Modelling dairy farming and grazing in the Netherlands: scenarios and results

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Paper prepared for presentation at the EAAE 2014 Congress
'Agri-Food and Rural Innovations for Healthier Societies'

August 26 to 29, 2014
Ljubljana, Slovenia

Abstract

In this paper we analyse the impact of different grazing policies on number of dairy cows in different grazing categories in 2025 by model simulation in the Netherlands. It can be generally concluded that in the absence of intervention there is a strong tendency towards a decline in grazing on Dutch dairy farms. This tendency is not inevitable and it can be counteracted by policies aiming at higher percentages of grazing on dairy farms. External information about differences in costs between alternative and observed grazing technology is used to calibrate the PMP model. This results into a more flexible substitution between alternative technologies.

Keywords: dairy farms, grazing, technology switch, mathematical programming, policies

1. Introduction

Grazing has long been a traditional element of dairy farming in the EU. The World Society for the Protection of Animals (WSPA) is concerned about a decline of grazing in the EU, particularly because of consequences for animal welfare. They commissioned a study carried out by the Agricultural Economics Research Institute (LEI) in the Hague (Reijs et al., 2013). Reijs et al. (2013) show that in different countries different trajectories on grazing of dairy cows are being developed. In Denmark and North-West Germany, for example, grazing gets comparatively little attention and seems to be disappearing. In Ireland and parts of the UK grazing is getting a lot of positive attention and appears developing. These trajectories are based on the (economic) circumstances but seem to build on existing trends. Though there are quite some efforts on stimulation of grazing going on in the Netherlands, it is still difficult to predict whether the Dutch will go towards the British or the Danish trajectory.

The objective of this paper is to study in more detail developments in grazing in the Netherlands under different scenarios towards 2025. More precisely the goals of this paper are: a) study developments in milk production and number of dairy cows per grazing category under a standard scenario for 2025 in the Netherlands. This builds on literature search and statistics. b) study the impact of different measures to stimulate grazing in the Dutch dairy sector in 2025.

For this purpose we use the Dutch Regionalised Agricultural Model (DRAM) (Helming, 2005). DRAM provides a detailed description of the Dutch agricultural sector and especially the Dutch dairy sector. For the purpose of this paper, different types of dairy farms with different grazing regimes are distinguished. A general description of DRAM and some technical details and assumptions can be found in paragraph 2. Paragraph 3 describes the current situation in the dairy sector in the Netherlands. In paragraph 4 the situation for 2025 is projected based on a scenario where policies remain unaltered. Paragraph 5 explains in more detail the modelling of the trade-off between grazing and no-grazing in DRAM and model calibration. A specific application of the PMP approach will be presented where the shadow value of the first phase production constraint is split into a component that shows the opportunity costs of alternative technologies (or extra costs to switch from one technology to the other) and a remaining part. The former is used to calibrate a linear opportunity cost function per activity while the latter is included as a constant cost per activity in the objective function. Paragraph 6 explores the effects of four different policy options and scenarios on grazing towards 2025 on the structure of the Dutch dairy sector and grazing. Paragraph 7 presents discussion and conclusions.

2. General description of DRAM

The Dutch Regionalised Agricultural Model gives a full representation of the regional agricultural sector in the Netherlands in terms of number of agricultural activities (arable and roughage crops, dairy cows, beef cattle and intensive livestock activities) and corresponding production and income possibilities (Helming, 2005). The dairy sector in DRAM distinguishes eight types of dairy cows (or dairy cow activities) per region that represent eight types or groups of dairy farms per region. Input of DRAM consists of prices and quantities of inputs and outputs per activity. Output of DRAM is mainly the allocation of land over the different activities, the number of activities and the corresponding agricultural output (e.g. number of dairy cows per type and total milk production). In the initial situation it is assumed that for all inputs and outputs marginal revenue equals marginal costs and prices and quantities are in equilibrium. Changes in the output of DRAM after a change in input data of DRAM, is steered by profit maximising behaviour of the agricultural producers. The change in the allocation of land over the different activities in DRAM is dampened by upward sloping marginal costs curves per activity; marginal costs per activity (e.g. a certain type of dairy cow) increases if the total number of activities increases and marginal costs per activity decreases if the number of activities decreases. Levels of inputs and outputs of DRAM will change until marginal revenue is again equal to marginal costs. Prices of inputs and outputs are fixed in DRAM. However, for this study we have adjusted the model to account for endogenous prices of milk and animal manure. In an iterative process, it is assumed that the milk price decreases with 1% if the production increases with 2.5%.

