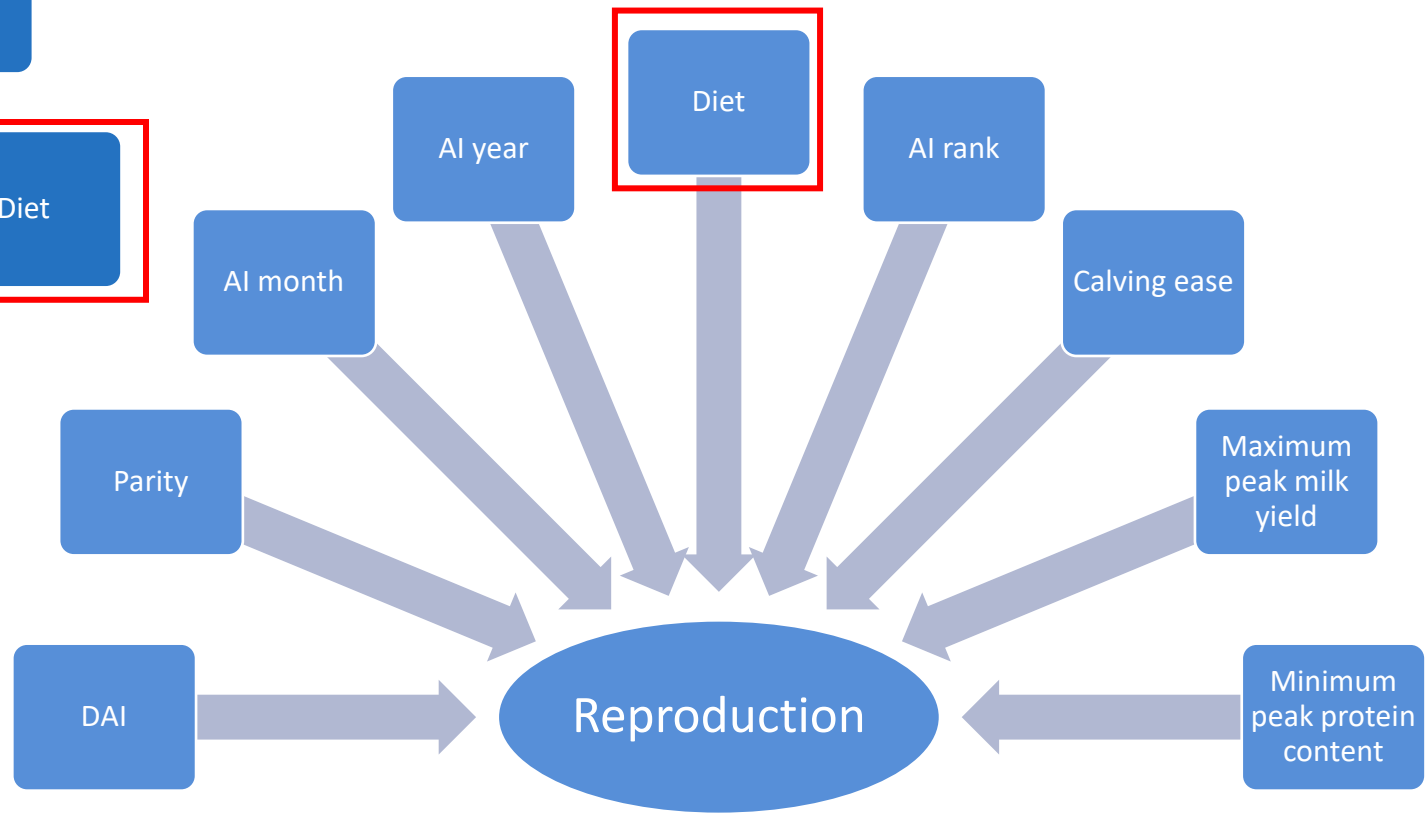
Why alfalfa?

- The most widely grown forage crop worldwide [1]
- High protein and fiber contents [2]
- Mitigates the acidosis risk [3]
- Fixes atmospheric nitrogen, which improves the soil fertility [4]
- Despite a low energy value, still used in dairy cows' diets

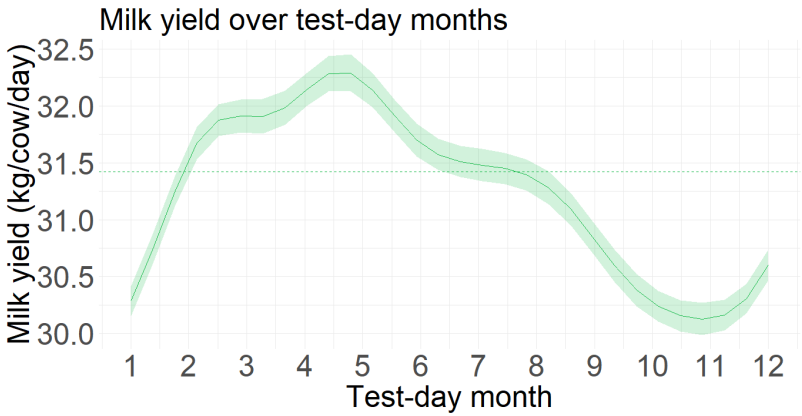
[1] Anthony *et al.*, 2023
[2] Gawel and Grzelak, 2014
[3] Thomson *et al.*, 2018
[4] Issah *et al.*, 2020

