Assessing impacts of new legislation on Dutch dairy farms using a revised linear programming model

A. van der Linden, L.M. Alderkamp, C.W. Klootwijk, G. Holshof, N. Van Eekeren, F. Taube, and C.E. van Middelaar

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Introduction

Improve water quality via new legislation:

1) Abolition of derogation in the Netherlands (2023)

	Derogation	No derogation
Organic N fertilizer (kg ha^{-1} $year^{-1}$)	230 / 250	170
Grassland (% farmland)	≥80%	-
Phosphate fertilizer application	Not allowed	Allowed

2) Additional measures of the 7th Nitrates Action program

Research questions

What are the effects of new legislation on farm structure, economic performance and environmental performance of Dutch dairy farms?

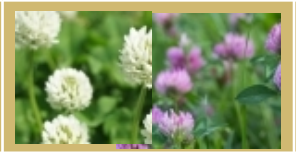
What are the effects of using grass-clover swards on farm structure, economic performance and environmental performance?

Materials & Methods

- Existing linear programming (LP) model (Berentsen and Giessen, 1995; Klootwijk et al., 2016)
- Model revised, written in R
- LP model for a typical Dutch dairy farm on a sandy soil
    - Objective function: maximization of labour income
    - Decision variables: dairy cows, crop cultivation, feed purchase
    - Constraints: labour, land, barn capacity, legislation

Materials & Methods

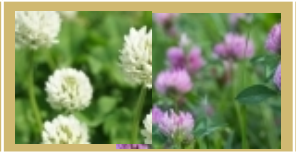
Scenarios for Dutch dairy farms

Scenarios	New legis.				
Reference		✓			✓
New legislat.	✓	✓			✓
G-GRW	✓	✓	✓		✓
G-GRW-GW	✓	✓	✓	✓	✓
GRW-GW	✓		✓	✓	✓

G = perennial ryegrass; GRW = grass + red and white clover; GW = grass + white clover

Results & discussion

Farm structure: number of cows and land use (% total farmland)

Scenarios	# Cows				
Reference	101	80%	-	-	20%
New legislat.	92	68%	-	-	32%

Results & discussion

Protein self-sufficiency (PS) and purchased inputs

Scenarios	PS (%)	Maize silage (t yr^{-1})	Concen-trates (t yr^{-1})	N fertilizer (t yr^{-1})	P_2O_5 fertilizer (t yr^{-1})
Reference	57	127	206	5.9	-
New legislat.	57	-	218	4.6	0.2

Results & discussion

Economic performance

Scenarios	Revenues (k€ yr^{-1})	Variable costs (k€ yr^{-1})	Gross margin (%)	Labour income (k€ yr^{-1})
Reference	396	203	48.8	12.2
New legislation	364	190	47.8	-6.6

Results & discussion

Environmental performance

Scenarios	GHG emissions (g CO_2-eq. kg milk)	N surplus (kg ha^{-1} yr^{-1})	P_2O_5 surplus (kg ha^{-1} yr^{-1})
Reference	805	183	6.9
New legislat.	806	118	2.5

Discussion

- Clover persistence and N-fixation capacity is key for adoption of grass-clover
- Carbon sequestration not taken into account in GHG emissions
- Payment for avoided social costs may be a policy option to compensate dairy farmers

Conclusions

- New legislation: economics ↓ and environment ↓
- Use of grass-clover: economics ↑ and GHG emissions ↓
- Use of grass-clover partly compensates for decreased labour income after implementation of new legislation.
- Adoption of grass-clover swards did not significantly affect social costs

Thank you for your attention!

Contact: aart.vanderlinden@wur.nl
lianne.alderkamp@wur.nl

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