The upward sloping marginal cost curves per activity consist of a constant part (part of marginal cost that is independent of the number of activities) and a linear part (part of marginal cost that increases with the increase of the number of activities). The linear part will be discussed below. The constant part includes costs of purchased concentrates and remaining costs. Roughage, fertiliser and land quantities per activity per unity are constant as well. Prices of land, roughage and animal manure are modelled as shadow prices given by the corresponding balances. The regional roughage (grass and fodder maize) balances equal yield per hectare per activity times hectares with grass demand, including net-export.[1] The regional land balance produces a shadow price of land that can be translated into market prices. Prices of roughage and animal manure are endogenous as long as these intermediates are produced and consumed nationally. Import and export prices of roughage and animal manure are exogenous.

3. Current situation in the Dutch dairy sector – Baseline

The dairy sector as characterised in DRAM distinguishes eight types of dairy cows (or dairy technologies) per region, representing eight types or groups of dairy farms per region. Agricultural Census data of 2011 (CBS, 2012) are used to include all dairy cows in the Netherlands. Shares found in FADN are used as the key to distribute the total number of dairy cows to the different types in DRAM. Technical economic variables per cow per type are based on individual farm data from the Dutch Farm Accountancy Data Network (FADN), accounting year 2010. Note, that DRAM does not calculate number of farms of a certain type, but number of cows per type.

[1] Net-exports also includes grass demand of activities not included in DRAM (horses, sheep, etc.)

In this study 'grazing time in May-October' (hours milking cows spend grazing outdoors in these months) is used as the criteria to define eight types of farms. For the purpose of a clear presentation the eight categories are combined to four different grazing regimes:

- Full or intensive grazing: milking cows graze more than 1220 hours in May-October (consisting of four cow types in DRAM).
- Restricted grazing: milking cows graze between 720 and 1220 hours in May-October (consisting of two cow types in DRAM).
- Very restricted grazing: milking cows graze between 220 and 720 hours in May-October (consisting of one cow type in DRAM).
- No grazing: milking cows graze less than 220 hours in May-October (consisting of one cow type in DRAM).

The boundary of 720 grazing hours corresponds to 120 days per year and six hours grazing per day (Convenant Weidegang), which qualifies for a premium top-up on the milk price in our grazing scenarios (see paragraph 6). Table 1 shows some selected data used in DRAM for the baseline 2010/2011.

Table 1. Characteristics of the Dutch Dairy sector in the DRAM baseline (2010/2011)

	Full or Intensive grazing	**Restricted grazing**	**Very restricted grazing**	**No grazing**	Total dairy sector
Milk per cow (*1,000 kg)	7.7	8.2	8.6	8.7	8.2
Dairy cows per ha (# cows per ha)	1.5	1.8	1.8	1.9	1.7
Milk per hectare (*1,000 kg)	11.3	14.3	15.2	16.0	13.5
Cows per farm (# milking cows)	70	89	80	108	84
Total Milk Production (*1,000 tonnes)	4142	3282	1043	3526	11993
No. of cows (*1,000)	540	402	122	406	1469
Grassland and forage crops (*1,000 ha)	367	230	69	220	885
Grazing time in May-Oct (hours)	2591	1037	518	18	1282
Gross Margin per cow	2264	2397	2368	2431	2355
Gross Margin per 100 kg of milk	29.5	29.3	27.6	28.0	28.7
Source: FADN, Agricultural census, processed by LEI Wageningen UR.					

Table 1 shows that the category no grazing is characterised by relatively high milk production per cow and per ha. The number of dairy cows per farm is also above the national average. In general grazing farms are smaller than non-grazing farms but this does not mean that grazing does not exist at large farms. On average cows are grazing for 1,282 hours which means that the average cow is grazing during 29.2% of the hours in the period May - October. The total milk production of 12m tonnes is relatively equally distributed over the categories no grazing (3.5m tonnes), restricted grazing (4.3m tonnes in two groups) and intensive grazing (4.1m tonnes). Roughly two-thirds of the cows ((540 + 402)/1469) graze more than 720 hours.[2]

[2] 720 hours corresponds to at least six hours during 120 days which is the definition of grazing according to the Dutch Convenant Weidegang.