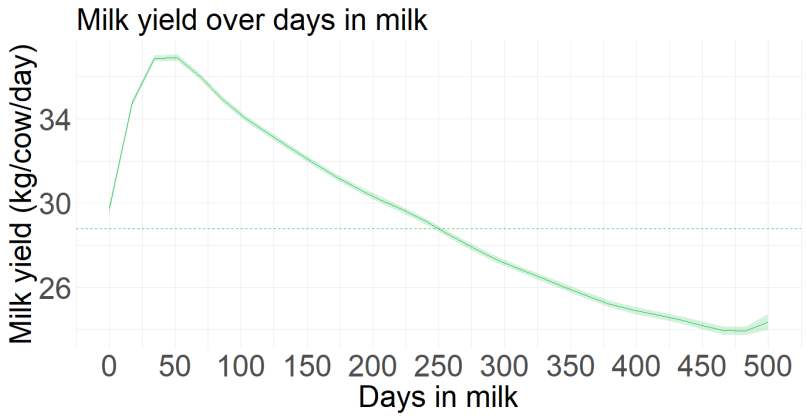
Influence factors

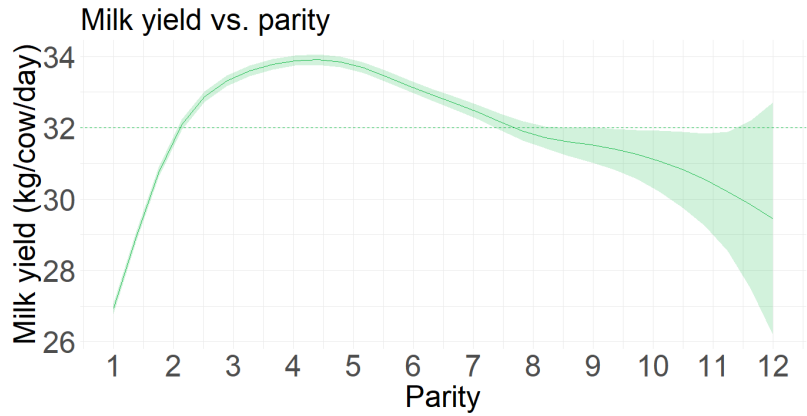


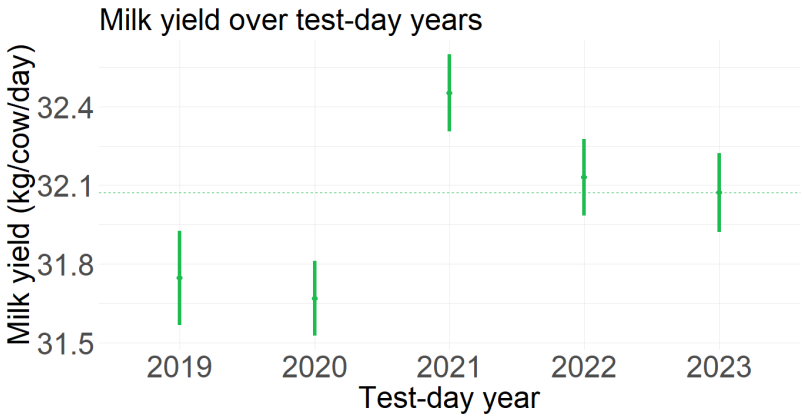


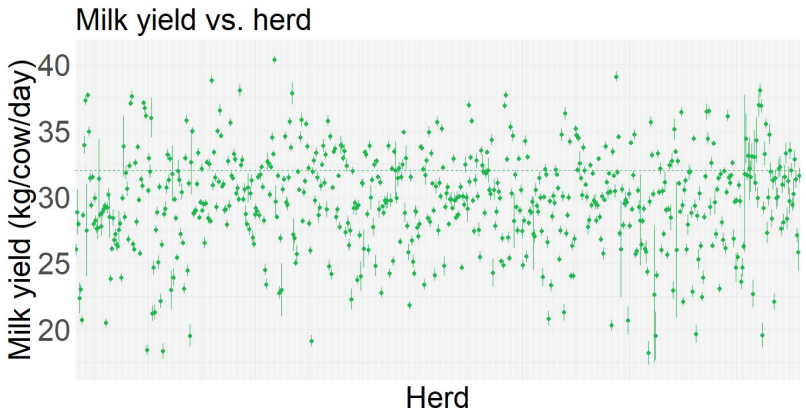
Milk yield results

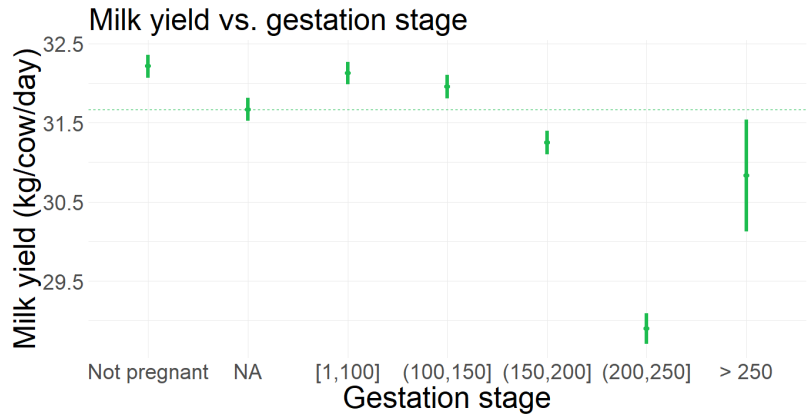












Overall results

p-value: 0 '***' | 0.001 '**' | 0.01 '*' | 0.05 '.' | 0.1 ' '
Reference of clusters: Corn & Grass silage

	Production			Reproduction		
	Daily milk yield (kg/cow/day) Ref.: 28.66	**Fat content (g/kg milk) Ref.: 41.52**	**Protein content (g/kg milk) Ref.: 32.86**	**Fecundity (HR) Ref.: 1.00**	**Time from calving to AI1 (HR) Ref.: 1.00**	**Probability of return to service Ref.: 0.29**
Alfalfa	**0.05** (0.03, 0.08) ***	-0.08 (-0.10, -0.05) ***	-0.03 (-0.04, -0.02) ***	0.99 (0.97, 1.01)	1.01 (0.99, 1.02)	0.50 (0.49, 0.51)
Alfalfa ↔ Corn silage	-0.02 (-0.05, 0.02)	0.00 (-0.03, 0.04)	-0.05 (-0.06, -0.04) ***	1.01 (0.99, 1.04)	1.00 (0.98, 1.01)	0.51 (0.49, 0.51)
Alfalfa ↔ Corn & Pasture	0.00 (-0.05, 0.04)	0.13 (0.08, 0.18) ***	-0.03 (-0.05, -0.01) ***	1.02 (0.99, 1.05)	1.01 (0.98, 1.04)	0.48 (0.45, 0.52)