4. Standard scenario 2025

The standard scenario 2025 assumes a development of the dairy industry in the absence of public or private policies or measures to support grazing such as industry premiums for grazing, technological innovations, knowledge development, CAP reforms and campaigns of NGOs. We assume an average increase in milk production per dairy cow from 0.75% per year, independently of region or type of dairy cow. Total milk production in the Netherlands is assumed to increase from about 12m tonnes in 2010/2011 in DRAM to about 13.3m tonnes in the projection year 2025. This corresponds to the findings in Berkhout et al. (2011). Average milk production per cow per year increases from about 8,200 kg in 2010/2011 to about 9,400 kg per year in the standard scenario 2025. Average milk production per hectare increases from about 13.5 tonnes in 2010/2011 to about 16.6 in 2025. Average number of dairy cows per ha per farm increases from about 1.7 to 1.8. Average gross margin per dairy cow decreases by around 6% from about €2,355 per cow in the baseline 2010/2011 to about €2,216 per cow in the standard scenario 2025. The decreases in gross margin are the result of a large increase in the direct costs compared to the revenues. The average total direct variable costs increase with about 43% compared to the baseline. This is especially due to increased costs of concentrates. Revenues from milk sales increase only slightly. This increase, experienced by all farm types, is due to increased milk production per cow rather than driven by higher milk prices or premiums. Following Berkhout et al. (2011), we have assumed that the nominal increase in the milk price from 2010/2011 to 2025 is very limited. Furthermore, revenues from CAP premium decrease strongly due to the introduction of the national flat rate of €350 per ha by 2025.

The standard scenario for 2025 assumes a relatively large increase in total milk production and number of dairy cows in the categories no-grazing and very restricted grazing. This is the result of our assumption that the development in farm expansion will continue with 50% of the rate observed in 2005-2010 (Reijs et al., 2013). In this standard scenario the number of dairy cows in the category no grazing increases from about 406 thousand cows in 2010/2011 to about 730 thousand cows in 2025. This increase in the number of cows results in an increase in the share in total milk production of the category no-grazing from about 29% in the baseline 2010/2011 to 53% in the standard scenario 2025 (Table 2).

Table 2. Development of share in milk production and number of dairy cows in the Dutch dairy sector in the standard scenario 2025 compared to the baseline 2010/2011

	Scenario	**Full or intensive Grazing**	**Restricted grazing**	**Very restricted grazing**	**No grazing**	Total dairy sector
% of milk	Baseline 2010/2011	35%	27%	9%	29%	100%
	Standard scenario 2025	9%	22%	16%	53%	100%
	Difference	-75%	-19%	+84%	+81%	0%
No. of cows (*1,000)	Baseline 2010/2011	540	402	122	406	1469
	Standard scenario 2025	135	323	223	731	1412
	Difference	-405	-79	+101	+325	-57
Source: FADN, Agricultural census, processed by LEI Wageningen UR.						

Average grazing time in May-Oct in the Netherlands decrease from 1282 hours in the baseline 2010/2011 to 575 hours in the standard scenario for 2025. When the current grazing definition of Stichting Weidegang is used, the percentage of grazing cows will drop from 64.1% to 32.6%. These structural developments are in agreement with current literature and data showing a strong and gradual decrease of the percentage of farms where grazing (according to the definition of Stichting Weidegang) is applied from 78% in 2007 to 66% in 2011 (Reijs et al., 2013). Moreover, it also concurs with research among farmers indicating that farmers expect grazing will further decrease and that by 2016 about 45 % of the dairy cows will be kept in no-grazing farms (Keuper et al., 2011).

5. Modelling the trade-off between grazing and no grazing in DRAM and model calibration

Data

In this section we present data and methodology to model the trade-off between technologies per cow type in DRAM. The focus is on the switch from no grazing or limited grazing to a technology with grazing. Evers et al. (2008) use a detailed budget model of Dutch dairy farms (BBPR) for an economic comparison between grazing and no grazing technologies. The budget model contains different sub modules for feeding the cows and grassland yields. Results show that in general farmer's income will be higher when grazing is applied, instead of no grazing. It is found that 'without difficult circumstances', the income of farms with 15,000 kg of milk/ha that apply grazing is €0.50 to €2.00 higher per 100 kg of milk than for farms of the same intensity that stall their cows. The profit for grazing, as compared to no-grazing, is at 20,000 kg of milk/ha €0.00 to €1.75/100 kg of milk (Evers et al., 2008). Figure 1 shows that even with automatic milking systems grazing is often more profitable compared to no grazing. This also holds for large herds and high milk yield per dairy cow. Only in the case of a low percentage of grassland that can be grazed, no grazing is more profitable compared to grazing. In this case the profit for no grazing equals about €0.5/100 kg of milk.

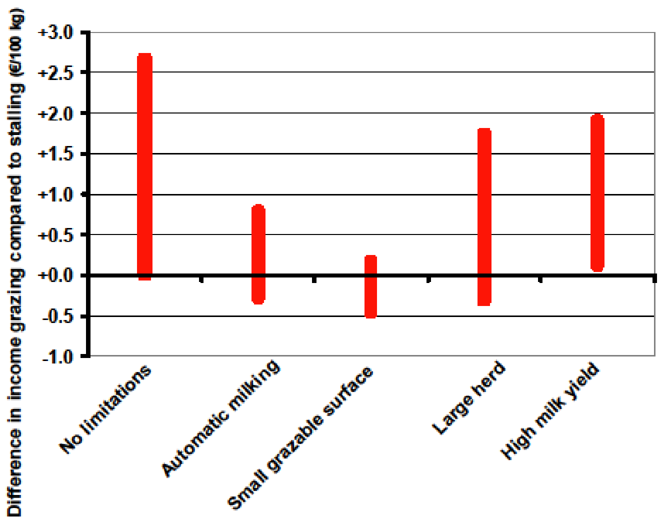

Figure 1: Difference in income between grazing and no grazing in difficult circumstances summarised. Amounts in € per 100 kg milk. A positive figure indicates that income is higher with grazing than with no-grazing. Source:Evers et al., 2008

Table 3 distinguishes between farm income under observed technology and alternative technology per grazing category in DRAM. As the alternative technology for the categories "no grazing" and "restricted grazing 5-16.7%" is considered a technology that qualifies for the grazing premium from the dairy industry. That is farm management and technology with grazing around but above 16.7%, corresponding to 120 day and 6 hours grazing per day (Convenant Weidegang). The alternative technology for the remaining categories is a technology with less or no-grazing. For all types of dairy cows it is assumed that the farm income corresponding to the observed technology exceed farm income under, what is considered here as the alternative technology. So the costs to switch from the observed technology to the alternative technology is positive.

Table 3. Assumptions on family farm income under observed technology and alternative technology (€/100 kg of milk)

Grazing system	**Farm category (% of time grazing in summer)**	**Observed technology**	**Alternative technology**	Difference
No grazing	0-5	*0.3*	-0.9	1.2
Restricted grazing	5-16.7	*2.9*	2.2	0.7
	16.7-25	*3.4*	2.9	0.5
	25-28	*4.7*	2.9	1.9
Full or intensive grazing	>28%	*5.3*	1.3	4
Source: FADN, own assumptions				

Following indications found in Evers et al. (2008), we assume a difference in farm income of €1,2 per 100 kg of milk in favour of the observed technology for cow type "no-grazing". For cow type "Restricted grazing 5-16.7%" this should be less, as less management and technology changes are required to switch to the alternative technology. The above tendency also works for the remaining categories; the difference in farm income between the observed technology (restricted or full grazing) and alternative technology (less or no grazing) increases again as the average percentage grazing increases and more management and investments are required to switch to the alternative technology.

Model calibration: standard PMP approach

To reproduce the observed situation[3] and to overcome the problem of specialisation (100% switch from one technology to the other) under simulation in our mathematical programming model, the approach of Positive Mathematical Programming is used (Howitt, 1995). This enables calibration of the model to observed situation and continuous and flexible adjustment during simulation. In doing so, marginal costs are written as a linear function of the number of dairy cows per type per region:

$$MC_{tr}=\alpha_{tr}+\beta_{tr}x_{tr} \qquad (1)$$

Where MC_{tr} is the marginal costs per type of dairy cow (t) per region (r) (€/cow), x_{tr} is the number of dairy cows per group per region and α and β are group and region specific coefficients to be calculated. The calculation of the coefficients of equation (1) is based on initial marginal costs and number of dairy cows per type and a given elasticity between marginal costs and the number of dairy cows per type. Marginal costs include a so-called PMP term which is obtained from the first step of the PMP, namely solving a constrained optimisation model (Howitt, 1995).