Alfalfa ↔ Pasture	-0.05 (-0.14, 0.04)	-0.01 (-0.11, 0.09)	-0.10 (-0.14, -0.05) ***	1.10 (1.02, 1.19) *	1.02 (0.95, 1.09)	0.49 (0.44, 0.55)
Alfalfa ↔ Grass & Corn silage	**-0.15** (-0.18, -0.12) ***	0.09 (0.06, 0.13) ***	0.00 (-0.02, 0.02)	1.02 (0.99, 1.05)	1.00 (0.98, 1.02)	0.51 (0,47, 0.54)
Alfalfa ↔ Hay & Wrapped grass	0.00 (-0.04, 0.04)	0.03 (-0.02, 0.07)	0.00 (-0.02, 0.02)	1.01 (0.98, 1.04)	1.00 (0.98, 1.02)	0.48 (0.45, 0.51)
Corn silage	**-0.38** (-0.45, -0.31) ***	-0.16 (-0.24, -0.09) ***	-0.02 (-0.05, 0.01)	0.97 (0.93, 1.01)	0.97 (0.94, 1.00) .	0.50 (0.49, 0.51)
Corn & Pasture	**0.16** (0.04, 0.28) **	-1.0 (-1.1, -0.87) ***	-0.27 (-0.33, -0.21) ***	1.03 (0.95, 1.11)	1.03 (0.96, 1.10)	0.50 (0.49, 0.51)
Pasture	-1.2 (-1.4, -1.1)	-1.2 (-1.4, -0.96) ***	0.00 (-0.11, 0.11)	1.02 (0.87, 1.19)	0.94 (0.83, 1.06)	0.50 (0.47, 0.53)
Grass & Corn silage	**-1.24** (-1.4, -1.1) ***	-0.19 (-0.34, -0.04) *	-0.74 (-0.81, -0.68)	0.87 (0.80, 0.96) **	0.91 (0.85, 0.98) **	0.50 (0.49, 0.51)
Hay & Wrapped grass	**-0.49** (-0.66, -0.32) ***	-0.75 (-0.94, -0.56) ***	-0.54 (-0.62, -0.45) ***	1.01 (0.92, 1.11)	0.97 (0.91, 1.03)	0.51 (0.50, 0.52)