[3] In case of 2025 this is the projected or assumed structure e.g. number of dairy cows per category.

Model calibration: opportunity costs (technology switch costs)

The standard PMP approach treats different technologies for the same output as separate activities. This hampers substitution among technologies and different solutions are proposed to solve this problem (Cortignani and Severini, 2011; Röhm and Dabbert, 2003). The basic idea of the these authors is that the elasticity of substitution is expected to be higher between technologies producing the same output. Röhm and Dabbert (2003) include extra constraints such that the slope of the marginal cost function of the individual variants decreases. In this paper the extra constraints are replaced by external information about the costs of the alternative technology in comparison to the observed technology.

To find the coefficients of equation (1) we use the opportunity costs per type of dairy cow per region (read: difference between alternative technology and observed technology) as presented in table 3. These differences are assumed constant in real terms for 2025. Moreover, an elasticity between opportunity costs and number of dairy cows per type equal to 1 is assumed for all types of dairy cows and regions. Next, to reproduce the observed situation with respect to number of dairy cows per type per region, the opportunity costs per type of dairy cow per region are subtracted from the PMP term. Equation (1) is included as a quadratic cost function in the objective function of DRAM. While the remaining part of the PMP term is included as constant remaining costs in the objective function of DRAM.

The model outcomes are driven by the assumption that farmers maximise their gross margin. If the extra revenue from the grazing scenario exceeds the extra costs to comply with the scenario restrictions, the farmer will switch to grazing. During simulation of e.g. a grazing premium from the dairy industry conditional on the percentage grazing, the following will occur. For cow types above 16.7% grazing, the MR or opportunity costs will increase. More farmers will choose for grazing and the number of dairy cows in the category above 16.7% grazing will increase (see figure 2).

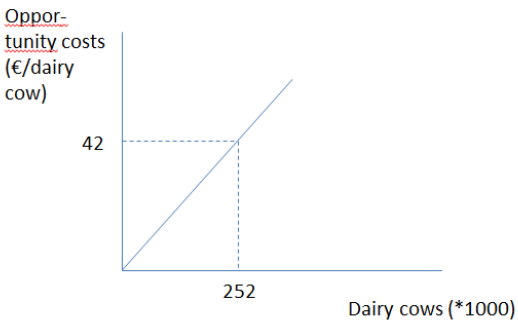

Figure 2: Relationship between opportunity costs and number of dairy cows for category 16.7% and 25%

6. Different grazing scenarios towards 2025: description and results

The different scenarios that will be analysed are presented in Figure 3. They reflect the introduction of various public and private policies and measures to support grazing.

Scenario	Interpretation
Grazing premium Dairy Industry	Top up on the milk price of €0.01 per kg for dairy cows in the categories more than 720 grazing hours
Grazing as greening condition CAP	Decrease in flat rate per ha in categories less than 720

	grazing hours of €100/ha
Innovative grazing management	Increase in grassland yields with 2.5% in category restricted grazing and 5% in category full grazing. Unchanged grassland yield in category no-grazing
Combination of all regimes	All three measures mentioned above combined

Figure 3. Definition of 4 different scenarios on grazing regimes

Results

Grazing premium

The grazing premium is the single measure which results in the largest changes in the sector. To comply with the conditions for the grazing premium, farmers in the categories no grazing and very restricted grazing need to adjust their farm management and switch to the categories restricted, intensive or full grazing. Rather limited farm management changes are necessary to switch from very restricted to restricted grazing. Figure 4 shows the effect on the share in total milk production per category. The share in total milk production of category restricted grazing increases with 68%. This corresponds to an increase of about 218,000 cows. Since the largest increases will occur in the restricted grazing group, the increase in average grazing time will however be limited, namely from 575 hours in the standard scenario to 712 hours in 2025 under the scenario with a grazing premium, see table 4.

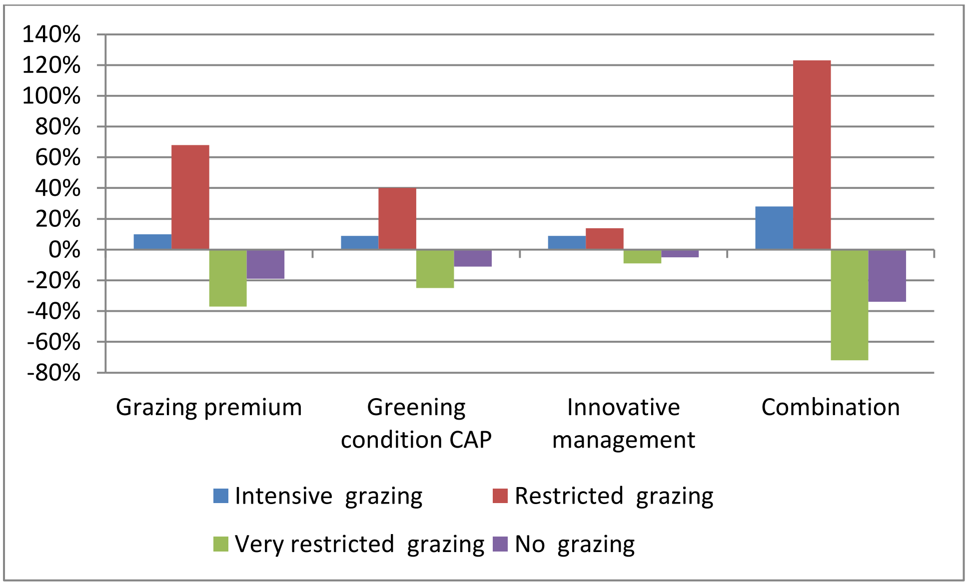

Figure 4. Development of share in milk production under different grazing scenarios in 2025. Percentage difference with standard scenario in 2025.

Grazing as a greening condition in CAP

The scenario that supports grazing as greening condition for the CAP works in the same direction as the grazing premium albeit the changes are smaller in magnitude. Again the largest changes are modelled in the categories very restricted grazing (decrease in milk production and number of dairy cows) and restricted grazing (increase in milk production and number of dairy cows). As a result, the share of milk production and number of dairy cows in the category restricted grazing increases with respectively 40% and 39%, while the share of milk production and number of dairy cows decreases with about 25% in the category very restricted grazing. Table 4 shows that the average grazing time in 2025 equals 663 hours compared to 575 hours in the standard scenario.

Innovative grazing management

The scenario with innovative grazing management also affects the number of dairy cows and the milk production in the different categories. The share in milk production decrease with about 5% in the category no-grazing and about 9% in the category very restricted grazing (figure 4). This corresponds to a total decrease in the number of dairy cows in these categories of about 53,000 cows. At the same time the number of dairy cows in the other categories increases. As before, this is especially the case in the category restricted grazing. The average grazing time in this scenario increases only limited in this scenario compared to the standard scenario (from 575 to 619 hours), see table 4.

Combination

All measures combined result in the largest impact in the milk production shares (and number of dairy cows) in the different categories. Changes in milk production shares (figure 4) correspond to decreases in the number of dairy cows in the categories no-grazing and very restricted grazing with 255,000 cows and 160,000 cows respectively, while the number of dairy cows in the category restricted grazing increases with about 384,000 cows.

Table 4	Characteristics of Dutch dairy sector in 2025 under different grazing scenarios. Percentages are percentage difference with standard projection in 2025				
Characteristic of Dutch Dairy sector in 2025	Projections 2025				
	Standard scenario	Grazing premium	Greening CAP	Innovation	Combination
Total Milk Production	13,250	13,318	13,007	13,259	13,119
(*1,000 tonnes)		0.50%	-1.80%	0.10%	-1.00%
No. of cows	1,412	1,429	1,392	1,416	1,417
(*1,000)		1.20%	-1.40%	0.30%	0.30%
Grassland and forage crops	799	813	791	804	811
(*1,000 ha)		1.70%	-1.10%	0.50%	1.50%
Grazing time in May-Oct (hours)	575	712	663	619	848
Hours		+24%	+15%	+8%	+47%
Gross Margin	2,216	2,250	2,205	2,225	2,278
(euro per cow)		1.50%	-0.50%	0.40%	2.80%
Source: Model Calculations with DRAM, LEI Wageningen UR.					

Overall effects

Table 4 shows impacts of the different grazing scenarios on average characteristics of the Dutch dairy sector. With exception of the greening condition, the tendency is that the number of cows and total milk production will increase slightly under the different scenarios. All scenarios lead to lower average milk production per cow, number of dairy cows per ha and milk production per hectare. The grazing scenarios have a beneficial effect on the average gross margin of the whole sector but with all measures combined the effect is limited to less than 3% (Table 4). Per grazing category the effect of the different scenarios on gross margin are however very different and this also has structural effects. A grazing premium on top of the milk price increases gross margin per cow with 3.5% at dairy farms with full or intensive grazing, while it is decreased with 0.8% on dairy farms with no-grazing. As the share of small farms is relatively large in the category full or intensive grazing, the grazing premium will have a positive impact on continuation of small farms.

The percentage of cows in the Netherlands that graze (according to the definition of the Convenant Weidegang) decreases from roughly two-thirds (64%) in the initial situation (2011) to one-third (32%) in 2025 in the situation where policies remain unaltered. When policies are introduced to stimulate grazing the predicted percentage of milking cows that graze in 2025 increases from 32 to 48% (grazing premium), 42% (grazing as a greening condition in CAP), 36% (innovative grazing management). With a combination of all three policies the percentage of milking cows that graze is predicted at 62% in 2025, which is almost equal to the initial situation (2011). The difference is that the share of dairy cows in the category full or intensive grazing is much larger in the initial situation (baseline 2010/2011). This also explains why average grazing time in 2025 with all measures combined (848 hours) is much lower than in the initial situation (1,282 hours).

7. discussion and conclusion

The model predicts that the percentage of cows in the Netherlands that graze (according to the definition of the Convenant Weidegang) decreases from roughly two-thirds (64%) in the initial situation (2011) to one-third (32%) in 2025 in the situation where policies remain unaltered. When policies are introduced to stimulate grazing the predicted percentage of milking cows that graze in 2025 increases to 36-48%. However, the model results suggest that only a combination of measures and a large effort in the stimulation of grazing can maintain grazing at the current level in the Netherlands.

The DRAM model is based on economic optimisation. The model is driven by the assumption that farmers want to maximise their income. Farm management and grazing regime is adjusted accordingly. The strength of this approach is that it creates an opportunity to make projections of future trends under different scenarios/assumptions. There are, however, a number of reasons why this approach also has limitations:

- Future trends are difficult to predict, especially in the current situation with changing legal frameworks (milk quota, CAP, nitrate directive action plans).
- Farmers' decisions are based on more than economic optimisation. It is, for instance, known that personal values and preferences also play a role in choosing for grazing or no grazing (Evers et al., 2008).
- Economic relations of the past might change in the future. For instance the fact that intensive grazing is currently mainly applied on the small farms in the Netherlands, might alter in the future as improved technologies and strategies allow for better grazing on large farms.
- Variation between farms within a farm type might be larger than the variation between farm types. Reijs et al (2013) showed that variation in the economic performance between different grazing clusters are large. As the model aggregates all dairy farms into eight groups, the full variation in economic and technical variables is not accounted for and this can give biased results.
- The PMP approach to model technology switch could also be applied to other assessments. Opportunity costs to model technology switch are however difficult to assess.

The result of this modelling study should be regarded as an illustration of the future development of grazing under different scenarios, rather than a prediction of the absolute outcome level. The interpretation of the results should be focused at the differences between the scenarios and the direction of the changes compared to the initial situation. The real percentage of grazing in 2025 in the Netherlands will depend on a large number of factors that are very difficult to predict. Besides stimulation by policies, knowledge development and technological innovation, the creation of a positive image on grazing amongst farmers and other stakeholders in the dairy sector will have an important influence.

In this paper we analysed the impact of different grazing policies on milk production and number of dairy cows in different grazing categories in 2025 by model simulation. It can be generally concluded that in the absence of intervention there is a strong tendency towards a decline in grazing on Dutch dairy farms (from two-thirds of the cows currently to one-third in 2025). This tendency is not inevitable and it can be counteracted by private and public policies aiming at higher percentages of grazing on dairy farms. Some of these measures are already being introduced in the Netherlands.

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